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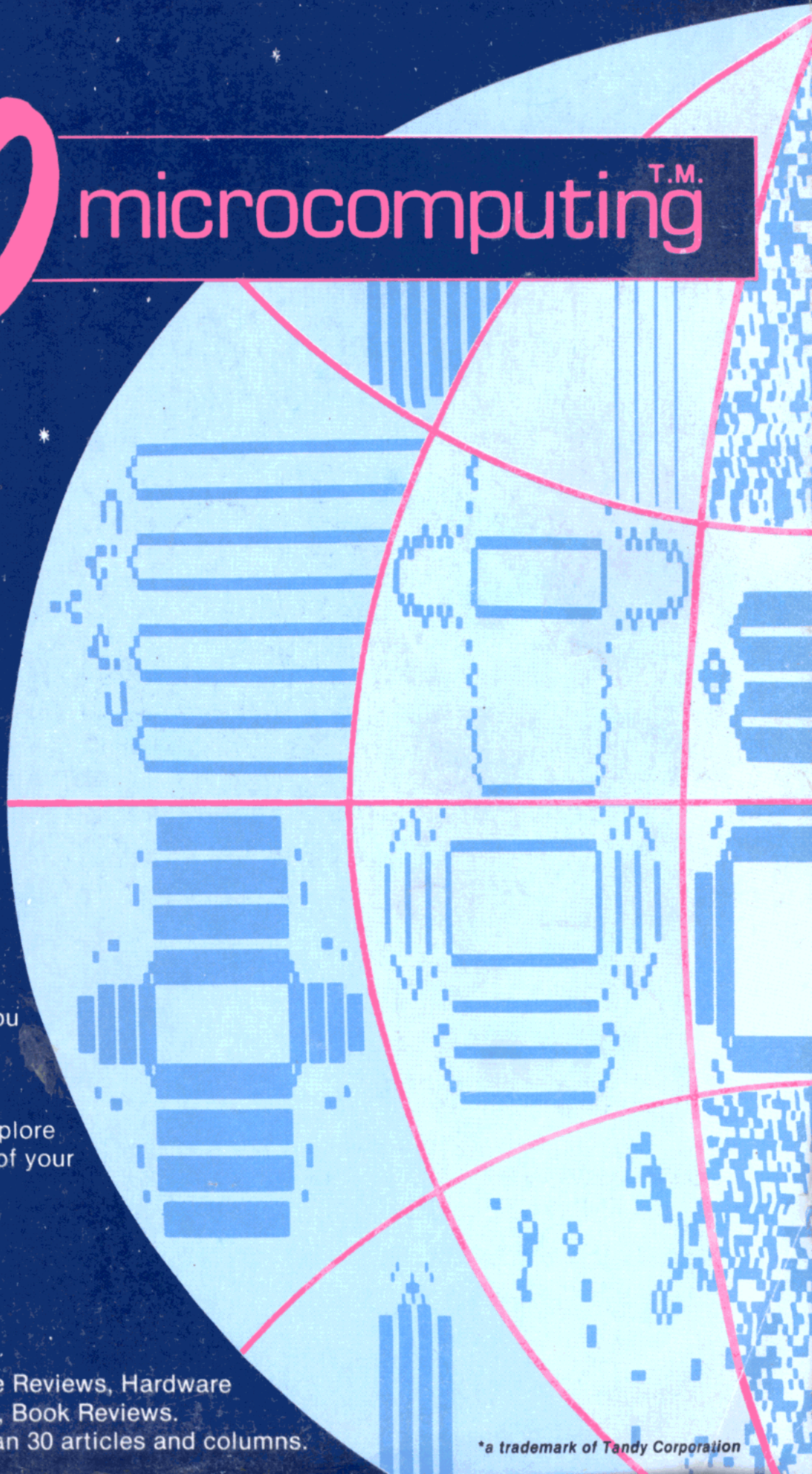
THE MAGAZINE FOR TRS-80* USERS

80 microcomputing T.M.



LIFE: Play the Game Pg. 38

Inside Level I: Learn how to better utilize its commands. **Pg. 96.**

Testing 1, 2, 3: Interface your 80 with test equipment. **Pg. 136.**

Computer Trainer: Helps you understand Assembly Language. **Pg. 118.**

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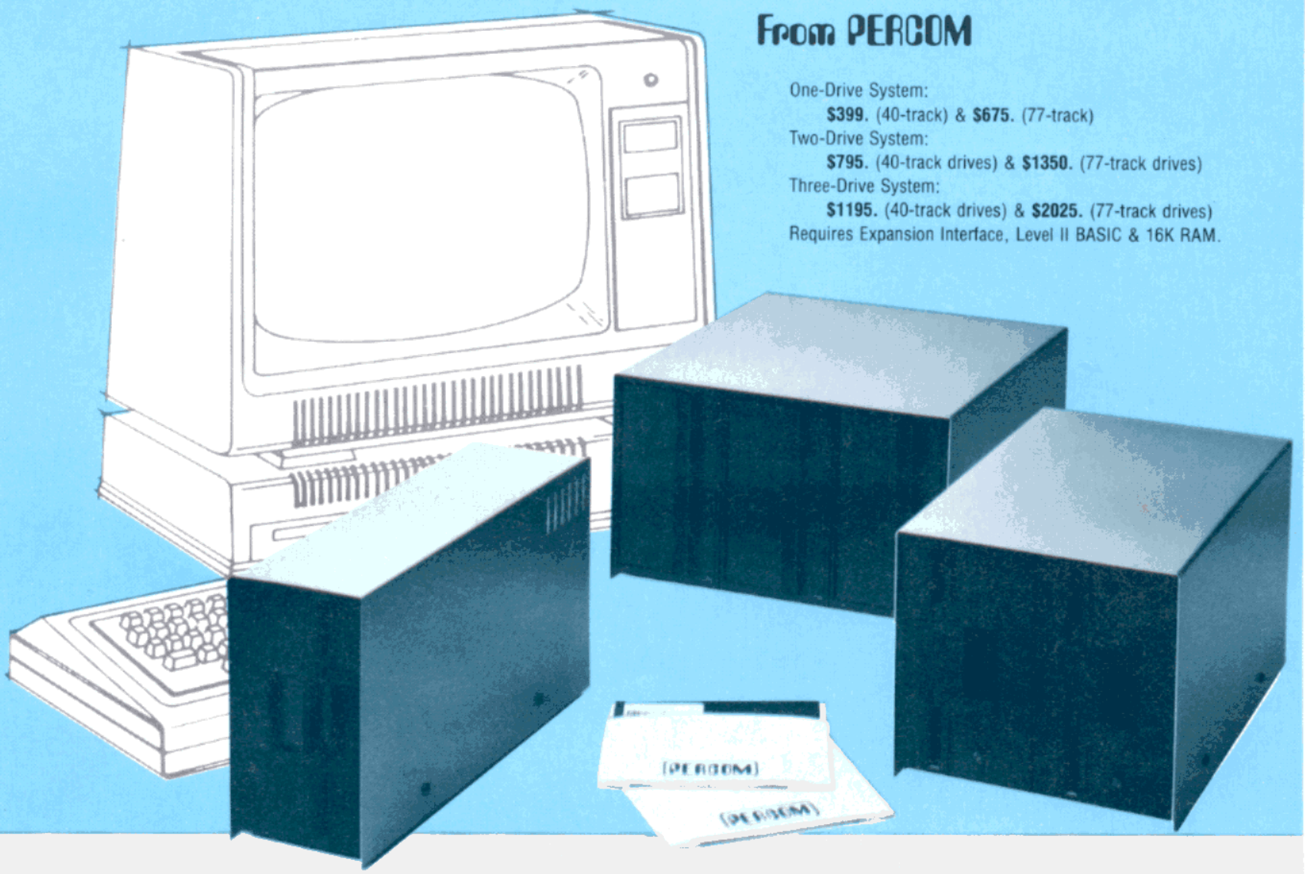

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June 1980 Issue #6

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- CHARACTER-type fields may be any length (total: up to 254 characters).
- NUMERIC-type fields feature automatic formatting, rounding, decimal alignment and validation.
- Full feature EDITING when adding or changing records:
  - ENTER FIELD (can't type-in more characters than specified).
  - BACKSPACE (delete last character typed).
  - DELETE FIELD contents.
  - RESTORE FIELD contents.
  - RIGHT-JUSTIFY FIELD contents.
  - SKIP FIELD (to next or previous field).
  - SKIP RECORD (to next or previous record).
- SORTING of records is MACHINE CODE assisted.
  - 200 RECORDS (40 characters) in about 5 SECONDS.
  - ANY COMBINATION of fields (including numerics) with each field in ascending or descending order.
- SELECTION of records for Loading, Updating, Deleting, Printing and Saving is MACHINE CODE assisted.
  - Specify up to 4 CRITERIA, each using one of 6 RELATIONAL COMPARISONS.
  - LOAD or SAVE selected records using MULTIPLE FILES.
  - Example: Select records representing those people who live in the state of Colorado, but not in the city of Denver, whose last names begin with "F" and whose incomes exceed $9000.00.
  - Example: Select records representing those sales made to XYZ COMPANY that exceed $25.00, between the dates 03/15 and 04/10.

MAPS-III (MTC AIDS PRINT SUBSYSTEM), included at no charge, has the following features:

- Full AIDS-III SELECTION capabilities.
- Prints user-specified fields DOWN THE PAGE.
- Prints user-specified fields in titled, columnar REPORT FORMAT, automatically generating column headings, paging and (optionally) indentation.
- Can create a single report from MULTIPLE FILES.
- Prints user-defined formats for CUSTOM LABELS, custom forms, etc.

BELOW ARE TESTIMONIALS from owners of AIDS systems. These are absolutely authentic statements and are typical of the comments we receive.

"This program will do more for my business than all the other programs I have, combined."
David Wareham, Vice President (EDP), National Hospital and Health Care Services Inc.

"We have 32 different Data Base Management packages for the TRS-80. AIDS-III is easily the best. It also makes it easier for us to step up to our Model II since the package is available for both computers."
Jack Bilinski, President, 80 Microcomputer Services

"Your AIDS program is far and away the finest information management system that I've ever seen. I am currently using it to maintain a clear picture of the demographic data on all the kids in our residential treatment program and it is working for me superbly."
Frank Boehm, Director, Front Door Residential Treatment Program

- COMPATIBLE with AIDS-II data files and AIDS subsystems.
- Move up from AIDS-II and EXPAND to 20 field capability WITHOUT REENTERING DATA.
- AIDS-II (Model I or II) owners may UPGRADE FOR ONLY $25.00.

*WARNING! This program is written in BASIC and can be listed in the normal manner. Modification of program code is NOT RECOMMENDED due to its extreme complexity.

MTC AIDS-II

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MTC AIDS-II $49.95
For Model II $79.95

CALCULATION SUBSYSTEM (CALCS)

Use for report generation involving basic manipulation of numeric data, such as quantity & cost computations, balances carried forward and columnar totals. Expands capabilities with respect to inventory, accounting and other numeric-based information systems.

MTC CALCS $24.95
For Model II $39.95

MAILING/INFORMATION LIST SUBSYSTEM (MAILS)

Use for report & label generation involving formatting of primarily non-numeric data, such as custom, "N-up" and "N-copy" label forms, index-type report formatting, and trimmed field capabilities for selection & print. Expands AIDS-II with respect to client/product reference systems, mailing lists and other non-numeric information systems.

MTC MAILS $24.95
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RECORD/FILE ORGANIZATION EXECUTIVE (REFORGE)

Use for expanding, contracting or reformatting AIDS-II files. Convert random & sequential files to AIDS-II format. Use for converting mailing lists to AIDS-II. Includes MERGE & PURGE capabilities for combining smaller files into larger ones and removing duplicate records.

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Frustrated because PEEK and POKE have been removed from Model II BASIC?. Satisfy your curiosity with PEEK&POKE from MTC. Included are 8-bit and 16-bit (LSB, MSB) self-relocating machine language routines, instructions, and demo program.

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Custom Cable only $19.95

Suitable for use with Radio Shack* transfer program(ACT 0131)

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For Model II $29.95
Includes MTC QUE Card!

Having trouble with RANDOM FILES? With MTC's Table-Driven Access Method (TDAM) you'll never fret over FIELDing again. No knowledge of random access files is required. Insert the TDAM "interpreter" into any BASIC program and type in a few DATA statements describing the information in your files. TDAM does the rest! Reads and writes fields and records of any type (even compresses a DATE field into 3 bytes!). Features automatic file buffer allocation/deallocation, memory buffering, sub-record blocking/deblocking, and handles up to 255 fields per record. Super fast and super simple! Complete with TDAM interpreter, instructions and demo program.

DIVERGE $19.95
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REBUILD $19.95
For Model II $29.95

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SHRINK $19.95
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Makes Every Byte Count!. Make programs smaller and faster! Combines lines & removes unnecessary code including remarks, without altering program operation. Typically reduces program size 25% to 40%.

SUPERSEDE $19.95
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A "must have" for the professional programmer or the serious amateur. Probably one of the greatest time-savers available. Write programs in shorthand - change variable names - generate program documentation - use with REBUILD and MINGLE to build new programs from old ones.

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80 REMARKS

by Wayne Green

"As the size of the magazine increases, so does the postage involved in sending it to the subscribers."

My editorial on electronic mail brought quite a bit of response. To my knowledge there are at least three firms designing Electronic Mail Boxes (EMB), a unit that will plug into both your computer and your telephone.

Some questions have been raised about my proposal. First, I suggested EMB's use 1200 baud because I felt the currently used 300 baud was far too slow. It should be possible to connect and transfer a one page message all within one minute . . . and that requires at least 1200 baud.

Suggests 9600

A letter from Art Brothers, who runs a small phone company out in Utah, suggests we think in faster terms. He claims that it is possible to jam 9600 baud over a phone line using compression and expansion techniques. Undoubtedly a lot of you readers are far more experienced with this than I, so we need some articles on the subject. A 9600 baud system which would work over any conceivable phone connection over long distance lines with 100 percent transfer of a message would be wonderful. If this is even remotely possible, we should work for it right now and not be forced to change standards in a year or two.

We also need to establish protocols for signaling over the lines. Then, we need a handshake protocol to initiate the transfer of the message and a protocol to assure that the message has been received 100 percent error free. We can use error correcting codes for this to some advantage, but we will still need a system for checking the received copy . . . and acknowledging it's receipt.

One suggestion is that the EMB automatically forward a received message, if desired. Perhaps we could get a dump of waiting messages from any remote terminal. Even if the first systems do not have these features, I think they will be along soon enough.

Received messages will have to be stored on tape or disk automatically, so that the system will be ready for the next message. And the software must be flexible enough that you can be writing messages to be sent at the same time as the system is receiving one.

Would we want a duplex switch on the system for immediate two-way communications similar to a Telex? Why not? A special signal might indicate that the recipient of the message is on the line for immediate answer.

The software should include a word processor so we can write our messages on the tube and edit them. It does not have to have all of the sophistication of a full fledged word processor, complete with paragraph movers and key word finders. If it does just a little better than a Teletype machine, it will be fine for this.

If there is enough interest in this, I will be glad to organize a symposium for individuals and firms interested in exchanging information so that we may standardize protocols. I think that between *80 Microcomputing* and *Kilobaud Microcomputing* I may have enough clout to make sure that the best system becomes a standard.

I believe that Radio Shack will be selling on the order of half a million computers this year and I will be disappointed if at least 75 percent of those buyers do not get an EMB to go with their system.

Research Done

In order to get this project moving, we first have to do the research and development. This means that the ball is in the air. Most of the technical development has been done and the results published in one or more magazines.

Cover Photos

Would you like the prestige of getting a photo on the *80 Microcomputing* cover?

Subject? Generally we like to have some photo which shows the TRS-80—either model —in use . . . hopefully with some interested people around.

Submissions will do best if they are larger than 35mm. We prefer the 6×7 cm or larger format, so we will have clear and sharp cover pictures.

Photographers should keep their eyes open for interesting applications of the Tandy computer system. Radio Shack stores are not exempt from the competition and a credit line on the photo will not hurt business one bit.

Oh, I almost forgot . . . we pay up to $100 for cover photos.

The Price Goes Up

When a publisher starts a new magazine, it is always a gamble. Of course I try to keep the gamble to a minimum by knowing my trade better than most people. I've gotten rather good at starting new magazines and having them succeed, right from the first issue. In 1975 it was *Byte*, in 1977 it was *Kilobaud Microcomputing* and now, *80*.

As the size of the magazine increases, so does the postage involved in sending it to the subscribers or in shipping copies to the newsstands. That is why cover prices and subscription prices tend to go up. Of course inflation makes matters even worse. In order to be sure that *80* got a good start I set the cover price and subscription rate much lower than normal for a technical magazine of its quality. There are several higher priced magazines with a lot less interesting material on the market.

Starting with the July issue the cover price of *80* will be $2.50 and the subscription rate within the U.S. will be $18 per year. A three year subscription is currently only $40. This will be going up to $45 with the July issue.

If you follow the normal pattern of procrastination, you'll do me a big favor and pay the higher price. In order to "save money" you'll buy at the one year rate and we'll do even better. I expect the cover price to go up again, possibly by the end of this year, to $2.95, with the subscription rate going to $25 for one year and $53 for three years. Why not wait and see for yourself?

See You in Hong Kong

You have always wanted to go to Asia, but you just haven't had the proper push to get you going. I'm pushing . . . so get out your checkbook and enjoy the ride.

Last fall I went on an IEEE sponsored tour of the Far East and had a fantastic time. The tour is running again and you'll want to come along and see Asia. it will be from October 2–22nd and the cost is just over $2,000 each, a wonderful bargain. That includes all plane fares, buses, hotels, banquets and sightseeing trips.

Quite a few microcomputer addicts and industry people make this trip, so it will be much more fun than going with undertakers or pipefitters. The trip coincides with consumer electronic shows in Tokyo, Taipei, Seoul and Hong Kong. Unless you are made of sterner stuff, you will find yourself getting enthused over importing some of the electronic and computer equipment that smaller Asian firms are making.

Or you may want to take advantage of the low cost production facilities for some product you are making or would like to make.

We'll plan on getting together with the president of the Hong Kong TRS-80 club, which had over 300 members last year. We'll also visit Akihabara in Tokyo, a section of town with hundreds of electronic stores.

If you're interested, drop me a line and ask for further information. I think we'll try for two tables of computerists—that's about 24 of us—so don't procrastinate. The address is: Asia Tour, c/o *80 Microcomputing*, Peterborough, NH 03458 ■


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80 INPUT

"The hate is generated by virtually everything Tandy does, and . . . doesn't do."

Past Lives

I want you to know how much I appreciated "The Mind Works Much Like a Computer" (Feb. *80*). I "flashed" on your suggestion that " . . . the human brain's *storage medium* is both infinite and permanent", with " . . . *of course*!" Somehow I just know that and don't know how.

An area which fascinates me is consciousness, although a computer could probably duplicate much of our decision, thought and analysis process, what would it take to make the computer *conscious* of its thoughts, decisions and analyses?

Thank you also for *80 Microcomputing*—truly tremendous! I've already placed several orders and contemplate several more. Thank you for your contribution to my life.

Leo Horowitz
San Diego CA

My feeling is that computers will not attain consciousness, no matter their complexity. Of course, we really don't know what consciousness is. We can try to define it as an awareness . . . or, in the case of people, an awareness of awareness, but this really doesn't help us to understand what it is and how it happened.

With the concept of consciousness we are getting into country where scientists are ill at ease. When we observe the actions of individual cells in our body, there is activity which seems to indicate some sort of cellular consciousness. Each of these cells is made up of a large number of replicating molecules, and, yet, each cell has a life of its own and an apparent consciousness.

When we go to the next order of abstraction we find that just as the molecules which made up the cells took on a life and consciousness of the unit, so do the cells which make up our bodies take on a consciousness of the unit. Of course it is unlikely that the cells, though they exhibit consciousness, are aware of the consciousness of the whole body.

Now getting back to our unconscious computer system. I might draw a parallel with a person, who has consciousness, and a library of information, which does not. Adding memory to a computer is akin, as I see it, to adding volumes to a library. Adding more computational circuits would speed the access to the information, but somewhere that spark of life is missing. We don't have any good explanation from religion either—other than attributing the whole thing to God. I'll buy that . . . at least until we get a better understanding of the matter.—Wayne.

Tandy Love—Hate

Since your observations are shared by others, I thought the readers of 80 Microcomputing *might be interested in your letter to Mr. Kornfeld. One can hope that Radio Shack will embark on a project to take customer problems to heart and work toward eliminating them in the future. Shall we drink to that idyllic world? —Wayne.*

Mr. Lew Kornfeld, President
Radio Shack
Fort Worth, Texas

Dear Mr. Kornfeld:

Owning a TRS-80 projects one into a Love-Hate relationship with his machine and with Radio Shack, which is unaffected by my ownership of one share of Tandy stock obtained in the good old days when we shareholders received a ten percent discount.

The love is generated by the wondrous little machine you have placed on my desk.

The hate is generated by virtually everything Tandy does, and what is left over is generated by things which Tandy doesn't do.

I started out small and put my office on the Level I cassette payroll. It was fair, but it was a nuisance to have to calculate the New Jersey state tax by hand each week for each employee, with a computer staring me in the face and doing the much more difficult job of calculating the Federal tax. A plea to Fort Worth for help? Dumb or arrogant answers, and certainly no help. For example, "We can't be expected to provided fifty different programs!" (Why not, you sell the TRS-80 in fifty different states without warning the purchasers that the program won't run automatically?) Why not set up state taxes like the Federal, with data lines to be changed by the user each year as rates changed? No reason, just indifference. Why not make documentation available so that the user could easily modify the program to his needs?

Yesterday, ready to move into the world of disks and printers, I made an appointment for a word processor demonstration at the East Hanover, New Jersey Computer Center. The appointment was made two days in advance, and I asked for assurance that a skilled operator of the system would be available to demonstrate it (having been previously advised by this center to call first for this demonstration). So, I left my practice for the morning, drove forty-five minutes, arrived at the appointed hour, and was pleasantly seated at the machine by a chain-smoking store manager, who was able to load the diskette, call up "SCRIPSIT/LC" and list "HIPPO/LC", and then sat helplessly before the screen, manual in hand, unable to demonstrate even a single editing function. The demonstrator had gone out to install a system!

I have purchased a number of excellent programs, all from other sources; REMODEL, PROLOAD, T-SHORT, LEVEL I IN LEVEL II, Z-CHESS, DUNJONQUEST and a package of programs from TBS. All of these have been excellent, and have enhanced my use and enjoyment of the computer.

Radio Shack sells inferior programs, gives terrible software support, provides an 800 "hot-line" which is almost always busy, and which has never been able to answer my relatively simple and unsophisticated questions, has sales personnel who usually know less about the computer than anyone who has finished the second page of the excellent Level I manual (what on earth went wrong with the Level II manual?), and puts on media blitzes advertising products that will not be available for months (how many Daisy Wheel printers have made it to the stores yet?).

The TRS-80 has been made into a huge success in spite of Tandy, and due to the efforts of such as Wayne Green and his *Kilobaud* and *80 Microcomputing* publications, and by companies such as Racet, Microsoft, Apparat, Houston Micro-Computer Technologies, and others who have supported your system with good programs, good peripherals, good articles, good fixes for your problems, sympathy, understanding, a willingness and an ability to help their customers, and, in point of fact, provide what Radio Shack should, but can't or won't provide.

They deserve your encouragement and support. Three TRS-80's have been purchased by friends and associates of mine, seeing my enthusiasm. Had it not been for the availability of outside support, that enthusiasm would not have existed, and those three individuals would not have become customers. Multiply that by the number of units out, and you will perhaps become appreciative of the need for continuing support of those who support you.

Robert A. Goldstone, M.D., P.A.
Paterson, NJ

Disk Primer Update

Having just received the March issue and noticing Mr. Kenderdine's comments on my article, "A Disk Primer," I thought I should put a quick note in the mail.

In as much as I dislike letters that begin "In Response . . . ," let me say that I agree with Jim a full 50 percent.

CMD"T and CMD"R work well on BASIC tapes, but system tapes, designed for the typical Level II, 16K configuration, as most are, load either over, under but almost always through DOS, forcing a reboot.

Perhaps I should have said " . . . Level II *SYSTEM* tapes are not compatible . . . "; it's just a quirk of mine that mentally blocks the fact that there are tapes in BASIC, since the bulk of them are games and I have a strong aversion to spending $4000+ for a toy to play games on.

As for the deletion of DOS programs to free disk space, yes, again he is correct, but the article was meant to be a *Primer*. When I first got my drive, I could hardly wait to start using it, but my Expansion Interface kept crashing, I lost a few files and routinely ran the FORMAT/BACKUP pair. Later on, with DOS 2.3, I used the check-out procedures (TEST1/TEST2) just after booting. And BASICR is something I find difficult to live without.

The point is, with *one* drive, inserting, extracting, inserting, extracting, ad nauseam, *is* fatiguing, especially after a six or seven hour session at the machine. I can see deleting the TAPEDISK/CMD and the 3/BAS utilities, but I think that brings storage space up to about 48 or 49K. I have nothing against being creative, but a valid and viable disk-based TRS-80 *must*, in my opinion, have two drives. It took me 3 months to come to that conclusion, after which I had to scrape and spend a long time waiting for it.

I think my DOS-mate, Mr. Kenderdine, will find this out as he goes along the Disk route. I do thank him for the compliment, and for piping out some more information, since that is the essence of learning. Without personal interaction, CRT might still stand for Crummy Rock Tablet.

Bill O'Brien
NYC, NY

Illegal Victory

Soon after receiving the March issue of your magazine, I approached my machine's keyboard and entered in William Lopez's Hexpawn game, making slight modifications so that it would run on my Level II machine. Then, after this long typing session, I started the program running. At first all went well—I first used the example given in the article, then strange things began to happen. I won the first round, as was expected, and also the second round, but from then on no matter what move I opened with, it conceded the game!

I listed out the program again, and found no error this time on my part. I thought maybe it was my machine, and so I checked its RAM with a memory tester, but found nothing. Once again I ran the program, only to have it cheat time and again (like putting captured men back on the board and moving diagonally to empty spaces.

I've gone over my work twice since then, and can find no flaw. Was there maybe a misprint (or an omission) from the magazine text? I pray some heartly soul can find what is causing such unsportsmanship in my machine.

Joseph Teller
Waltham, MA

Squot's Travels

I enjoyed the article/program "Ball Box" by James D. Lewis in *80 Microcomputing*, April 1980. I modified the listing to enable me to run the simulation on my Level II system without any problem (POINT(X,Y) returns –1, if the point is set).

In the process of enhancing the mini-universe, I have discovered a heretofore unreported phenomenon which other Level II users might also want to investigate. I have designated this effect "Space Wrinkle" (SPRINKLE). It may be observed by inserting the following line in the Level II version of the program (sorry Level I users):

```
5125 IF INKEY$<>""THEN IF RND(2) = 1 THEN A = - A
     ELSE B = - B
```

Once the modified program is running and the Squot starts its travels, the SPRINKLE may be observed by depressing any keyboard key. The investigator will notice a certain degree of control which he now has over Squot's travels. This control may be invoked benevolently (i.e., to help the unfortunate creature to find the food) or merely as an experimental tool (i.e., "Will Squot ever find that neat slide, if I don't help?").

I also believe that line 5001 contains an error for both Level I and Level II versions. It should read:

```
5001 Y = RND(48 - 4) + 2
```

Jim Cardell
Bethlehem, PA

Problem Winker

In response to the Winking Cursor article on page 68 of the January 1980 issue, I submit the following observations:

I had been working on a program for some time and had a requirement for a "Winking Cursor". My approach was somewhat more lengthy then Mr. Lovy's. Needless to say I was impressed and decided to utilize his approach. After a few short tests, I discovered something was amiss.

The first problem was that on second and subsequent string entries FI$ equals all characters that have been input. The solution for this is to null FI$ upon each call to the subroutine. (Example 1 line 1002.)

The second problem occurred when I attempted to utilize the LEN($) statement to test string length upon return from the subroutine, after inputting a string including one or more backspaces. It seems that our friend FI$ keeps track of not only wanted characters but also every backspace intended to delete unwanted characters. This means that LEN($) will return the number of characters wanted plus the number of backspaces. My solution to this problem was twofold.

First if FI$ is null and a backspace is encountered we disregard and start over. (Example 1 line 1009.) Second if FI$ is not null and a backspace is encountered, we must adjust FI$ string length to the desired length by subtracting a character for each backspace. (Example 1 line 1010.)

T. D. Sylvester
Atlantic Beach, FL

Simple APPENDing

The article in the February 1980 issue by C. Gerald on APPENDing programs was interesting but I think it complicates a rather simple procedure. It is possible to APPEND programs using CLOAD and a few PEEKs and POKE as follows:

1. With your first program already entered in core PEEK at 16633, 16634. This is a pointer to the end of the BASIC program and start of variable storage.
2. Subtract two from the address you get in Step 1 as follows: If 16633 is greater than one just subtract two from it; if 16633 is less than or equal to one, add 254 to it and subtract one from the number in 16634.
3. POKE the resulting numbers into 16548 and 16549. Do not do anything to 16633 and 16634.
4. 16548, 16549 is a pointer to the beginning of a BASIC program, normally 17129. We have now altered it to point to the end of the present program, actually the two zero bytes where the next line pointer would normally be.
5. CLOAD your program to be APPENDed.
6. At READY, POKE 16548 with 233 and 16549 with 66. This sets the pointer back to 17129 and you're done. All the pointers for variables, etc. will be properly handled by CLOAD.

If you forgot Step 6, the system will only know about your APPENDed program and if you try a LIST, it will look like you lost your original program. Also RUN will only execute your APPENDed program. Try it!

I've used this method many times and it works like a charm.

The article also has a technical error in stating (see Table 1) that line numbers take 1 byte followed by a null byte. They actually take 2 bytes. His examples had line numbers less than 256 which leaves the 2nd byte zero.

M. Winnick
Plano, TX

continued on next page

80 DEBUg

Conflict of Interest

I have received many calls concerning my letter in the April issue about putting Sargon II on disk. It is not clear to people that the DOS "DUMP" command requires blanks: one after the word DUMP and one after the filespec SARGON2/CMD. Thus the correct syntax is:

```
DUMP SARGON2/CMD (START=X'8000',
     END=X'AD19',TRA=X'ACFD')
```

where the blanks have been emphasized for clarity. While it is necessary to have one blank in each of the indicated positions, it is also important that the rest of the command (between the parentheses) not have any blanks.

Many of the owners of this expensive program were quite upset that they could not run it from disk. I am surprised that this important fact is not mentioned in the ads. Also, subscribers to other magazines may be interested to know that some have refused to publish my technique, citing conflict of interest with their advertisers.

Roxton Baker
Ellington, CT

Break Disable

In my article printed in April *80 Microcomputing*, "Break Disable" (p. 128), an error appeared in line 10, the beginning of the FOR-NEXT loop.

The start of the loop is wrong, causing the program to be POKEd into the wrong place in RAM. Line 10 should read:

```
10 CLS:FOR X=32743 TO 32767
```

I trust this will help your readers make the "Break Disable" work.

Jim Rastin
London, ONT

KWICest Index

In my letter concerning the article I authored, KWIC Index, there are three errors in the published listing brought to my attention by Dr. Ronald Ribler. The errors are in lines 1110, 1160 and a missing line 1265.

The correct lines are:

```
1110 IF W(I)=TW THEN 1190
     (not IF W(I)=TTW THEN 1190)
1160 TC=TC+" "+TW
     (not TC= - TC+" "+TW)
1265 TC="":REM SET TC TO NULL STRING
```

When these changes are made the program runs as shown.

I am embarassed over my failure to catch these errors and apologize for the inconvenience caused you and your readers.

Leslie E. Sparks
Durham, NC

BUGged Light Pen

There appears to be a BUG in program listing 7 on page 42 of the April article, "Build a Light Pen". The assembly language program does not work. (At least it didn't for me.)

According to the Radio Shack Level II and DOS manuals, a machine language program which is called by the USR function will not return a value if terminated by a RET instruction. In order to return the status of the light pen (light on or off) the value of the light pen must be loaded in the HL register and a JP 0A9AH will return this value to the USR function in the BASIC program.

I am by no means an assembly language programmer but I did change the program to reflect this requirement. A copy of the listing is attached.

I did construct the light pen and encountered no problems. The pen works very well using the BASIC programs and with the modification to the machine program that also ran. I have used the machine program on a Level II system and also a two disk system using the NEWDOS+ operating system with no problems. I substituted a Radio Shack photo transistor (part #276-130) for the one specified. In all, an excellent article, and I think a very useful piece of equipment.

Many thanks for such an excellent machine. The April issue is about three days old and already dog-eared and coffee-stained. Also very glad to see the start of an assembly language column.

Thomas J. Bell
Mickleton, NJ

```
                00090 ;CORRECTION TO ALLOW LIGHT PEN STATUS TO BE
                00092 ;RETURNED IN HL REG. TO USR(N) / USR0(N) FOR DISK
                00100 ;LIGHT PEN SUBRTN / 80 MICRO - APRIL 1980
                00110 ;READS LIGHTPEN STATUS AND RETURNS
                00120 ;HL = 0 IF 'NO LIGHT' OR 128 IF LIGHT
                00130 ;
7FE5            00132         ORG     7FE5H   ;32741D
7FE5 21DC05     00150 LPEN    LD      HL,1500D
7FE8 3E00       00160         LD      A,0
7FEA D3FF       00170         OUT     (255),A
7FEC 2B         00180 LOOP    DEC     HL
7FED 7C         00190         LD      A,H
7FEE B5         00200         OR      L
7FEF 20FB       00210         JR      NZ,LOOP
7FF1 DBFF       00220         IN      A,(255)
7FF3 E680       00230         AND     128
7FF5 6F         00240         LD      L,A     ;LOAD PEN STATUS IN HL
7FF6 2600       00242         LD      H,0     ;
7FF8 C39A0A     00250         JP      0A9AH   ;FOR RET IN USR FUNCTION
7FE5            00260         END     LPEN
00000 TOTAL ERRORS

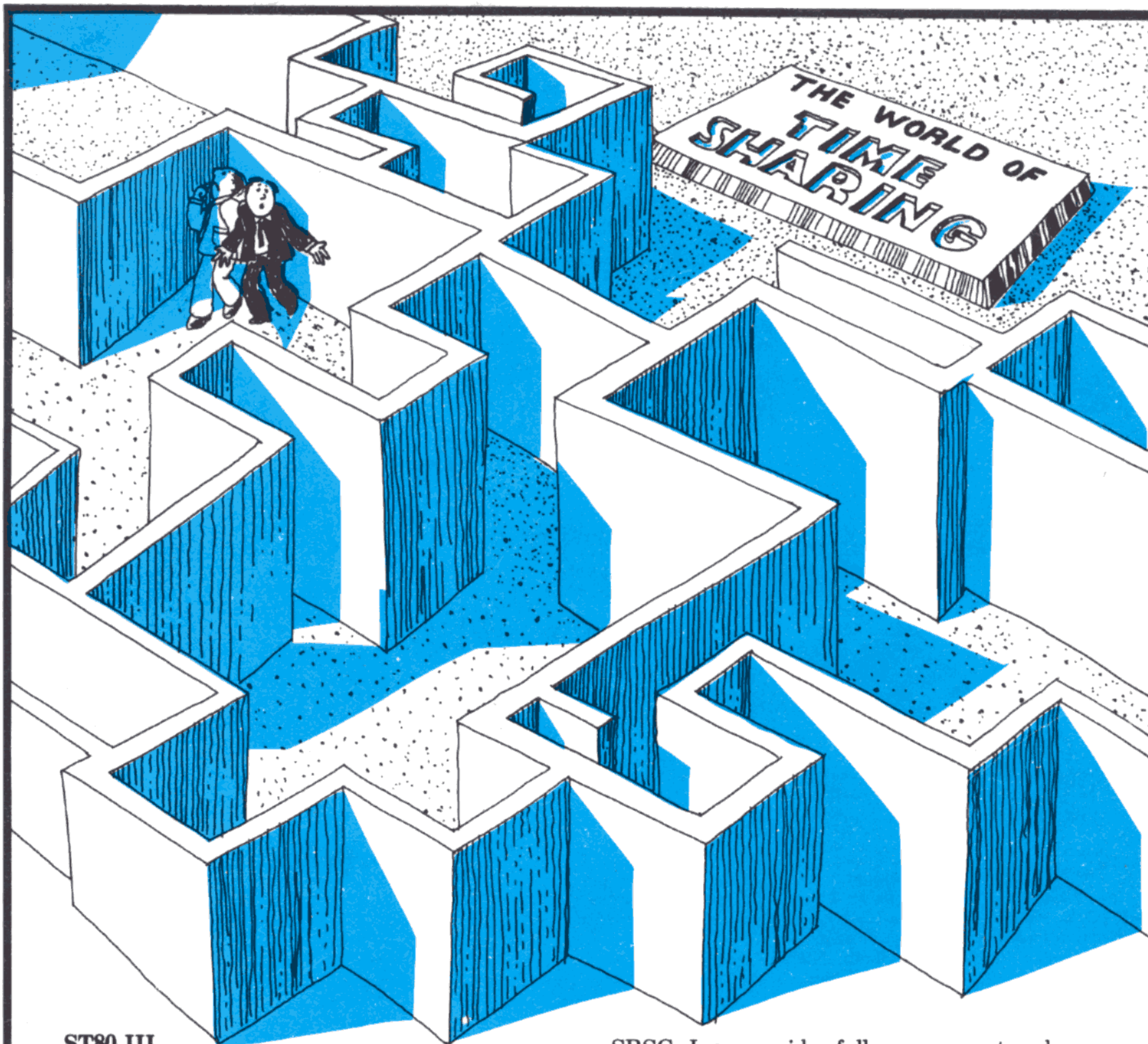

LOOP    7FEC 00180   00210
LPEN    7FE5 00150   00260



FOLLOWING IS DECIMAL EQUIVALENT OF ASSEMBLY PROGRAM
WHICH CAN BE POKED IN MEMORY WITH A BASIC PROGRAM.


1 DATA33,220,5,62,0,211,255,43,124,181,32,251,219,255,230,128,111,38,0,195,154,1
0
2 FORX=32741TO32762:READP:POKEX,P:NEXTX
```

Assembly Listing by Thomas Bell



ST80 III
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SBSG, Inc., provides full user support and markets three other ST80 products. Any computer with communication capability can be accessed by ST80 III via your TRS80. Here are those computers SBSG has accessed:

Harris 7	Apple	Dartmouth TS
Sigma 6 & 7	Northstar	Source
DECsystems	TRS-80* MOD I	Micronet
HP2000	TRS-80 MOD II	FORUM-80's
CDC	Superbrain	Tymshare
Honeywell	Zenith/Heath	Comshare
IBM 370 & 360	Altos	Compugraphics
PDP-11	GE	Burroughs

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↙18

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80 REVIEWS

"We once received a tape with a program on one side and Barry Manilow's Greatest Hits on the other."

Acu-Data Tape Digitizer
Alphanetics Mfg.
Forestville, CA
$54.95

by Chris Brown
***80* Staff**

Ah CLOAD, a much maligned mode. That the process works at all is testimony to the flexibility of the electronic devices involved. Cassette recorders were never really meant to handle data, even at slow rates, and microprocessors wince at the thought of their internal timing being upset by wildly gyrating cassette tape transport mechanisms.

Nevertheless, if you persevere, you can often actually load a program from tape into a computer via a cassette recorder. It may take some time, but it can be done. If your time (and patience) is at a premium however, you should consider acquiring an Acu-Data from Alphanetics.

Data Pulses are Shaped

The Acu-Data is designed to facilitate CLOAD and tape duplication. In essence, it is a combination filter, rectifier and pulse shaping device. Placed at the recorder output, it conditions the tape data. Hum and other spurious noise is filtered out. Data pulses are then rectified and shaped to insure that proper pulse amplitude and timing is achieved before the computer ever sees the pulse train.

An Acu-Data has been in use at the *80 Microcomputing* editorial office for six months. Quite simply, it works.

Program tapes of questionable quality often accompany article submissions to the magazine, and loading these gems can be a real epic. We once received a tape with a program on one side and "Barry Manilow's Greatest Hits" on the other. The Acu-Data rarely encounters a tape it can't handle (including Barry Manilow's).

The unit runs on 110VAC so batteries are not necessary. Other features include an LED to indicate the presence and amplitude level of data, a polarity switch that allows the user to select either positive or negative going data pulses (to compensate for differences in the head and audio circuits or various cassette recorders) and a copying digital output jack that allows duping of processed program tapes.

The model we have has an optional switch that provides computer control of the recorder. This option, especially handy when sequentially loading data in long programs, costs an extra five bucks.

The most immediate benefit of an Acu-Data is that it ends your worries about recorder volume settings. The unit produces the proper output level under widely varying input conditions: No more fooling with your kid's Dick Tracy Wrist Radio and the recorder volume control to get a good load.

The Acu-Data has proved to be a miracle worker when it comes to salvaging marginal tapes.

In addition, lousy originals can generate good copies when the copying digital output is used for duplicating.

There are limits to the capabilities of the Acu-Data. Generally though, if you could not quite load a tape through the Acu-Data, you would not have gotten close without it.

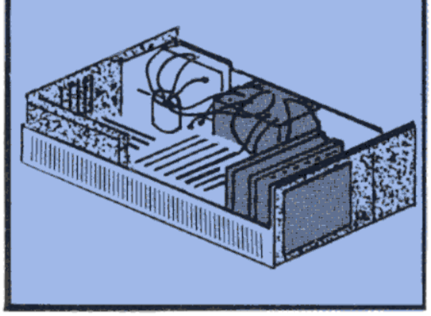
The unit is ruggedly built, enclosed in a shielded metal case. The version we have shows signs of last minute fixes on the clad side of the PC board. The manufacturer assures us that they are not present on current production models.

Always On Line

The Acu-Data is on line whenever it is plugged into a 110VAC outlet. No provision for removing AC from the primary of the line transformer is made and, consequently, the transformer is forced to dissipate a respectable amount of hysteresis generated heat. How this constant heat dissipation will effect its service life is a good question. So far, it has not affected the performance of our unit.

The comprehensive user's manual is clearly written and includes many hints on using tapes.

HARDWARE



A schematic and parts list was not available, but we did see the warranty. It is impressive. Each Acu-Data comes with a ten-day, money back guarantee. In addition to a 90 day, unconditional warranty on parts and labor, a flat $15 maximum repair fee is guaranteed on any problems encountered within the first 12 months.

Guarantees like this are rare in the microcomputer industry and certainly inspire confidence. Three cheers for Alphanetics.

Alphanetics has a winner in the Acu-Data. For tape oriented computerists who prefer to think in terms of black boxes and have no desire for breadboard projects, the Acu-Data is a worthwhile investment at $54.95. ■

TC-8 Cassette System
JPC Products
Albuquerque, NM
Kit: $70
Assembled: $100

by Carl A. Kollar

I guess I don't have to tell any TRS-80 owners how frustrating the cassette system that comes with the computer can be. Even with the factory mod that's available, the annoyance of loading and checking programs becomes just barely tolerable.

If you're like me, after you've just plunked down a chunk of money for a Level II 16K machine, "you ain't got nuttin left" for even one disk drive at 500 bucks apiece. So you suffer.

A reasonable alternative is the Exatron Stringy Floppy (ESF). This will cost you about 250 bucks and totally eliminates your loading and saving problems, automatically and fast. I've had one of these for about six months and love it!

But, if the price is still too steep, have I got a device for you!

The Device

The February 1980 issue of *Microcomputing* had an ad that intrigued the hell out of me. It was for a high-speed cassette system by JPC Products acclaimed as a "poor man's floppy." It made all sorts of seemingly ridiculous claims such as "loads five times faster," "stores 50,000 bytes on a 10-minute cassette," "less than one bad load in a million bytes with the volume control anywhere between one and eight."

All this for a measly 70 bucks? How could this be? A call to Albuquerque answered a few questions: Yes, it had its own power supply,

Continue to page 16

ATTENTION TRS-80 USERS!

TAKE ADVANTAGE OF OUR

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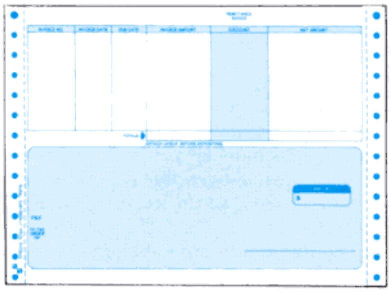
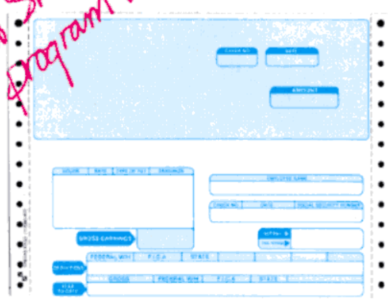
Now you can order checks and statements that are guaranteed to work with your Radio Shack programs.

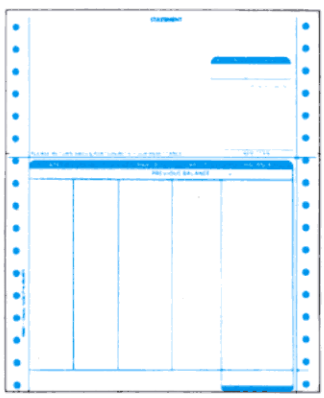


Standard Radio Shack payroll check (Designed for use on TRS-80 TM Model I with tractor feed printers I or III)

NEW! order forms for the new Radio Shack ® accounts payable program and save!



Standard Radio Shack accounts payable check. (Designed for use on TRS-80 TM Model I, line I & III printers only. Adjustable pin feed printer)



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TRS-80™ FORMS

80 REVIEWS

From page 14

and, it stored programs five times faster because it utilized higher density data. The computer outputs the information at a higher rate out of the rear keyboard connector.

The ad had even claimed anyone could build it even if you have never soldered before. JPC would make it work, if you couldn't—for free. I was sold. I placed my order, and it arrived about two months later (parts shortage).

I work in electronics, so I found the unit exceptionally easy to build. It took about an hour. The manual is superb. (That's better than great.) It was clear, concise and exact with no ambiguities. Important parts placements are stressed (polarity markings on electrolytics, bands on diodes, etc.).

JPC was right! With these instructions, you couldn't go wrong. The board quality is excellent. It is double-sided and parts locations are clearly marked on the component side of the board. There are no jumper wires to install. JPC utilizes PC traces and plated-through holes for connections to traces on the other side of the board.

Also, there are absolutely no adjustments or settings to bother with.

The documentation is a sheaf of 8½ x 11 papers stapled together. It is written in the nicest format I've seen in a while. Each command and/or subject is covered on its own sheet in large type. All explanations are in easy to read English—not computerese.

Commands and Features

SAVE"filename": Saves your BASIC program on cassette.
LOAD: Reads the next BASIC program from the cassette.
LOAD"filename": Searches for and loads the specified file from cassette.
LOAD? and LOAD? "filename": Reads file from cassette, and compares contents to memory.
LOADN: Prints a list of all the programs on a cassette, until interrupted by the "break" key.
LOADN"filename": Same as above except the tape will stop at the end of the program named.
KILL: Removes the file manager program from memory so that the extra memory can be used by large programs.
RSET: Allows the operator to rewind and position the tape on tape recorders that have these functions tied to the motor control jack.
RUN"filename": TC-8 searches for a specified program and runs it immediately.
PUT"filename": Same as SAVE"filename", except it is for use with system tapes.
GET: Same as LOAD, except it is for use with system tapes.
GET"filename": Same as LOAD"filename", except it is for use with system tapes.
GET? and GET? "filename": Same as LOAD? and LOAD?"filename", except it is for use with system tapes.
GETN and GETN"filename": Same as LOADN and LOADN"filename", except it is for use with system tapes.
OPEN: Required before cassette input or output of a data file can be attempted.
CLOSE: Required to end a cassette data file.
PRINT#: Allows numerical or string data to be output to a cassette file.
INPUT#: Allows numerical or string data to be input from a cassette file.

I haven't counted them, so I don't know about the "one load in a million bytes" claim, but my son, Anthony (age 11), loaded about 30 of his programs from his Radio Shack format tape to a new TC-8 format tape. He's run them all and found no bad loads.

Unlike the standard tape system, you can position your tape anywhere before the program you want and not have to look for a blank spot between programs. The TC-8 patiently waits for the program you want and then starts loading without getting confused by the portion of the previous program you just fed it.

Try that on your regular cassette system; you'll wear out the reset button. ■

MAYDAY +S
Uninterruptable Power Supply
Sun-Research, Inc.
New Durham, NH
$325

by Chris Brown

Mayday, the international signal of distress, is not likely to be the first word uttered by a computerist when the power fails in the middle of a lengthy program. Personally, I can think of many more satisfying expletives, but Mayday may be more appropriate. It is the trade name for an uninterruptable power supply, designed to end power line problems.

Emergency Power

Mayday is a fail-safe device which, in the event of a drop in line voltage, provides emergency power to a microcomputer system. Once on emergency power, you can terminate the system in an orderly fashion with no program crash or loss of data. Emergency operation time varies with the Mayday model and the size of your system, that is, how many disk drives you own. The Mayday +S can generate up to 30 minutes of emergency power.

Sun-Research, Inc. is a new manufacturing and marketing venture launched by Phase-R Corporation, a diversified New Durham electronics firm. Among its products are laser devices manufactured for the medical field and the government.

The original Mayday unit was created to meet Phase-R's need for a reliable, isolated power source for the office TRS-80. The company's rural location resulted in frequent power outages, and the TRS-80's close proximity to heavy machinery made it difficult for it to run without glitches. After a few monthly payroll records were lost, the Mayday was born.

Not only does the unit provide instant backup power, it also isolates the computer from spikes and transient voltage surges on the AC line.

The Mayday uses a modified, 120 Hz, square wave generator as a DC to AC converter. When power fails, this generator supplies power from a 12-volt battery to the computer. A specially designed isolation transformer allows the Mayday to maintain, plus or minus, five percent required computer power during switch-over to internal power. Plus or minus one-half percent is maintained thereafter. Switch-over time is on the order of five milliseconds, so no loss of memory occurs.

A 12-volt automotive battery (available separately) is used in conjunction with the Mayday and is enclosed in a high impact plastic case. A built-in trickle charger keeps the battery voltage within accepted limits.

The computer monitor, interface, keyboard and peripherals plug into a bank of outlets on Mayday's front panel. The entire system is controlled by one circuit breaker, while an idiot light indicates system status. A very convenient layout.

Line Surge Protector

Most versions of the Mayday incorporate an MDS line surge protector. If your computer operates in an electrically noisy environment, this option is a must.

If its operation in our office is any indication, Sun-Research has met its design goals with the Mayday. The 80 editorial offices share building space with a printshop and darkroom, and the AC line that our computer runs on is subject to large voltage swings and noise. The constant shrinking of our video as presses came on line was a real source of worry.

Once the Mayday +S was installed, the shrinking video was eliminated. Now, the occasional excursions of the line below normal levels result in a smooth transition to emergency power rather than a catastrophic program crash.

One drawback of our Mayday +S is its inability to power the 60 Hz AC fan motors used in our disk unit and printer. This can be overcome by wiring these motors directly to an external AC source. To alleviate this problem, Sun-Research has developed a Mayday unit that supplies a 60 Hz sine wave source of voltage. This new Mayday is suitable for use with Model II machines.

As the air conditioning season approaches and brown-outs become more frequent in metropolitan areas, the computer chaos caused by erratic AC lines will increase. A Mayday unit can be your first line of defense against system glitches. Now, if you can only get your TRSDOS squared away . . . . ■

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✓ Reader Service — see page 162

TRS-80 Disassembled Handbook
Robert Richardson
Richcraft Engineering Ltd.
Chautauqua, NY
$10 Vol. 1, $15 Vol. II

by Dennis Bathory Kitsz

The programmer's afterworld is destined to offer three options: a heaven of powerful, high-level languages; a hell of detailed machine code; and a purgatory, where everyone uses Richcraft Engineering's *TRS-80 Disassembled Handbook*.

The handbook's premise is that once a user has struggled (resentfully, no doubt) through machine code, "it is ridiculous to 're-invent the wheel' . . . when these routines already exist in Level II ROM." Much of this premise is sound, and author Richardson, with more than a few questionable generalizations about the primacy of his book and the ease of his method, takes the reader step by step through the many useful subroutines available in Microsoft's BASIC.

Hurrah for the Evangelist

For once we may say, "Hurrah for the evangelist of the short-cut," for Richardson does insist that knowing machine language well is prerequisite to using these subroutines effectively. Indeed, a technique that dips into the netherworld of another person's code can be disastrous and misleading for a novice, but perfectly valid for an experienced machine language program author, who does not care to expend either the time or the memory necessary to write, for example, double-precision decimal arithmetic.

The available options for a user-programmer are, of course, inevitably slow BASIC; assembly language coding; compilers such as BASEX or FORTH; or a combinational method such as the handbook suggests. The compilers are generally straightforward, but cannot efficiently co-exist with resident programs. Where a TRS-80 must fill a variety of needs, machine language programs easily accessible through a SYSTEM or USR(X) command are most desirable.

Richardson's technique stands out as singularly effective, because most of the speed of original machine language software is maintained, and memory is conserved through generous use of calls to Level II ROM.

On the other hand, much of Richardson's proselytizing is overbearing and self-righteous, and often useful points are obscured by his tone. A bit overeager in self-appreciation, the author states that his work is the first revelation of the inner workings of the Level II ROM, when in fact, *TRS-80 Supermap*, published by Fuller Software, exposed and annotated the ROM's contents six months before the appearance of Richardson's book.

Even worse, the organization of the book is weak, and the continuous cross-pollution of hexadecimal and decimal references further blurs the operations of a code still based on the octal language of the 8080 archetype. Finally, one is forced to question the value of 16 pages of the 70-page handbook dedicated to a hex listing of Level II ROM. Since none of it is disassembled, the user cannot learn how registers and memory are employed.

Plenty of Oratory

In short, Richardson does not help us learn; he presents a technique, some examples of its use, and plenty of oratory. A sample: "Only a retarded 3rd grader would overlook them (the BASIC names) in memory locations 5712 through 6172."

And one more: "Let us be kind, though, and presume that Radio Shack had not the slightest idea what Level II ROM contained, and if they did, had not the slightest idea on how to find it and use it. If such is not the case, they surely stand guilty of gross negligence and malice aforethought . . . ."

Fortunately, the handbook's techniques are significantly more space-efficient than the author's writing.

Now to the question: As microcomputer users, we have been overwhelmed with software and printed matter which seems priced far above its worth. By comparison with other fields, we pay an enormous amount for companion products for our machines. Is the *TRS-80 Disassembled Handbook* worth its cover price? Perhaps.

For less than $20 the *TRS-80 Supermap* comes with a detailed annotation of the operation of Level II ROM subroutines. That and Richardson's book, plus Editor/Assembler, T-BUG and the Z-80 Technical Manual, return no change from a hundred-dollar bill. Together, they are a powerful resource. But on its own *TRS-80 Disassembled Handbook* provides only a modest return in exchange for your investment. ■

Adventure
by Gordon Letwin
Softwin Associates
Microsoft
Bellevue, CA
$30.00

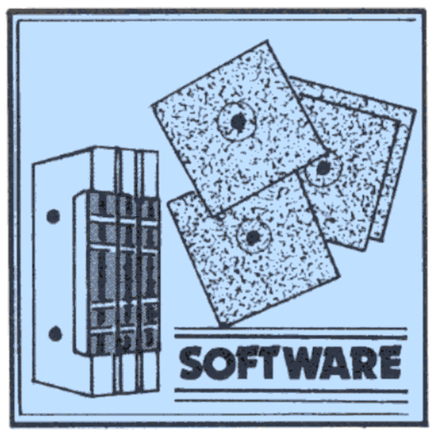
by John Warren

Having been introduced to Adventure on a Burroughs 6802, I just couldn't get excited about the many mini-adventures written for home computers. However, Gordon Letwin of Softwin Associates has produced a rip-snorter that is almost indistinguishable from the original.

A player explores a giant cave, finds treasures and battles knife-wielding dwarves. The computer is directed with one an two-word commands like "get axe" or "north" (go north). Part of the fun is finding out what commands the computer accepts and when it accepts them. Adventure is not a game that someone learns in a few minutes, plays in half an hour and forgets in a week.

In a mainframe environment, experienced adventurers assist (and tantalize) novices with hints. "So the dragon has got you stuck. He isn't any problem if you're tough. Come on now—what would Conan do in this situation?" To overcome the micro-user's isolation, Softwin has prepared a series of four hint books and is selling them for a buck apiece (4 for $3).

The game runs on a 32K, single disk TRS-80. To say that it uses the disk is an understatement. Almost every move causes a quick search. However, the delay is insignificant—rarely over a second. Playing a mainframe over a 300 baud line is much more frustrating.



The specially designed DOS seems to occupy only one sector, leaving the rest free for program and data. Software filchers are going to be tearing their hair out on this one, since there is no "copy" utility and data is disguised by a sophisticated bit shifting routine. Unfortunately, this also means there is no way to make a backup. Microsoft recognizes this and offers a one-year replacement warranty.

Because of the lengthy playing time (several hours), a "save" feature allows players to suspend the game for later resumption.

The game is attractively packaged and comes with a clearly written instruction book. Clearly, both the $30 price tag and the extensive hardware necessary are going to limit sales, but this is an exceptionally entertaining game, and if the fanaticism of the mainframe adventure addicts is any indication, it should enjoy a steady increase in popularity. ■

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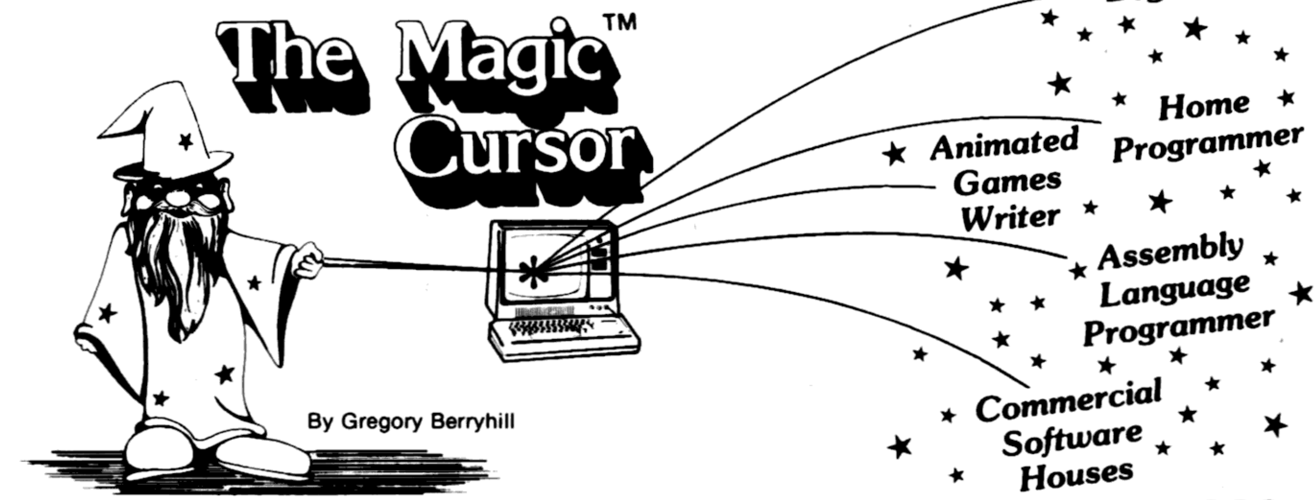

By Gregory Berryhill

The **Magic Cursor** is a Revolutionary Family of Products which provides a dramatic new method of reproducing drawings and displays that you create on your screen. It makes both simple displays and complex interactive data input forms. It stores a "BASIC PROGRAM" on disk (or tape) ready for you to execute alone or as a subroutine. It produces screens in both standard and wide screen.

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80 ACCOUNTANT

by Michael Tannenbaum C.P.A.

". . . even if these problems can be overcome, the mechanical construction of the Model I has limitations."

During the period in which I have been writing articles for this column, one of the most frequently asked questions has been how much disk storage is available for the Model I microcomputer.

By now, most users know that the Model I can handle up to four drives. Each drive accommodates just under 90,000 bytes (words) of information.

In some data processing systems a word equals one alphanumeric character, however, the 80 can pack several numeric characters into each word. Accordingly, it is difficult to calculate the numbers of words of disk storage available for mixed numeric and alphabetic data.

How Many Bytes

The technical reasons for this are as follows:

• Integers—up to 64,000—require two bytes of storage.

• Single precision data require four bytes.

• Double precision data require eight bytes and each alphabetic character requires one byte.

An additional complicating factor is the way the 80 reads and writes disk records. All Model I operating systems, with the exception of VTOS 3.0, read and write 256 bytes at a time in the random mode. Thus, if you have a random access file with less than 256 bytes, you lose storage.

Data type and record length affect the ultimate size of the file. However, the real storage problem in the TRS-80 is the fact that a file cannot span more than one disk. For example, a file with 6,000 names requires multiple disks to contain the data. You must break the file into segments. Each segment can be entered on a separate disk, but the software must be written so that the directory of each disk is accessed before processing.

Of course, changing data on this file causes problems. As you add and delete data, gaps appear. The system would have to maintain a record of every gap and, periodically, rearrange the file to accommodate new data.

Since the data would have to be inserted randomly, access would require the extraction of key words and the development of a sorted index. To sort 6,000 keys into any kind of order is a time-consuming task on the Model I.

If the sort could not be performed in memory, then a disk sort and an index disk would be required. This separate disk might be required in any case to retain key words and pointers to locations on the main data file.

Using an index disk can also create problems. You might have to remove data disks to provide a drive for the index, if sufficient core was not available for the index to be kept in memory.

But, even if these problems can be overcome, the mechanical construction of the Model I has limitations. The Model I can only detect if a disk drive is on or off line. The program has no way of knowing whether or not someone inadvertently took out a portion of the file. Because this increases the chance for error, most software developers prefer not to write programs for accessing large files on the Model I.

Although the Model II disks contain more data than the Model I diskettes, you cannot escape the limitations of floppy storage. Even with its larger files, a Model II cannot control all items. Systems that use extremely large files require a hard disk.

Continue to next page

CAPTAIN 80

by Bob Liddil

Here's Captain Eighty, sitting in his reviewer's chair, assessing this month's mail. Response to the contest was lively. Entries ranged from high camp to very serious. Many readers were less than convinced that we really had a contest going at all.

Andy Anderson, from Larimore, ND, suggested an Elections game, where players receive a random dollar amount from Fat Cats, to be spent in media exposure, transportation, office support and insurance against ethnic jokes, slipping on buses, and stuff like that. A second program, appropriately entitled Headache, dealt with taxes, government agencies, the economy and all those pesky problems that interfere with a politician's partying, after his election.

The last of Andy's three paragraph program series would finance and manage World War III, a situation that came about as a result of our messing up in the second.

Thanks, Andy. I hope the programmers out there are paying attention.

More Letters

Craig Griffin, from Bessemer, AL, would like to see language translation programs, particularly Portugese, in which an English sentence entered would elicit the appropriate foreign phrase. Very useful. After all, a computer has more memory available than those little hand-held calculators.

Tom Mason, of Akron, OH, suggests programs that "shoot anything"—X-wing fighters airplanes, ducks, tanks, ships, world leaders—and with selectable skill levels. Impressive graphics is a must for the hit, says Tom, as well as a user selected description: boss' name, mother-in-law's name. You get the idea.

Al Mescha, of Chicago, IL, sent in a one liner (that contest hasn't started yet, Al). He says, "When I use the INPUT command, I use the following format: PRINT STRING$ (60)," ";CHR$(28); :INPUT. This homes the cursor and clears the first line only. Thus, you only have to draw your graphs, pictures or whatever once." This is a handy little ditty, try it.

Rob Robinson, of Palo Alto, CA, sent in an educational program he wrote for his six year old. Called Scrambled Words, it features a blinking cursor and a reward display named Anthro. This program is excellent.

Rob, I suggest that you submit your program to *80 Microcomputing* along with a description. It would fill a void in *80*'s educational programming department.

NITS Software, Rialto, CA, also sent me an educational sampler. To my absolute surprise and delight, Wordmaster, a terrific reading and spelling program, loaded the first time out. A fresh, professional approach to the subject, Wordmaster gives the student (early third grade) plenty of work without overwhelming him. Wordmaster builds vocabulary and reading skills with style, grace and charisma.

This is not NITS' only offering. The company has a catalog full of educational material, which should be every bit as well written as the above. Drop these guys a line at 680 North Arrowhead Ave., Rialto, CA, 92376. I'm sure they'll pop a catalog to you in the mail.

Radio Shack has a new Adventure, Pyramid 2000. It's impressively packaged and reasonably priced. Hard core Adventure fans will no doubt mourn the omission of the Scott Adams split screen and blinking cursor. Radio Shack chose to ignore all Adams' genetic

Continue to page 26

However, the Model II can detect changes in a drive's directory. When a disk is removed and a new disk is put in place an initialization command must be used. The DOS then reads the directory to learn its contents.

The Model II has an additional advantage over the Model I—with the exception of those who use the VTOS 3.0 operating system—in that every byte on the disk is available. It is the disk operating system that fills the tracks and handles sector boundaries. This advantage means that not only can the Model II utilize disk space more efficiently, but the burden of managing data storage is removed from the programmer.

Recordkeeping from Osborne

During the past year, I have had the opportunity to review accounting software developed by the Osborne Company. This software, originally developed for a Wang Minicomputer, was designed for firms using job cost recordkeeping. Because this system has been published in book form, many software houses have copied the package and are distributing it under their name.

I have reviewed portions of the package from various vendors. The most recent was the Accounts Receivable, adapted from Wang BASIC by the Small Systems Business Group. Perspective purchasers of Osborne systems are advised to purchase the description books which are available at many computer stores: *Payroll and Cost Accounting in BASIC, Accounts Receivable, General Ledger.*

Since the system was designed to keep track of expense by job, the program handles large files. When the job is billed, the net profit on the job can be calculated.

The Small Systems Business Group has dropped much of the job-costing features of the original Osborne program. This is fortunate, because it reduces the size of key files. On the Model I, the Accounts Receivable program permits a maximum of 670 accounts and 650 transactions for a four-disk system. If these limitations do not dissuade you, it has its advantages:

- The documentation explains the system and permits modification.
- The user manual is relatively readable.
- Because of the program's wide publication, it has been accepted as somewhat of a business standard.

The receivable system is of the open item type. Open item receivable systems retain details of all active transactions (invoices, payments and credits) until updated. Once updated, completed transactions are purged, and only open items are retained.

There are two advantages to this type of file maintenance. One is that file agings indicate open transactions. This significantly aids follow-up and resolution of old balances due. If only a balance forward is kept, details of outstanding items must be researched or maintained manually.

A Second Advantage

The second advantage of an open item system is that aging reports can be prepared accurately, since the date of all transactions is present. In a balance forward system, cash application is particularly troublesome, if applied to the wrong category.

Under the Osborne system no payment or transaction can be recorded, unless an invoice is already on file. This is both a safeguard and an inconvenience. It is a safeguard in that transactions can be tracked back to a document. However, if you get cash on account before an invoice is prepared such a system will cause problems. In order to record the cash on the receivable system, a dummy invoice must be created. This is inconvenient to say the least.

Generally, you will find that the Osborne program creates excellent reports in a readable format. The receivable system can be purchased separately, or integrated with a payables system and the general ledger. ■

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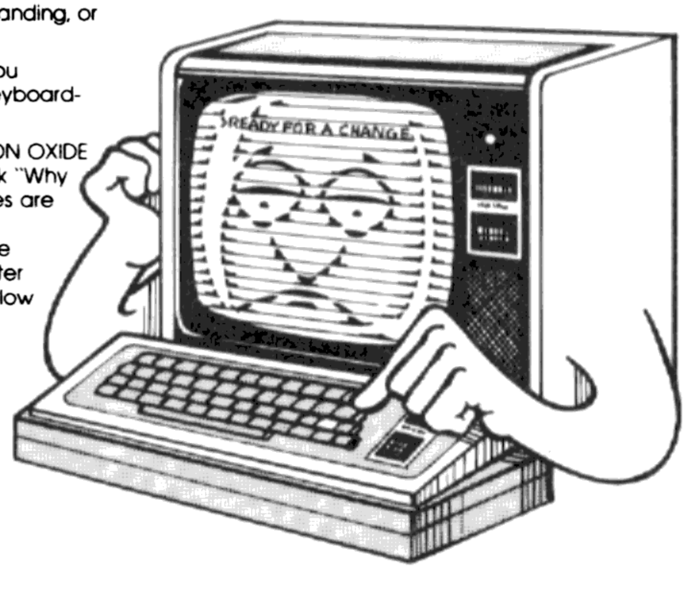

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THE ASSEMBLY LINE

by William Barden, Jr.

"This is the heartbreaking story of why it is so difficult to use TRS-80 graphics to their full potential."

"Six into eight don't go", said the Duchess, evenly.

I've always wanted to start a best selling novel with that line. The novel has never materialized, but at long last I can use it. This is the heartbreaking story of why it is so difficult to use TRS-80 graphics to their full potential.

Most of the readers know very well how graphics are used on the TRS-80. To refresh your memory: There are 16 lines of 64 character positions on the video display. Each character position occupies one byte of video display. The addresses of video display memory are from 3C00H through 3FFFH (15360 through 16383 decimal).

"If you're hazy on this point use BASIC to POKE various values into video memory . . ."

When any of those bytes in video display memory are loaded with a value from 20H through 7FH (32 through 127 decimal) an ASCII character is displayed on the screen. The ASCII character is generated by the video display electronics hardware on the CPU board, which contains a character generator chip that translates from ASCII into a pattern of 5 by 7 dots for the character.

When a byte in video display memory is loaded with a value from 80H through BFH (128 through 191 decimal), a graphics character is used in place of the ASCII character; the character generator is not used in this case, but the logic sets one or more of six pixels, dependent upon which bits are set in the value as shown in Fig. 1.

Note that for any graphics character, bit 7, the "high-order" bit, is set, bit 6 is ignored, and bits 5 through 0 determine whether the pixel is on or off.

If you're hazy on this point, use BASIC to POKE various values into video memory until you can predict which pixels will be set based on the value POKEed.

What we'd like to develop here is an assembly language routine to SET any one of those 6 by 1024 pixels. Although the 6144 pixels provide rather coarse resolution when the TRS-80 is compared to some other microcomputers, the graphics mode is much better than working on a character position basis.

Set the Pixel

Before we can develop the assembly language code, we need to know the algorithms involved. (Algorithm is simply a synonym for plan or formalized procedure.) Let's see what's involved in setting a pixel on or off.

Fig. 2 shows a generalized character position on the screen that contains a pixel to SET or RESET. If we start with any X,Y position, what can be said about the position of that pixel in the 1024 bytes of video display memory?

First of all, the line number of the character position containing the pixel is given by the quotient of Y/3. For example, Ys of 0-2 are in line 0; Ys of 3-5 are in line 1; and so forth, up to Ys of 45-47, which are in line 15. What happened to the remainder of Y/3? Ask me again later.

The character position along the line is given by the quotient of X/2. There are 64 character positions along the line, numbered 0 through 63. Xs of 0 and 1 are in character position 0; Xs of 2 and 3 are in character position 1; and so forth, up to Xs of 126 and 127, which are in character position 63. What happened to the remainder of X/2? Ask me again later.

Knowing the line number and character position, it is easy to find the actual location of the video display byte that contains the pixel in question. If the line number is the quotient of Y/3, and the character position is the quotient of X/2, then the byte displacement, or position from the start of video display memory is: Byte Displacement = (Line #)*64 + Char Pos. The actual memory location is the Byte Displacement + 3C00H, or Byte Location = (Line #)*64 + Char Pos + 3C00H.

Now that we know how to find the byte con-

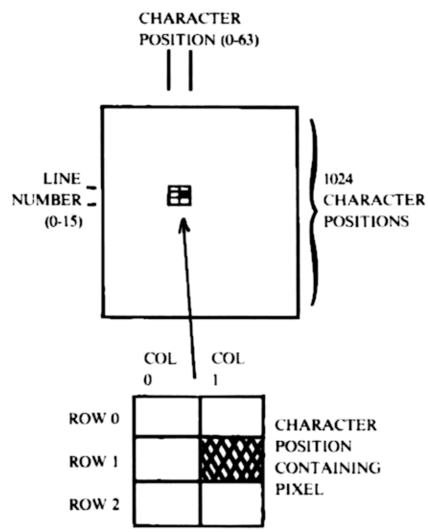


Fig. 2. Line Number, character position along line, row, and column of Pixel

taining the pixel, how do we know which of the six bits controls the pixel? Would you hand me those remainders, please?

If we separate each graphics byte into two columns and three rows, we can use the remainders of Y/3 and X/2 to find the right bit.

The remainder of X/2 defines the column number of the pixel. For example, Xs of 0,2,4,6, etc., define a pixel in column number 0; Xs of 1,2,5,7, etc., defines the row number of the pixel. Ys of 0,3,6,9, etc., are in row 0, Ys of 1,4,7,10, etc., are in row one, and Ys of 2,5,8,11, etc., are in row two.

Knowing the row and column, we can also

Continue to 24

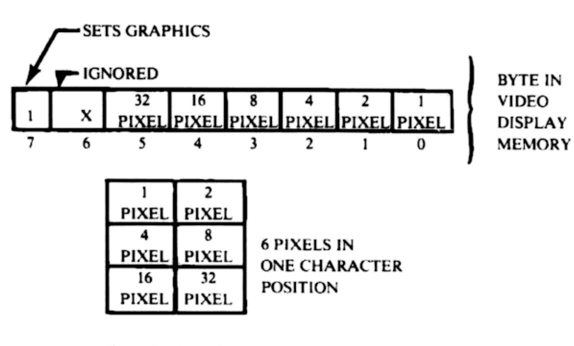
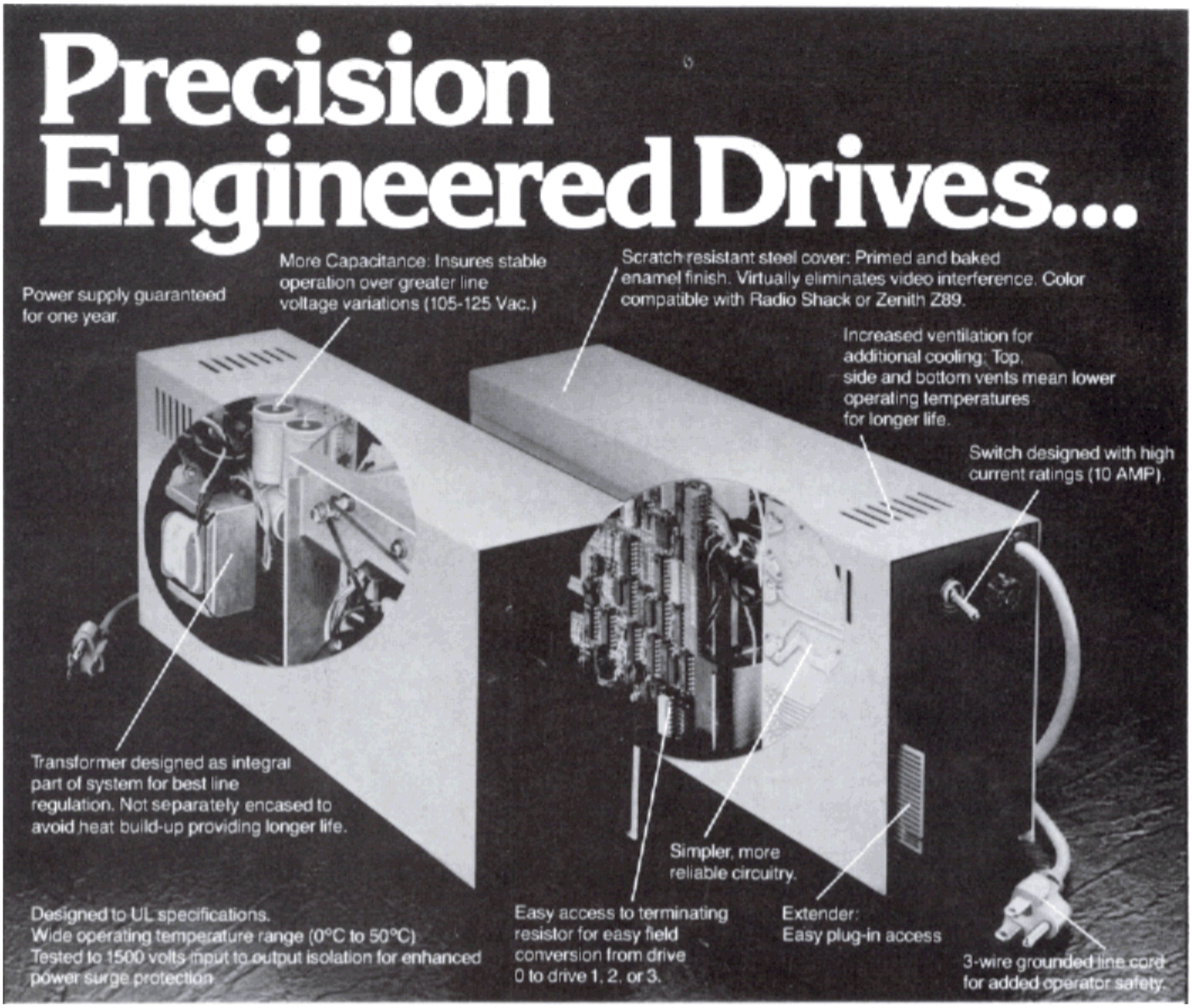


Fig. 1. Graphics Mode Pixel Mapping



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find the bit position in the byte by Bit Pos = (Row #)*2 + Col #. For example, row one, column number one, is defined by bit 3 of the byte.

Seven Incomprehensible Formulas

We now have seven incomprehensible formulas that we can use to develop the code for SETting or RESETting any pixel. They are shown in Fig. 3.

Now that we've got the formulas, let's develop the assembly language routine. Hummm . . . dividing by two is easy—a simple shift right will divide by two and even save the remainder of 0 or 1 in the carry. Multiplying by 64 is also quite easy—an ADD HL,HL multiplies by two and six of them will multiply by 64. It look like the hardest part is the division by three. Three is not a "convenient" divisor as it is not a power of two. The code for this task is shown in Listing 1.

The code from SET to SET10 finds the character position (CP) by dividing the X value in the E register by two. The SRL shifts the contents of the E register one bit right to do this, and the remainder of zero or one is shifted to the carry flag after the shift. The state of the carry is used to put either a 0 or 1 into the D register for the column number (CN).

The code from SET10 to SET25 finds the line number (LN) and row number (RN) by dividing the Y value by three. The divide is done by successive subtraction of three from the Y value in the A register. The count of the number of times three is subtracted is held in the B register. As long as A remains positive, the subtraction is continued. When A goes negative, the ADD A,3 restores the remainder to A while the quotient remains in the B register.

At this point we have the four basic values of line number (B), character position (E), row number (A), and column number (D).

Now we can use these values to find the actual byte containing the pixel, and then find the bit within the pixel. SET25 to SET27 finds the bit position in the byte by multiplying the row number by two (RLCA) and adding the column number. This bit position is saved in the C register.

The code from SET27 through SET32 multiplies the line number by 64 by shifting it 6 bit positions left. This multiplication is done by 6 ADD HL,HL instructions. This must be a double (16-bit) add because the product may be as great as 15*64 (960). At SET32, the line number*64 is in the HL register pair.

The code from SET32 to SET34 adds the character position in DE to HL to find the byte displacement, and then adds the displacement to 3C00H to find the actual location of the byte. At SET34, the location of the byte containing the pixel is in the HL register pair.

Now the only thing left to do is to SET the pixel of the byte. The code from SET34 on uses the bit position in C to "index into" a table of masks, using the IX register. The A register is loaded with the byte containing the pixel (LD A,(HL)), followed by an OR (IX) to set the proper pixel, followed by a store of the altered value (LD (HL),A). Note that bit 7 is always set by the mask value to ensure that graphics mode will be used.

We now have a general subroutine to set any pixel at will.

Reflections on the SET Subroutine

What you're seeing in SET is the result of a great deal of work. I could say here that I sat down and wrote this code in five minutes. Tain't so. I have seen programmers who could generate such code in fifteen minutes, but they are few and far between. It would not be unusual for many programmers to spend a day on the algorithms and a day on the code for this subroutine.

How fast can assembly language code be generated? This depends on a number of factors, such as access to the computer, interaction with the system, complexity of the code, definition of the problem and others. As assembly language programmers on the TRS-80, we have probably the best of all environments—a highly interactive system with a single user and excellent assembly and debugging tools.

Typical industrial standards used for assembly language code are on the order of 10 to 30 lines of assembly-language code per day! That's right, per day! Of course, those figures are based upon the complete program design, coding, debugging and documentation task,

Continue to 26

```
FF00                      ORG     0FF00H         ;CHANGE ORIGIN FOR YOUR SYSTEM
                ;**************************************************
                ;* SUBROUTINE TO SET A PIXEL GIVEN X (0-127) IN H  *
                ;* REGISTER AND Y (0-47) IN L REGISTER             *
                ;**************************************************
                ;
FF00 5C         SET     LD      E,H            ;X
FF01 7D                 LD      A,L            ;Y
FF02 CB3B               SRL     E              ;GET CHAR POSITION (0-63) IN E
FF04 1600               LD      D,0            ;SET COL# TO 0
FF06 3001               JR      NC,SET10       ;GO IF COL#=0
FF08 14                 INC     D              ;COL#=1
FF09 06FF       SET10   LD      B,0FFH         ;-1 TO B
FF0B 04         SET20   INC     B              ;BUMP QUOTIENT IN B=LINE#
FF0C D603               SUB     3              ;SUCCESSIVE SUBT FOR /3
FF0E F20BFF             JP      P,SET20        ;GO IF NOT NEGATIVE
FF11 C603       SET25   ADD     A,3            ;ADD BACK FOR REMAINDER=ROW#
FF13 07                 RLCA                   ;(ROW#)*2
FF14 82                 ADD     A,D            ;(ROW#)*2+COL#=BIT POS
FF15 4F         SET27   LD      C,A            ;SAVE BIT POS IN C
FF16 68                 LD      L,B            ;LINE #
FF17 2600               LD      H,0            ;NOW IN HL
FF19 0606               LD      B,6            ;SHIFT COUNT
FF1B 29         SET30   ADD     HL,HL          ;MULTIPLY LINE#*64
FF1C 10FD               DJNZ    SET30          ;LOOP TIL DONE
FF1E 1600       SET32   LD      D,0            ;DE NOW HAS CHAR POS
FF20 19                 ADD     HL,DE          ;(LINE#)*64+CHAR POS IN HL
FF21 11003C             LD      DE,3C00H       ;START OF VIDEO
FF24 19         SET34   ADD     HL,DE          ;(LINE#)*64+CHAR POS+3C00H
FF25 0600               LD      B,0            ;BC NOW HAS BIT POS
FF27 DD2133FF           LD      IX,MASK        ;START OF MASK TABLE
FF2B DD09               ADD     IX,BC          ;POINT TO MASK
FF2D 7E                 LD      A,(HL)         ;LOAD PIXEL
FF2E DDB600             OR      (IX)           ;SET PIXEL
FF31 77                 LD      (HL),A         ;STORE IN VIDEO
FF32 C9                 RET                    ;RETURN
FF33 81         MASK    DEFB    81H            ;MASK TABLE
FF34 82                 DEFB    82H
FF35 84                 DEFB    84H
FF36 88                 DEFB    88H
FF37 90                 DEFB    90H
FF38 A0                 DEFB    0A0H
0000                    END
00000 TOTAL ERRORS
```

Program Listing 1. SET Pixel Subroutine

```
8000                      ORG     8000H
                ; 8-BIT SQUARE RT SUBROUTINE BY CLIFF DEJONG
                ; A CONTAINS NUMBER ON ENTRY, B CONTAINS RESULT ON EXIT
                ;
8000 010100     SQRT    LD      BC,1           ;B=0 C=1
8003 91         LOOP    SUB     C              ;A=A-C
8004 D8                 RET     C              ;DONE IF A<0
8005 0C                 INC     C
8006 0C                 INC     C              ;C=C+2 NEXT ODD #
8007 04                 INC     B              ;B=B+1 BUMP COUNT
8008 18F9               JR      LOOP
                ;
                ; 16-BIT SQUARE RT SUBROUTINE BY JAMES BRAUD
                ; HL CONTAINS NUMBER ON ENTRY, A CONTAINS RESULT ON EXIT
                ;
800A AF         BEGIN   XOR     A              ;INITIALLY TRY 0 AS SQ RT
800B 01FFFF             LD      BC,0FFFFH      ;BC=-1
800E 09         LOOP1   ADD     HL,BC          ;IF NUMBER IN HL BECOMES NEG
800F D0                 RET     NC             ;YES-RETURN
8010 3C                 INC     A              ;NO - TRY NEXT RT
8011 0B                 DEC     BC
8012 0B                 DEC     BC             ;UPDATE SUBTRACTOR
8013 18F9               JR      LOOP1          ;TRY AGAIN
0000                    END
00000 TOTAL ERRORS
```

Program Listing 2. Square Root Subroutine

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and also are based upon larger programs than ten or twelve instruction subroutines.

On a positive note, though, standards for higher level language code, such as BASIC, also show that not many lines of code can be generated rapidly when the entire design, coding, debugging and documentation tasks are considered.

The point of this monologue is that you should not be dismayed if some of the assembly language code takes longer than you expected; you have plenty of company!

The SET routine is a "medium hard" piece of code, and it encompasses a lot techniques. If you can follow it, you've gone a long way into learning assembly language methods.

By the way, it's entirely possible that there is a more efficient way to accomplish this problem. I would be most interested in any better subroutines.

Why is it so difficult to SET a pixel? The "mapping" of X and Y into the corresponding byte and bit values is not straightforward, as we have seen. Could it have been made easier? Yes, but at the expense of increased hardware costs. For the moment, we have to "program around" the fact that six into eight don't go—evenly.

1. LN = LINE # = $\left(\frac{Y}{3}\right)$ QUOTIENT

2. CP = CHARACTER POSITION = $\left(\frac{X}{2}\right)$ QUOTIENT

3. BYTE DISPLACEMENT = (LN)*64 + CP

4. ACTUAL LOCATION = (LN)*64 + CP + 3C00H

5. RN = ROW NUMBER = $\left(\frac{Y}{3}\right)$ REMAINDER

6. CN = COLUMN NUMBER = $\left(\frac{X}{2}\right)$ REMAINDER

7. BIT POSITION = (RN)*2 + CN

Fig. 3. Pixel Formulas

Assembly Line Programming Contest

Back in the first Assembly Line column I offered a challenge to the readers in the form of a programming problem: "Given a number, find the integer portion of its square root in a short assembly language routine. For example, given 137, find the 11 portion of 11.7047 in a short piece of code."

Since that time I've received a number of replies, many with interesting comments about assembly language topics. I appreciate them all. There were three winners for this problem, and they will each receive an autographed copy of my new Howard W. Sams book *Z-80 Microcomputer Design Projects*, $12.95 ($11.95 autographed).

Some of the readers tried brute force for finding the square root, but there is a trick. The "nth" perfect square is the sum of the first n odd integers. A perfect square is $1^2, 2^2, 3^2, 4^2$, and so forth. If n is six, for example, its square is 36, which is the sum of the first six odd integers, 1+3+5+7+9+11. All we must do to find the integer portion of the square root of any number is to successively subtract 1,3,5, . . . until the residue goes negative. The number of subtractions, minus one, is the integer portion of the square root. If we have 137, for example, we have:

137 − 1 = 136 − 3 = 133 − 5 = 128 − 7 = 121 − 9 = 112 − 11 = 101 − 13 = 88 − 15 = 73 − 17 = 56 − 19 = 37 − 21 = 16 − 23 = −7. We had 12 subtractions, and 12 minus one is 11, the integer portion of the square root.

The shortest 8-bit routines were submitted by Gary E. Clark of Bethesda, MD and Cliff DeJong of Colorado Springs, CO. As several readers pointed out, I had not specified whether 8 or 16-bit arithmetic was to have been used. The shortest 16-bit routine was written by James Braud of Bay St. Louis, MS. Cliff's 8-bit routine and James' 16-bit routine are shown in Program Listing 2.

The eight-bit routine uses 10 bytes. The BC register pair is loaded with one. In fact, this load really loads the C register with one and the B register with 0, saving one byte over two separate "load immediates" of B and C. The remainder of the routine is a loop. Each time through the loop, the count in B is bumped by one, and the odd number in C is incremented by two. A SUB of the odd number in B is performed before the increments. If the result has gone negative, a return from the subroutine is made.

The 16-bit subroutine uses 11 bytes. The A register is first zeroed to hold the count minus one, which may be a max of 255. The BC register is then loaded with −1. This will be changed by decrementing twice to −3, −5, −7, and so forth. The loop portion of the subroutine adds the current negative odd number to the residue in HL. If HL goes negative the carry flag is reset, and a return is made. The remainder of the loop bumps the count in A, decrements the odd number to the next value, and then loops back for the next iteration.

Although the subroutines contrived here are short in terms of memory requirements, they are not necessarily the fastest code that can be implemented to find the integer portion of the square root. If we assume that the average 16-bit square is 32768, then it will take 181 iterations to find the integer portion of the square root.

Each iteration takes about six instructions, and the average time for each instruction is perhaps six microseconds. Roughly, then, the average processing time for square root computation will be:

181*6*6 microseconds, or about 6.5 milliseconds. Putting it another way, about 150 roots can be extracted per second, on the average.

This would be quite efficient for a DDS, but is quite inefficient for assembly language code. The routines presented here are interesting because of the "trick" involved and are not presented as the best method of finding square roots.

The trade-offs between memory space and speed are just two factors to consider in writing any program. Other factors are program development time (Does the code take a long time to produce because it is too "tricky"?), debugging (Has the code been adequately debugged, with test cases that represent typical and limiting parameters?) and program maintenance (Will you pick up the code at a later time when a bug is discovered and be completely at a loss to explain the tricks you employed?).

A New Challenge

Since the last puzzle was moderately successful, here's a second challenge to the readers of The Assembly Line. All results should be sent to me at the address at the end of this column. We'll announce the winners in a later column, and there'll be a token prize to make it interesting.

Problem: Write the fastest subroutine possible to multiply two eight-bit unsigned (0-255) numbers in the A register and B register. The result should appear in the HL register pair, and the two operands in A and B should be unchanged.

That's it for this month; next month we'll continue the topic of high-speed graphics, and have other topics geared to the assembly language beginner. ■

CAPTAIN 80

From page 20

niceties and go their own way. But whatever Pyramid 2000 lacks in familiarities, it makes up in descriptions and plot.

Name That State

Last on the review list is a game-educational offering from Synergistic Solar, Inc., Miami, FL. Name That State Quiz is the title, and it comes with sound. The program draws the shapes of different states on the screen and presents a user selected format of questions about that state.

Identifying a state by its shape can be a bit difficult, but I managed to get the first four or five right. T'pring, resident tabby cat in the Captain 80 headquarters, came over to investigate the pleasant sounds. Then I got one wrong. The computer emitted this unearthly combination buzz and gargling noise. T'pring, thinking I had killed it and she was next, leaped from the side of the desk, bowled over a cardboard box, lost traction, bounced off a doorjam and took up residence under a bed.

I liked Name That State Quiz for its educational value but a combination of its slow drawing speed and chalk-on-the-blackboard sound could hinder it in the classroom.

Next month, the winner of the Program in a Paragraph Contest will be announced. Until then, here's Captain 80 in Software Secret Headquarters signing off. ■

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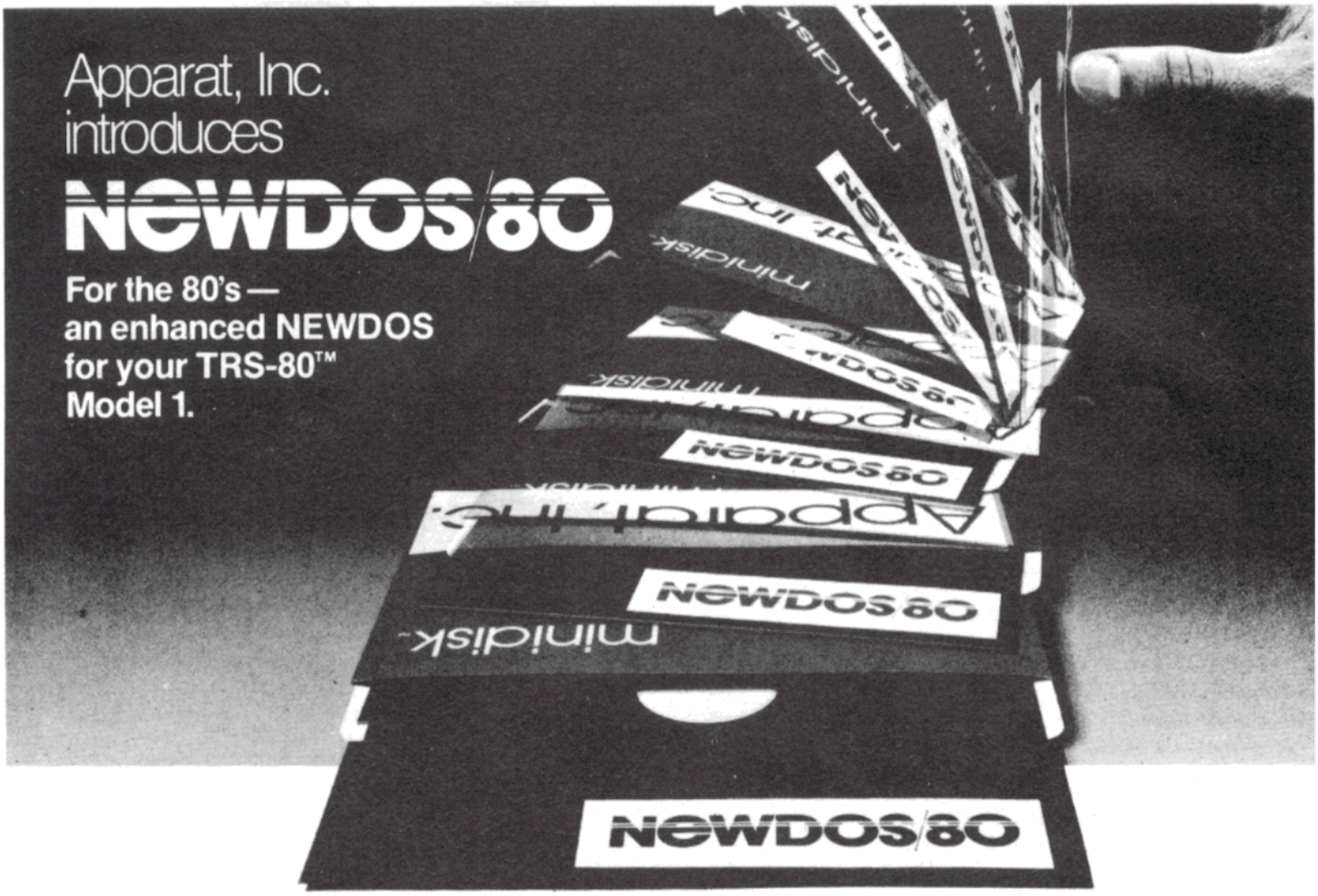

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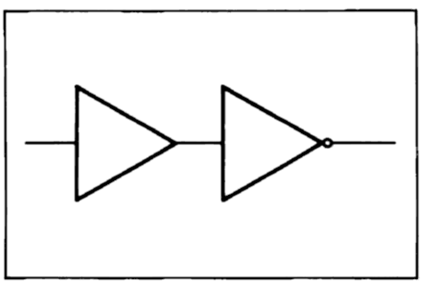
80 APPLICATIONS

by Dennis Kitsz

"A gate electronically evaluates its input to determine the pattern of similarity and difference."

Between last month and this, I hope you were successful in building the input port for the TRS-80. This month we will finish with some theory and an application.

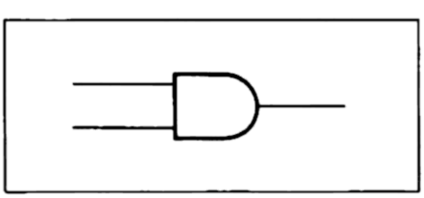
Fear not; basic digital electronics is tediously logical, but seldom very difficult. Let's return to the locked door analogy we used in April and see how the door can be opened. Here is one of the eight "tumblers" of the output port:



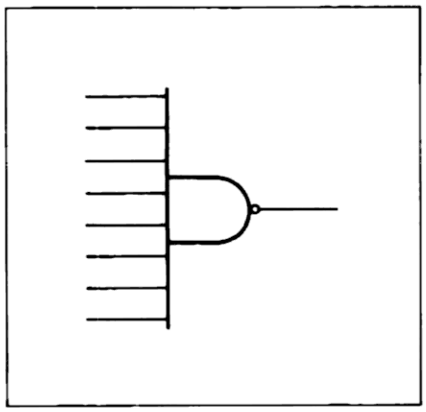
The triangle is a buffer—it leaves the signal unchanged, but protects the TRS-80's electronics from being overburdened with attachments. The second triangle is an inverter, having a small circle at its output meaning NOT. If the signal (bit) entering is one, its output is NOT one; if the input is zero, the output is NOT zero. The 81LS95 integrated circuit contains eight buffers, and the 81LS96 package contains eight inverting buffers.

The Gate's Job

A gate electronically evaluates its input to determine the pattern of similarity and difference and produces a specific output. The design below represents one sort of simple gate:

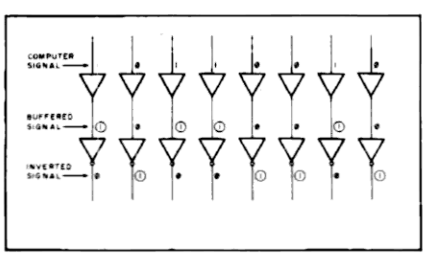


This gate's job is to determine if the first *and* second inputs are both one (high). Only then will its output swing high. We are using eight address signals to open the port's lock, so our "lock cylinder" must evaluate eight input. It looks like this:



Notice the NOT circle at the output. It means that if all input is high, and only then, the result will be NOT high. This cylinder is an 8-input NAND (NOT AND) gate.

How do we use this lock? In April's column, our key was cut to binary 1011 0010, which translates to hexadecimal B2 or decimal 178. The NAND gate, the lock's cylinder, has to see all one's to operate, so we set up the tumblers to produce this result:



The signals shown by the circled numbers are all ones—precisely what the "cylinder" circuit needs in order to respond. The tumblers are set, the NAND gate responds by trying to open the latch. Now refer to the complete circuit diagram: Z1 and Z2 are the tumblers, Z7 is the cylinder. Z5 and Z6 form the latch. The job of this latch is to allow signals to pass through its door when it is unlocked (enabled) and at no other time. This latch operates on a high (one) signal.

Look for a moment at Z8; it is a NOR (NOT OR) gate. If the first OR second (or both) input is high, the output is NOT high. Only if each input is low, will this gate swing high. Let's follow this through. The address of our output device has been found by the "tumblers" and the "cylinder" turns, but the Z5-Z6 latch will only snap open if a low signal called OUT is being sent by the computer at the same time. Data from the computer can now flow through buffer Z3, into the latch, and is locked in place for our use.

Before looking at the rest of the circuit, notice that the OUT signal from the TRS-80 also enables Z3. If we have so carefully designed our lock and latch, why isn't Z3 just left on? Isn't this extra signal redundant? One truly critical aspect of the eight lines handling data on the TRS-80—in fact, on virtually all microcomputers—is the dual use of these lines.

An address is a set of signals always commanded by the Central Processing Unit (CPU) in the computer; on the other hand, data must flow both to and from the microprocessor. This data, whether in or out, is sent on the very same set of signal lines, the "data bus." The computer has to tell us which way the data is expected to flow, and we must respect that. The CPU gives us this information on separate signal lines, some of which READ data from memory or WRITE data to memory, and two similar signal lines which indicate INput to and OUTput from ports.

Now, turn back to the diagram, and notice, in addition to the OUT line going to Z3, there is also an IN line to Z4. If we have any intention of relating reasonably to the outside world, the "data" door had better swing both ways!

A Short Circuit?

But if the output of Z4 is connected to the input of Z3, doesn't this form a short circuit? Or does Z3 get confused as to what input it is receiving? The answer could be a devastating yes. However, if we respect the computer signals, the doors can appear to be invisible—a special condition, a third state, neither on nor off, but rather one appearing electronically disconnected. A signal comes from Z7 to tell Z3 and Z4 (each an 81LS95 buffer) that their address has been selected; but the computer must send an IN or OUT signal to decide which one will be used—which way the information door will swing.

If the door swings in, the computer wants information from the outside world (for more details, see "A Simple Interface" in *80 Microcomputing*, February 1980). When the door swings out, the signals are latched by Z5 and Z6 for our use.

Finally, take note of the small circles at four of the outputs of each latch (Z5-Z6). Even at this final stage, we have our choice of data either in the form the computer sent it, or in its inversion. Some peripherals may turn on with a high signal, others with a low signal. It allows us programming simplicity, as we can always think of "on" as "one," no matter what control signal the peripheral device expects.

Why, then, do we not have the option of inverted signals on the input? It is possible, but because the TRS-80 is a computer, it can with simple elegance invert the input signal in a *program*—the software equivalent of an output latch!

I want to encourage you to understand that this device is versatile and can be a real alternative to searching for the special, expensive hardware that fills your need. I have spent considerable time with this device because from time to time, future columns will describe simple devices to "control your environment": generating sound, operating lights, motors and displays, checking temperature, and so forth. All will need a form of latched and buffered input/output device similar to this one.

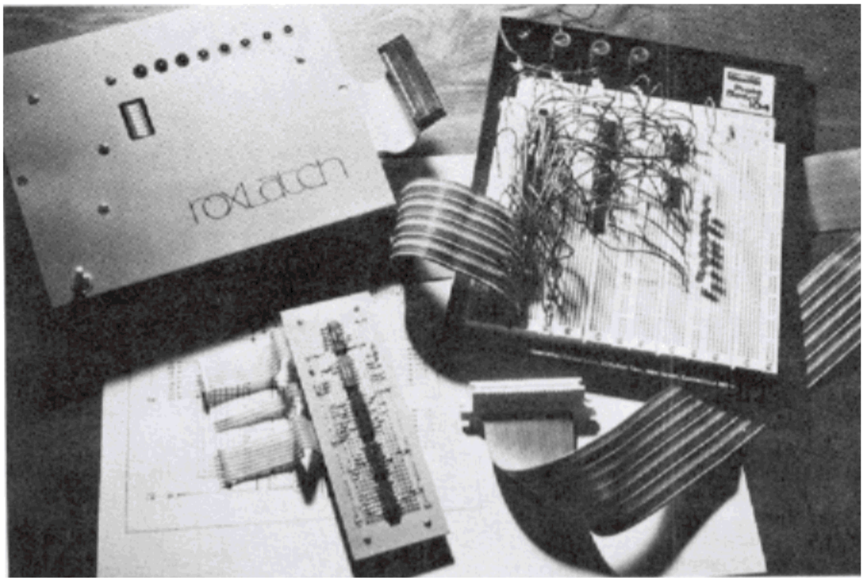


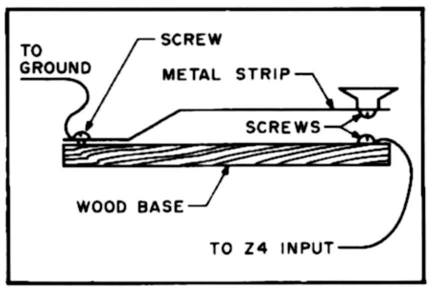
Photo by Dennis Kitsz

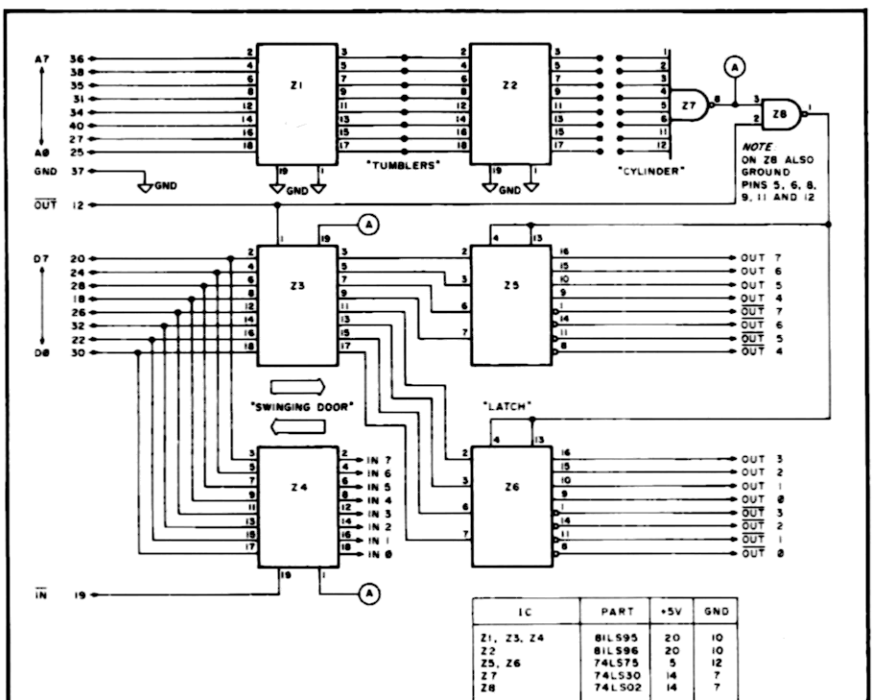
Before and after versions of the I/O latch project.

Fair Game

Finally, let's put together a simple, but very useful attachment, a "fair" input for playing games on your computer. Since the TRS-80's keyboard is scanned a row at a time, Player A always has the advantage of being first in action games that use INKEY$.

Attach a 1000-ohm resistor between each input of Z4 and the 5-volt supply. This ensures that the input "sees" a high signal, and that the millions of changing signals all around it don't accidentally trigger it into producing a zero. Next, obtain a small keyboard, or better for remote use, eight momentary-on pushbuttons. You can make a terrific set for youngsters or any folks who have difficulty with small objects (I built some for a nursing home) by attaching a long strip of aluminum to a large, flat board, so:





IC	PART	+5V	GND
Z1, Z3, Z4	81LS95	20	10
Z2	81LS96	20	10
Z5, Z6	74LS75	5	12
Z7	74LS30	14	7
Z8	74LS02	14	7

Fig. 1. Completed Circuit Diagram

Connect a wire between one side of each pushbutton and ground; connect the other contact to its respective input at Z4. This input floats high; pressing the button brings the signal low.

Here's a subroutine to use it; players in this example are holding buttons 1, 3 and 4 (connected to inputs IN0, IN2 and IN3):

```
1000  A = INP (178)
1010  A = NOT A
1020  A = A AND 13
1030  X = (A AND 1) + 12
1040  Y = (A AND 4) + 9
1050  Z = (A AND 8) + 5
1060  IF X = 13 PRINT "X",
1070  IF Y = 13 PRINT "Y",
1080  IF Z = 13 PRINT "Z",
1090  PRINT : GOTO 1000
REM • NUMBER OF PORT IN USE
REM • COMPLEMENT OF INPUT VALUE
REM • MASK FOR BUTTONS IN USE
REM • PLAYER 1 (IN0)
REM • PLAYER 2 (IN2)
REM • PLAYER 3 (IN3)
REM • RESULTS OF INPUT
REM • RESULTS OF INPUT
REM • RESULTS OF INPUT
```

Both space and devilishness prevent me from explaining this program; I leave it to you. Clues? 1. Think it in binary. 2. Write it in binary. 3. Aha!

Next month: software. (phew!) ■

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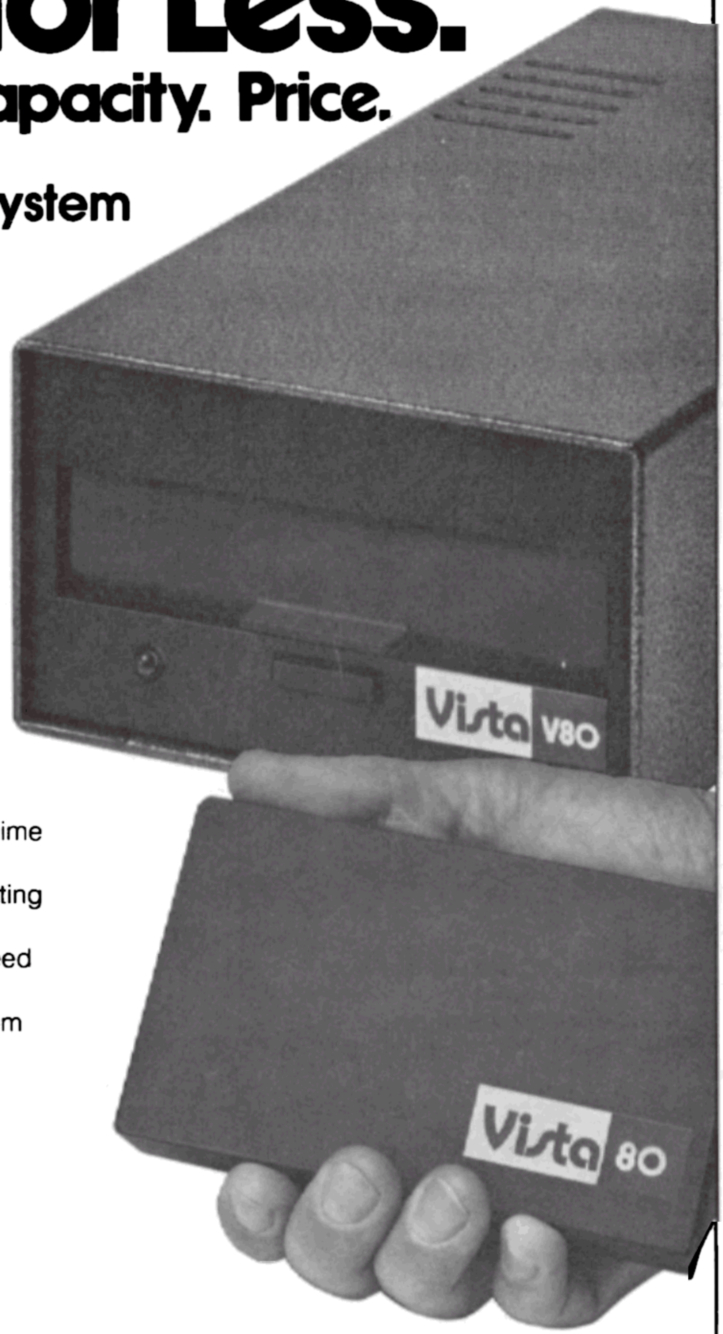

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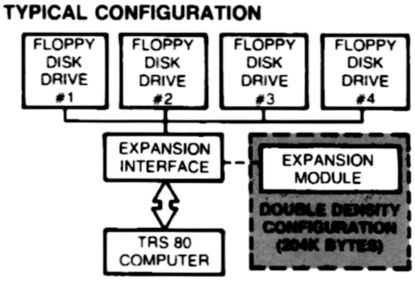

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CLUB 80
by Ross Wirth

"Someone recently estimated that there was a backlog of $200 billion . . . in software projects."

A new Pascal special interest group is being formed this month. The coordinator is Richard J. Bonneau, PhD (6 Tanglewood Dr., Shrewsbury, MA 01545). Richard is a computer software consultant and feels more people should be made aware of the potential benefits of higher-order languages. If you have an interest in Pascal pass your thoughts and ideas along to Richard.

Do the FORTRAN, FORTH, COBOL and LISP users out there desire a special interest group for their language? All it takes is one person to take the lead and serve as the coordinator.

Business Special Interest Group

A local business group is forming in the central coast area of California. The local coordinator is John J. Duemler (128 S. Elm St., Arroyo Grande, CA 93420). John works for H&R Block and has written and is using data processing and payroll programs in three H&R Block offices. He is currently planning to write a program to check tax returns (a natural). If you use a TRS-80 for business and desire to meet fellow users, you can call John at (805) 489-1414.

Education Special Interest Group

George Christoph is forming a special interest group for the exchange of information on computers in education. George teaches computer programming in a Cincinnati Junior High School (using seven TRS-80's) and BASIC programming in the local community education program. The first Information Processing Tournament, held in Ohio in 1974, was sponsored by George. To contact George Christoph write to him at Finneytown Junior High School, 8916 Fontainebleau Terrace, Cincinnati, OH 45231.

And don't forget about the High School Science Special Interest Group (Richard A. Marble, c/o Casady School, Box 20390, Oklahoma City, OK 73156).

Amateur Radio Operators' Group

If you are a ham, interested in the TRS-80 this new group may be just for you. For information contact Sam Martinez N3SM, 625 Kingston Road, Middle River, MD 21220.

Getting Behind?

Someone recently estimated that there was a backlog of $200 billion (that's right, billion) in software projects. Are you among all the others waiting for the "right" program to be developed? If you do not have the expertise to develop the software yourself and do not want to pay the full price for a custom program, there is still hope. Offer a free-lance programmer the marketing rights to the programs he writes for you. I often do this for clients and it benefits everyone. The programmer gets a little something right away and the possibility of a later profit, if he does a good job. You, the customer, get a program to your specifications. The public also gets another program to choose from.

Programming Hint

To disable the BREAK key in NEWDOS use the following BASIC statement in your program:

```
POKE 23461,0
```

To reactivate the BREAK, you should PEEK the contents of 23461 into a temporary variable before POKEing 0, and then use another POKE to replace the original value when you want the BREAK enabled.

I am always happy to hear from you. Please send your comments to me at 15906 E. 96 St. N., Owasso, OK 74055. Please include a self-addressed stamped envelope for personal replies. ■

UNLIMITED 80's
by Sherry Smythe

Recently, I was given the red carpet treatment by Radio Shack while visiting the Tandy Towers in beautiful downtown Fort Worth, Texas, where the West begins.

It's hard not to be impressed by one of the world's nicest private subway systems, a Tandy Center free service given to the residents of Fort Worth. The end of the line takes you to a mall whose center attraction is a large ice skating rink with all the trimmings—beautifully costumed skaters and their pupils.

Upstairs, about seventeen floors higher, are Tandy's corporate offices paneled with oak, offering breathtaking panoramic views of the city.

Tight Security

About ten minutes away, amid tight security, in what used to be a J. C. Penney's store and later a Motorola factory, is now a Tandy manufacturing plant, assembling TRS-80 Model I's and II's. Inside, in the austere waiting room, visitors sign in, receive passes and wait for a tour escort. Mr. Nishikawa conducted our tour.

Everywhere you look Model II's are in all stages of completion. Much of the sub assembly work is done in the orient, and many of the raw materials for this assembly come from other Tandy enterprises. The assembly line in Fort Worth is a narrow track that winds its way through the room. Each computer rests on a flat car that rolls along until the Model II is fully assembled and packed. Quality is controlled by a machine that can pinpoint any short on a board and reject it, if it is not perfect. Every Model II has two burn-in periods. One is under normal conditions for 24 hours and the other under extremes of heat and projected user abuse.

In a smaller area of the same building, Model I's are constructed. Only the keyboard-CPU unit is assembled in Fort Worth. But quality is controlled in every step of the production.

Mr. Nishikawa keeps his employees competitive within the organization by recording the progress of various construction stages on a series of five or six TRS-80's mounted in the wall. Each displays the performance records of the departments and the daily percentage completed of their assigned goals.

The number of rejected units is shown and teams of employees endeavor to keep their reject scores low and their daily output high.

Upgrading

One part of the Model I assembly area is dedicated to upgrading the machines. Everything from new chips to new keyboards are installed.

Repairs are performed in another area with special diagnostic equipment that tells the operator just what's wrong and in most cases how to fix it. Spooky! Computers fixing computers.

John Roach assured me that Radio Shack is planning to maintain support on all existing computers, even though new and more exotic equipment is now being developed to hit the marketplace in late summer or early fall. And witnessing the thousands of computers being cranked along the assembly line, I believe it. ■

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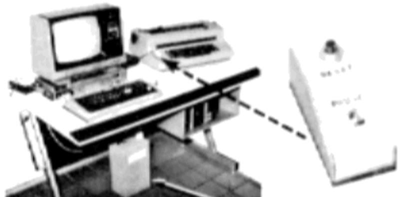

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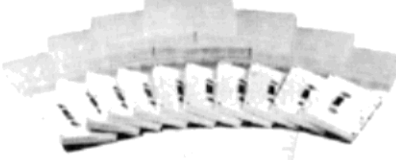

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80 NEWS

by Nancy Robertson

Radio Shack Support Of Computer Products

According to statements made by company President Lewis Kornfeld in a recent press release, Radio Shack is offering wider support of their computer products. Computer leasing has been available since January. Computer centers have been opened in the 50 major markets and on-site service is an option to carry-in service.

Kornfeld states that the computer centers each incorporate "a full servicing facility, as well as a classroom, stockroom, sales room and display area."

Charlie Philips, company vice president, explains that, theoretically, each computer center has an instructor and a technician on the payroll. Courses are offered in the basics of computing. Customers are offered advice on devising a system of hardware and peripherals that is best for their specific needs.

The on-site service contract will bring a repairman to your door. To maintain and repair the equipment after the warranty lapses, contracts may be purchased for limited or unlimited on-site service for the Model II. This option is generally available for Model II service only. If you own a bevy of TRS-80 Model I's, it may also be possible to contract for the service.

Contracts and costs for on-site repairs vary from system to system. According to Philips, the most common form of the limited service agreement provides an installation visit, one preventative maintenance call and two remedial calls for $500 within a 50 mile zone of the service center.

TRS-80 Model II

Further information on leasing and on-site service contracts is available from computer centers and from company owned RS stores. Check with dealers as well. Computers centers may be located through the yellow pages or directory assistance in large urban areas. Local Radio Shack owned stores can direct rural residents to the center nearest them.■

Three Software Utilities

There is another editing tool on the market. This one, Packer, is sold by Cottage Software, 614 N. Harding, Wichita, KS 67208. Using five options, Packer helps save memory and time. It is one of three new releases from Cottage Software.

Packer is written in machine language, and is supplied on two tape cassettes in three versions, one each for 16K, 32K and 48K for Level II or Disk BASIC. Packer is sold with an instruction manual for $29.95. It works with the following commands:

UNPACK unpacks multiple statement BASIC lines into single statement lines while maintaining program logic. It also inserts spaces for easy reading and editing. You select the starting and ending line numbers, or unpack the entire program.

SHORT removes unnecesary words (eg. LET, GOTO after THEN or ELSE), spaces, and remark statements to shorten program length. Again, you can specify starting and ending line numbers.

PACK performs UNPACK then SHORT. Next it packs lines into multiple statements up to the maximum length you specify. It maintains complete program logic, including IF/THEN/ELSE statements, branches, etc. You can PACK the entire program or just sections of it.

RENUM renumbers your BASIC program lines including all branch references, such as GOTO, GOSUB, etc. You may input the first line number to be changed, the new line number and the increment for all subsequent lines to the end of the program.

MOVE moves any number of program lines to any new location in your program, and changes all branch references to the new line number.

Cottage Software's Disassembler disassembles Z-80 object code into Zilog mnemonics and shows ASCII Strings during disassembly.

With the MEMORY DISPLAY/MODIFY routine you can see the contents of 256 bytes of memory at one time in either hex or ASCII. You can modify the contents of RAM from the keyboard. STRING SEARCH searches through memory for a string of object codes to find subroutine calls, compares, register loads, etc. With READ/WRITE OBJECT TAPE you can read an object tape into memory for disassembly or modification, and then make a copy on tape of any part of ROM or RAM.

A program written in BASIC that edits Disassembler for use on a line printer and a program that allows loading and inspection of any TRS-80 500 baud tape are included in the package which costs $19.95.

System Tape Duplicator, another Cottage Software product, duplicates machine language tapes. Programs recorded on your own equipment normally load more easily, as the folks at Cottage Software point out. This item sells for $12.95.

Reader Service ✓ 170.

Machine Code Disassembler

Datagraphics, P.O. Box 566 Union Station, Endicott, NY 13760, is selling Disassembler-80. This software disassembles ROM or RAM, and has selectable output to either video display or a printer. It prints standard Z-80 mnemonics, with decoded data and addresses, in an easily readable format. Disassembler-80 handles all legal code combinations and traps illegal codes.

It provides an aid to assembly language programmers and is an educational tool for anyone interested in learning the workings of the Z-80 microprocessor. The package is supplied on tape for 16K Level II with optional line printer and is disk compatible. It costs $9.95 for the Model I. It has just become available for Model II, as well.

Reader Service ✓ 169.

Products Stretch Memory of Models I & II

For the Model I TRS-80, Vista Computer Co., 1401 Borchard St., Santa Ana, CA 92705, offers the V-80 Disk Drive System. Available in one-, two-, and four-drive configurations, the V-80 is a 40-track system which provides 102K bytes per drive. Track-to-track access time for the V-80 is 12ms compared to 40ms for the TRS-80.

A program patch, supplied at no charge by Vista, will adapt your TRSDOS disk operating system to accommodate the 40-track drives and faster access times. Patches are available for all existing versions of TRSDOS. Cables are available for two and four drives.

Another Vista product, the VXM-80 Expansion Module, operates with the TRS-80 expansion interface to provide double density storage. In other words, total storage on a 40-track diskette can be increased from 102K to 204K bytes. VXM is priced at $239, including all hardware and software.

Beware: The VXM-80 is designed for use with Vista's V-80 Disk Drives, and Vista does not guarantee its operation in double-density format with TRS-80 drives.

Vista also offers Model II Disk Expansion System, which is available with up to three eight-inch, 77-track disk drives. A three-drive system can add 1.5 Mbytes of storage to your Model II TRS-80, giving the system a total of up to 2 Mbytes of on-line disk storage. Vista's Model II is fully compatible with the TRS-80 Model II, and plugs directly into one of the expansion connectors on the TRS-80.

The single-drive expansion system lists for $1000, the two-drive for $1550, the three-drive for $2100 and additional drives for $525. Vista products carry a 120-day warranty which covers both parts and labor.

Reader Service ✓ 180.

Level II Data Management

A data management utility for the TRS-80 Level II 32K, TRSDOS or NEWDOS, is available from Standard Systems Corp., Marketing Department, 2421 Tanglewood Road, Decatur, GA 30033.

The program, which is written in Disk BASIC, is called Customized Record Inquiry/Edit System (CRIES). It is menu managed for key-indexed records.

Naturally, the program will EDIT, ADD and DELETE records. It will allow listing of record keys, searching by examples and merging of disk selected portions.

The disk package contains CRIES, DOS command file, documentation and sample data files for $45.

Reader Service ✓ 164.

Create and Compile Graphics and Animation

Electra Sketch is an animation and graphics compiler which is available from Macrotronics, 1125 N. Golden State Blvd., Suite G, Turlock, CA 95380.

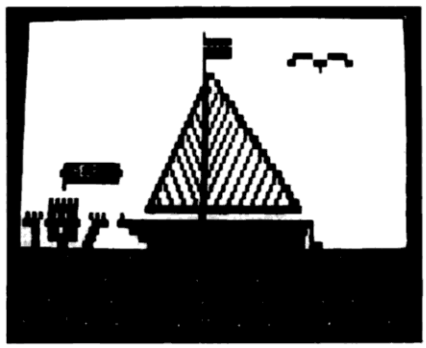
Macrotronics explains Electra Sketch will let you create your own movie sequence or combine graphics and plain text to create animation.

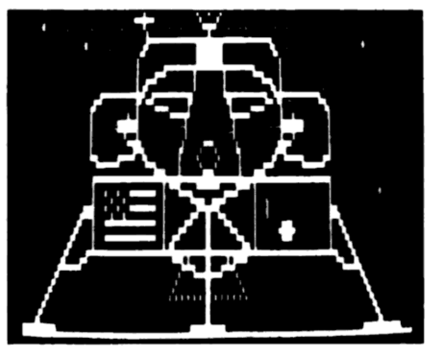
Electra Sketch works with one-key commands to control cursor direction, erase, draw vectors, fill in backgrounds, or create titles. Frames are saved on disk, can be recalled, edited and printed on a line printer.

Saved frames are animated by displaying them in either forward or reverse sequence. The speed of the animation can be changed in 10 increments from slow motion to rapid play.

Macrotronics is charging $14.95 for Electra Sketch. A catalog of 30 Macrotronics products is available without charge.

Reader Service ✓ 163.





Examples of Electra Sketch graphics

Series 8000 Medical & Dental Management Systems

The Series 8000 Medical and Dental Management Systems for the TRS-80 Model II (and most other 32K CP/M disk based microcomputers) upgrades Univair, Inc.'s early version of the package.

Among other things, the new features include automatic display and computation of normal office charges, improved patient scheduling routines, alphanumeric patient sorting and archiving, provisions to link special user-developed programs into the main menu, and detailed operators manuals.

Series 8000 Medical/Dental Systems are on sale from Univair, Inc., 10327 Lambert Int. Airport, St. Louis, MO 63145 for $495 each. The price includes telephone consultations on initial set-up. Series 2000 owners may upgrade their systems at a cost of $100 and will receive a new six-month warranty. Operators manuals may be bought separately for $15.

Reader Service ✓ 177.

Accounts Receivable/ Invoicing for Model II

Accounts Receivable/Invoicing System for the TRS-80 Model II is available from Taranto & Ass., Inc. The package design is the result of users' experience with Taranto's Model I conversion of the Osborne/McGraw-Hill Accounts Receivable book, and has also been expanded to include an invoice program.

Customer and invoice files are key controlled for quick access. Up to 51 items may be billed on a single invoice. Both invoices and statements are printed. Package users define sales tax rates as they apply to each customer. Customer service charge rates are also defined by users. These functions are then computed as they apply.

The package generates reports which list invoices that have not been billed, open items, closed items, and an analysis of age and open items.

Osborne/McGraw-Hill's *Accounts Payable/ Accounts Receivable Wang Book* documents much of the package and must be used in conjunction with it. Both the book and the package are available from Taranto & Ass., Inc., Box 6073, 4136 Redwood Hwy., San Rafael, CA 94903. The book costs $20. Accounts Receivable/Invoicing System costs $249.95.

Reader Service ✓ 162.

Data Base Management

IDM-M2, an interactive data manager for the TRS-80 Model II, provides a general purpose approach to data base management. Micro Architect, who produces IDM-M2, suggests that it allows many applications for users without the technical knowledge required by most data base programs.

The package is a conversion of IDM-IV for the Model I with additions. It includes two levels of security, up to 40 fields, search command, statistics and error trapping. The report generator has optional column justification, dating and automatic paging and a record selection range. The report writer includes field addition and subtraction, and operators for filter criteria, field updates, record deletion and a display format for records.

IDM-M2 is written in BASIC. It requires 64K memory. The package is priced at $199 and is sold by Micro Architect, 96 Dothan St., Arlington, MA 02174. Demonstrations can be arranged.

Reader Service ✓ 176.

32K Expansion Interface

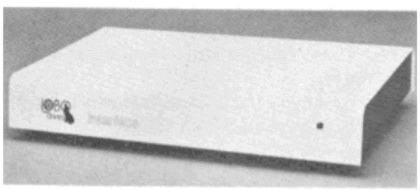
An expansion interface for the TRS-80 called Model LX80 is available from Lobo Drives Int. It expands memory capacity up to 40 million bytes, or 32K of RAM.

A switch permits overriding the keyboard ROM for booting in diagnostics and customized operating systems. Connectors for the 5.25 and eight-inch floppy disk drives and other peripheral devices are located on the side and rear panels.

Other features include a parallel Centronics printer port; a port for the Lobo Drives Model 7710T Winchester hard disk drives, a screen printer port, two microprocessor-controlled bidirectional serial ports and a crystal controlled real time clock.

The interface is sold by Lobo Drives Int., 5082 Shirley Drive, LaPalma, CA 90623 for $525. Dealer discounts are available.

Reader Service ✓ 178.



Lobo Drives' Expansion Interface.

Nevada COBOL for TRS-80s

Business Microproducts, Livermore Financial Center, 1838 Catalina Ct., Livermore, CA 94550, has the Nevada COBOL compiler available for the TRS-80 Model I and II. The compiler has been running for one year under PTDOS and was converted to CP/M in 1979. It has been relocated to 4200H for the Model I, while the Model II works with the standard CP/M.

Nevada COBOL by Ellis Computing was designed specifically for small businesses using microprocessors. It quickly translates source language programs into machine language programs and is simple to use.

The compiler is a subset of ANSI-74 and includes random access file support, both fixed and variable length sequential files, debugging capability, copy statement, character string, 16-bit binary and packed decimal (COMP-3) data types, 18-digit accuracy, hexadecimal nonnumeric literals, English language error messages and interactive ACCEPT/DISPLAY.

Nevada COBOL requires 16K RAM, two five-inch single density drives, or one eight-inch single density drive.

Including a run time package, sample COBOL program and terminal configuration program, the compiler is supplied on a CP/M data diskette. The cost, including a manual, is $99. Documentation is available separately for $25.

Reader Service ✓ 166.

Software for Dentists

Dentalware, a package combining patient treatment plans with patient billing, is being sold by Caldata Systems, P.O. Box 178446, San Diego, CA 92117. Caldata explains that "complete word processing capability" is thrown into the bargain.

Besides keeping track of past and planned treatment for each patient, the package can take care of all patient accounts. Fees are set by the package user, then the package will issue itemized statements and tally balances. Dentalware can also be used to fill and file insurance forms.

Designed for the Model II, the complete package costs $2600. (From what Caldata says, you get the impression that pulling teeth will be just about the only thing left for the dental staff to do.) The instruction manual may be purchased separately for $35. The word processor, Word Magic II, costs $100 when purchased separately.

Reader Service ✓ 181.

Electric Pencil Products

Several new Electric Pencil products are available from Michael Shrayer Software, Inc., 1198 Los Robles Drive, Palm Springs, CA 92262.

The Electric Pencil II is being shipped for TRS-80 Model II users who have CP/M. It is available with three print packages:

Standard Print Package runs with serial or parallel interfaced printers. It costs $275.

Diablo/Qume Print Package works with serial versions of the Diablo and Qume Micro Sprint 5 printers. It is priced at $300.

NEC Print Package works with serial interface NECs only. The price is $300.

All these packages contain fractional character spacing (pseudo proportional), bidirectional printing, boldface and automatic negative linefeeds.

The TRS-80 Model II TRSDOS version of the Electric Pencil II for non CP/M users is also available. Additional features in this version are word left, word right, word delete and page numbering at the bottom.

Standard Printer Package retails for $325 and the Diablo/Qume/NEC Printer Packages retail for $350. The company makes no upgrades or exchanges between CP/M Model II and TRSDOS versions.

Convert is a conversion utility program which converts files created by the Electric Pencil II to CP/M. Files may be created in assembly language, BASIC, Fortran, etc., using the Electric Pencil and then converted into CP/M files for further processing. Convert is available for $35.

Reader Service ✓ 167.

Personal Finance Package

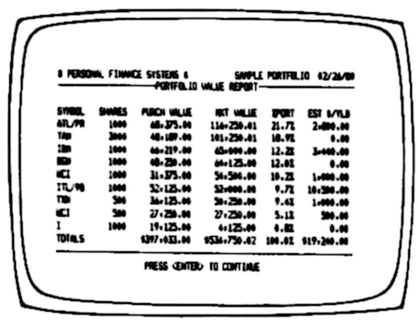
Investment Portfolio System, a data base management program with a broad range of applications, is available from Personal Finance Systems, 1446 Durham Rd., Madison CT 06443.

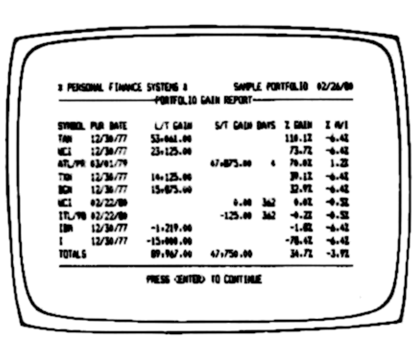
The program will store and report data on as many as 72 securities and review items in the portfolio by price, yield, percent gain or loss. It provides four special reports: complete summary data on the portfolio; current value and return; long and short term gain and a security analysis report. This latter report provides information about return on investment, annualized yield and earnings and yield gain compared to market index.

Personal Finance Systems is developing other data base management programs, which will record sales as well as purchases, issue tax reports and Security Exchange Commission reports and update the data base via a telephone modem.

Investment Portfolio System is available in a disk version for TRS-80 32K LII single drive computers, and in a tape version for 16K LII. Both programs are supplied on a single tape. The package, including documentation, costs $39.95. Documentation is available separately for $7.50.

Reader Service ✓ 165.





Sample gain on value reports

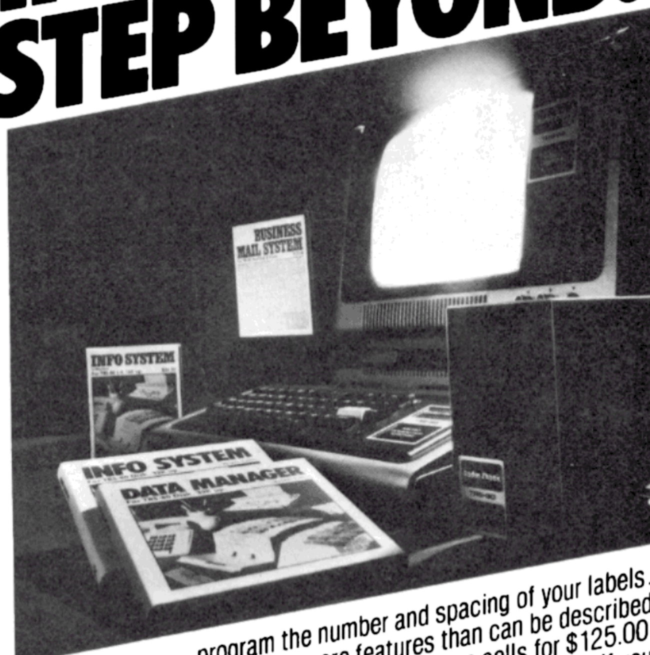
Mediamix Typesetter

Mediamix, PO Box 8775, Universal City, CA 91608, is selling PSRJ + 2.0 for use with their IBM Model 50 Typewriter/TRS-80 Interface. This machine language program prints out an Electric Pencil text file (or any ASCII file) using the IBM 50's proportional spacing type elements, with full right justification.

The user can imbed codes in the text for centering of titles, indenting paragraphs, underlining, typing special characters and pauses during printing to allow changing type fonts for titles, italics, etc.

Reader Service ✓ 174.

TBS-80
DATA PROCESSING SYSTEMS.
ONE STEP BEYOND.



If you thought the TRS-80™ microcomputer was just a toy, think again. These **TBS-80** software systems will turn that computer into a **powerful data processor.**

INFORMATION SYSTEM by Dale Kubler is simply the best in-memory, data base manager on the market. It allows you to create files with up to ten fields per record, up to 40 characters per field and 200 characters total per record. Data from the keyboard is entered directly onto a screen display of one entire file. Once entered, you can sort or search your entire data base by any category and have the information desired displayed on the screen. **INFORMATION SYSTEM** provides a thorough editing mode allowing changes by line without rewriting an entire file. This program allows you to program your own printouts to almost any form you desire for line or serial printers. Screen prints from anywhere in the program are also available. **INFORMATION SYSTEM** creates either disk or cassette files depending upon the version you use. From mail lists to recipes, this program is the ideal small system information manager. The price for this program, 32K up disk is $34.50. For systems 16K up tape it's $24.50.

DATA MANAGER by Dale Kubler starts out where INFORMATION SYSTEM leaves off. Requiring 32K and one disk, it accepts up to ten user-defined fields with up to forty characters per field and 255 characters per record. As with all TBS software, data entry and editing is professional and simple to use. What makes this program stand apart from "in-mem" data managers is that it uses up to four disks on line as memory, or as much as 320K of memory storage. Because disk sorts take more time than in-mem sorts, **DATA MANAGER** enables the user to create and maintain up to 5 "key" sort files for quick access of data. A utility program is provided to calculate the number of records possible since the amount of records you can maintain is dependent on a number of variables. This program also supports the upper/lower case modification, and printouts can be programmed to almost any format and sent to line or serial printer. Background printing is provided enabling the computer to search and print at the same time. If you already have INFORMATION SYSTEM, **DATA MANAGER** will accept those files. A necessity for organized people, this program sells for $49.50.

BUSINESS MAIL SYSTEM by Dale Kubler is designed for large-scale business users. Requiring 32K, two disks and printer, this program will store up to 150,000 names in a single file spread out over multiple disks. Each data disk holds 500 names. After data entry, BMS automatically sorts the data by zip code and alphabetical order within the zip code. The program tells you when and which data disk to insert, expanding your files automatically until you've reached 300 disks. Data is input directly onto formatted screen display with the option to use Company Name/Attention instead of Last Name/First Name. Three numeric and one alpha code fields are provided to help you use the search and printout mode. **BUSINESS MAIL SYSTEM** allows you to program the number and spacing of your labels. With more features than can be described here, this high-powered program sells for $125.00.

TEXT MERGE is the program that puts it all together. If you have the ELECTRIC PENCIL from Michael Shrayer, 32K and one disk drive, then this program is a must. It will merge your data base from any of the above programs with an Electric Pencil file. For example, when you write a letter that is going to several hundred people, you can "code" it by entering a field name from the above programs in place of the actual information. Then, when **TEXT MERGE** is run, it will print out your Pencil file and substitute the "code" with the actual data. In other words, you can print out 1,000 personalized letters without stopping the computer. This program will also enable you to selectively search out only the records from your data base that you wish to use. Also included is the ability to set left, right, top and bottom margins, set page numbers anywhere on the page, and print out right justified if you so choose. **TEXT MERGE** will turn your computer into a powerful data processor and it sells on disk for $49.50.

TBS has other incredible software for Tandy's microcomputer. Intent on making it a powerful tool, we have **large scale business accounting systems, general accounting systems, system utilities** and the **Library 100.** We have the only **DISK HEAD CLEANER** (for APPLE too!) and **GRAN MASTER DISKETTES,** the best on the market.

TBS is **YOUR COMPANY,** and we build systems, not just software. The above products are available now, nationwide. Visit your local Computer Dealer or Associate Radio Shack Store and demand the best, demand TBS. For more information, contact us through the numbers below.

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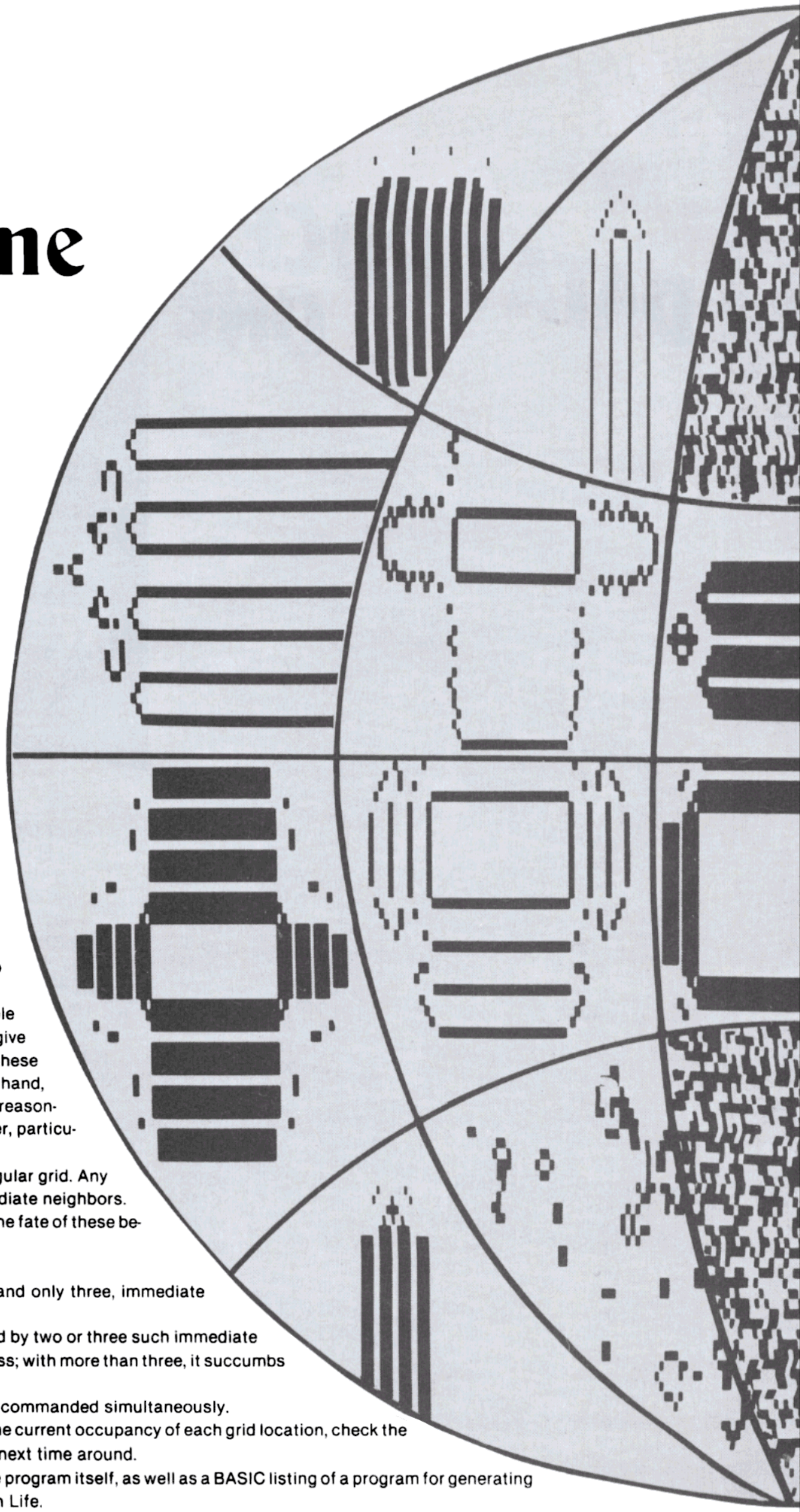
THE BOTTOM SHELF, INC.
(404)939-6031 • P.O. Box 49014 • Atlanta, GA 30359

The Game Of Life



Dennis Bathory Kitsz
Roxbury, VT

Classic among challenges in computer programming is the Game of Life, conceived and developed in the early 1970's by British mathematician John Conway. Life is not exactly a game, it is more than a pastime, and most of all, it is a stunning display of video graphics for the TRS-80.

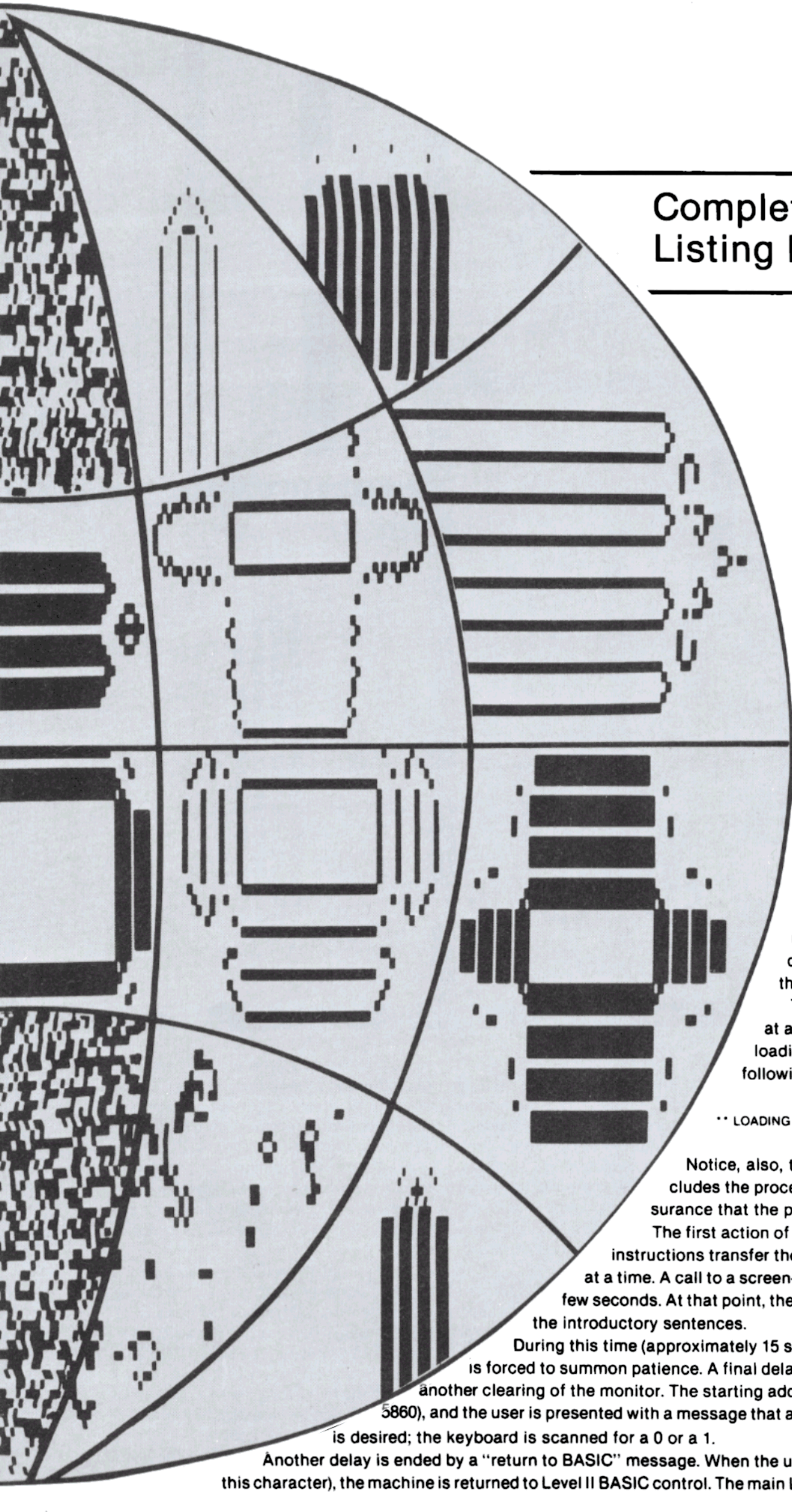
The Game of Life is based on a few very simple rules. A universe of beings is created to live, give birth, and die. An infinite, random universe of these beings would be most interesting. On the other hand, a limited, regularly-ordered universe is the only reasonable way Life can be programmed on a computer, particularly on a computer of the TRS-80's size.

Conway's original universe consisted of a regular grid. Any being on this grid is surrounded by eight immediate neighbors. Conway provided only three rules to determine the fate of these beings.

1. A potential being, surrounded by three, and only three, immediate neighbors, is given birth.
2. A being, once born, stays alive if bordered by two or three such immediate neighbors. With less than two, it dies of loneliness; with more than three, it succumbs to overpopulation.
3. Every generation of births and deaths is commanded simultaneously.

This is an ideal computer problem: Examine the current occupancy of each grid location, check the number of its neighbors, and readjust the grid next time around.

What follows is an assembly listing of the Life program itself, as well as a BASIC listing of a program for generating "seed" populations. I call it Playing "God" with Life.



Complete Assembly Code Listing Begins on Page 54

About this Version

This version of Life was created with certain of the frustrating aspects of real life in mind. In the beginning, when the screen clears and the introductory text is presented, a long delay ensues. Each letter appears separately, and the text builds on the screen. The machine is taken from the hands of the user until the text is complete, and, even then, will accept only the requested input, with no help from the ENTER or BREAK keys.

Take a look at the actions of the program a step at a time. The assembly program, Listing 7, gives a loading message to the user starting at line 240. The following statement is displayed:

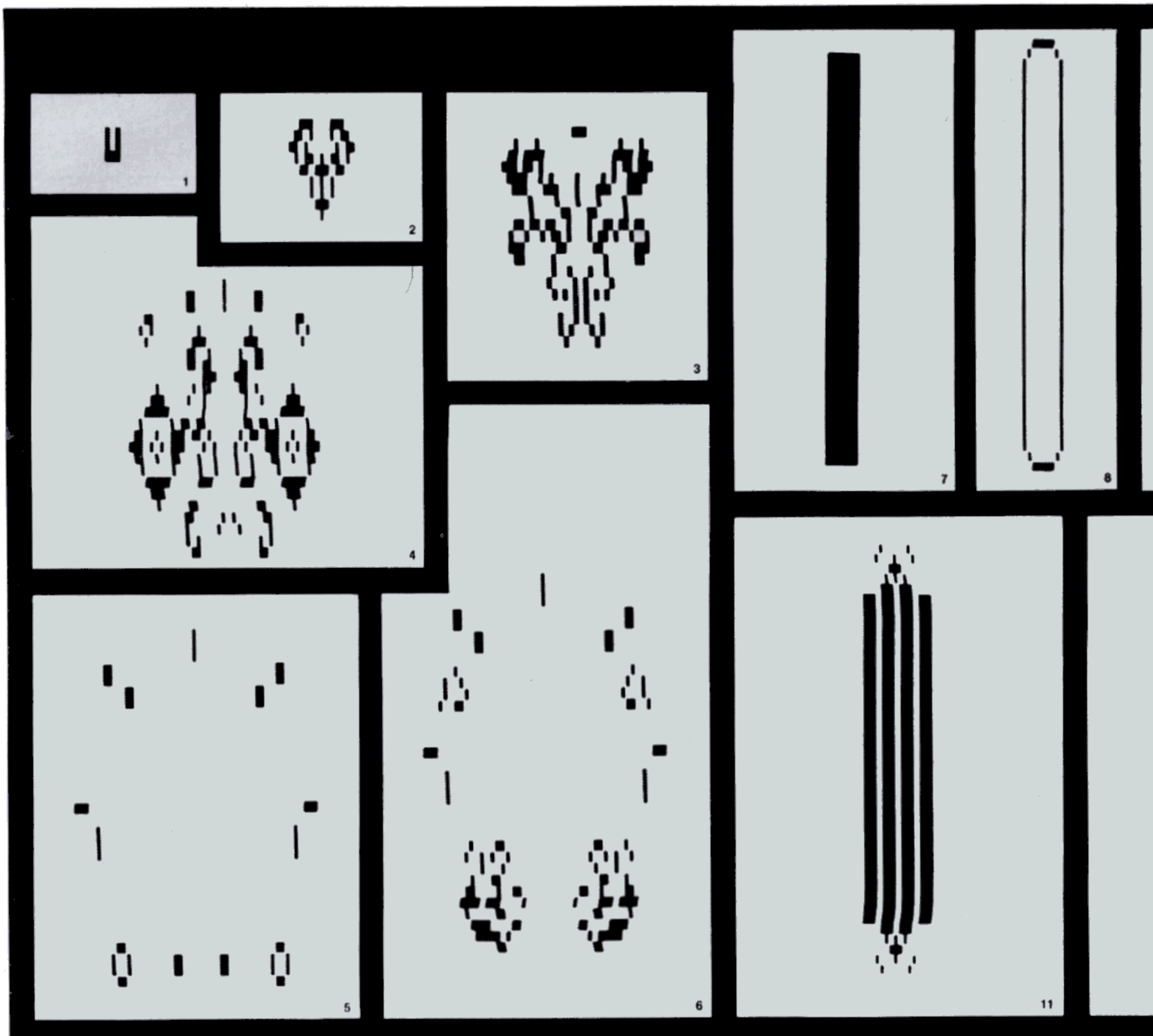
** LOADING LIFE9 *** WAIT FOR "GOOD LOAD" *** THEN ENTER "/" **

Notice, also, that a ***** GOOD LOAD ***** message concludes the process (line 6740), in order to offer a measure of assurance that the program made it.

The first action of the Life machine program is at line 5190. These instructions transfer the opening monologue to the screen a character at a time. A call to a screen-clearing subroutine is made, which is held for a few seconds. At that point, the first two lines of text are displayed, followed by the introductory sentences.

During this time (approximately 15 seconds), the keyboard is disabled, and the user is forced to summon patience. A final delay holds the message on the screen, followed by another clearing of the monitor. The starting address of BASIC's "USR" call is put in place (line 5860), and the user is presented with a message that asks whether a count of the passing generations is desired; the keyboard is scanned for a 0 or a 1.

Another delay is ended by a "return to BASIC" message. When the user enters a zero (the program responds only to this character), the machine is returned to Level II BASIC control. The main Life pro- *continued to page 44*



In the Game of Life, the pattern of growth should be fluid—although for theoretical purposes, this fluidity is not important—the beauty of the changes is often the most important reason for programming Life. But the larger the grid of beings, the slower these changes can be calculated by the computer.

A small (and certainly uninteresting) total universe of four cells by four cells demands 16 checks on each cell and its eight neighbors, or 144 examinations in all. A 20 by 20 grid is still small, hardly two square inches on the video monitor, but demands about 3,600 distinct cell checks.

The TRS-80 video graphics system offers an irresistible arrangement of 48 cells deep by 128 cells wide—6,144 in all. For that large a grid, over 55,000 cell examinations have to be made to complete each generation.

After that introduction, the game may sound like a dry process, but the screen patterns produced are beautiful designs that are often referred to by names such as gliders, ponds, space ships, flashers, traffic lights, and by more poetic terms such as civilizations, gypsy troupes, marauding bands, hermits, and so forth. Take a look at the first series of photographs, 1-6.

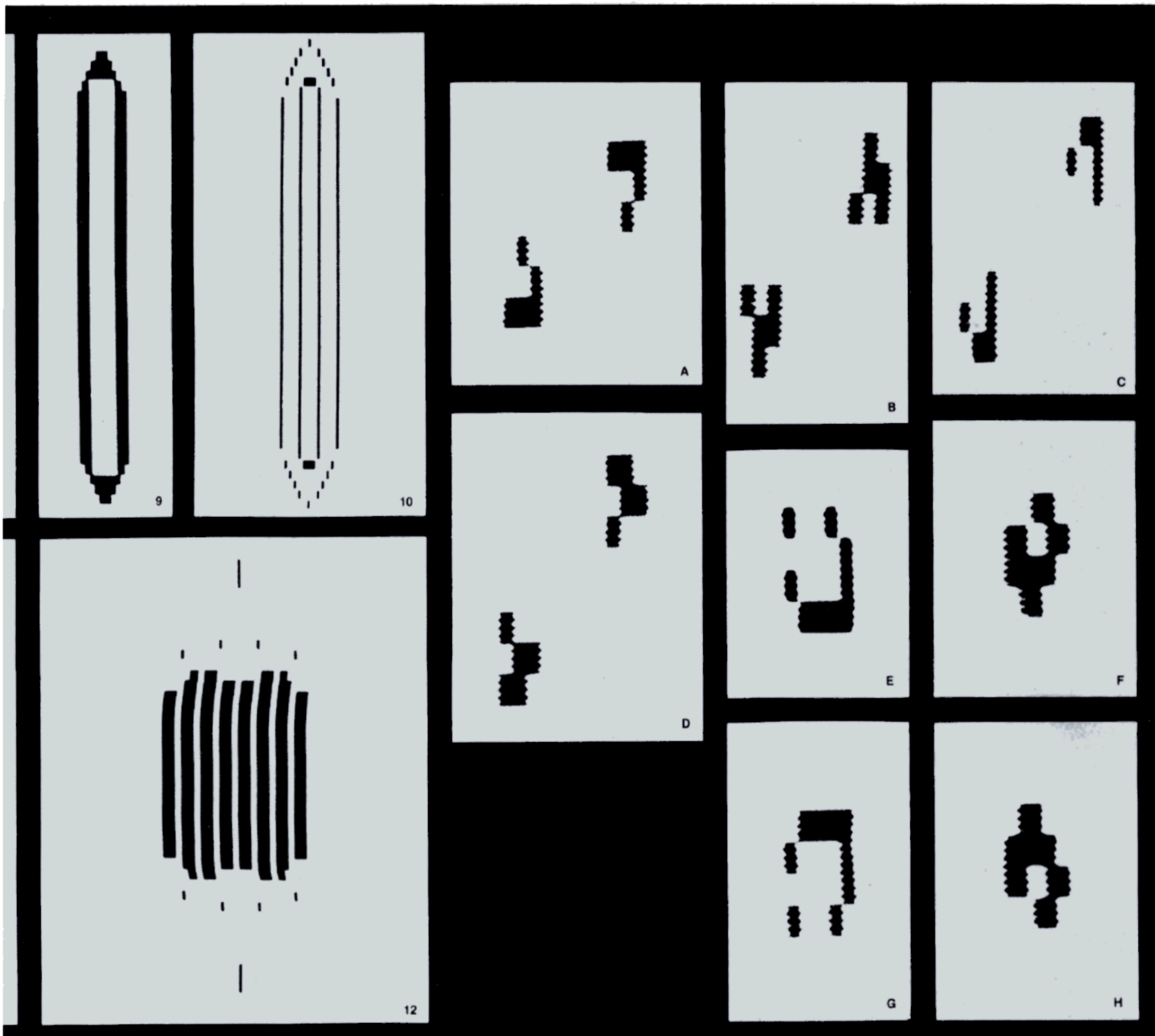
A simple group of seven beings formed in the shape of an arch (sometimes called pi) develops over the course of 173 generations, producing fascinating symmetrical patterns. Through its life, this civilization grows larger.

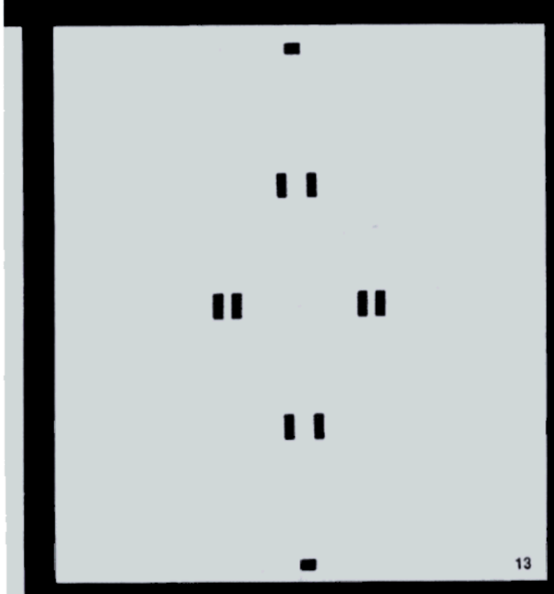
One interesting pattern, dubbed a glider in Conway's original description, is among the group of pentominoes, or patterns built from five characters. The glider goes through a few permutations, eventually cloning itself after four generations, but moves in an angular path with each self-duplication. See photos A-D.

Another of the familiar Life patterns is the spaceship, photos E-H, which replicates itself in four generations as well, but appears in mirror image every two generations.

The tall bar presented in photos 7-13 reaches stability much earlier, but during that time offers dozens of designs reminiscent of art deco, or, at the very least, like an old Wurlitzer juke box!

The third series of photos, 14-6, shows three points in the long life of a random initial population, which reaches stability only after hundreds of generations. Some random patterns will continue for thou-





Photos 1–6: The Life of the arch pentomino, at birth; generations 18, 90, 113, 159, and stability at generation 173.

Photos 7–13: A tall bar created of several hundred cells, at birth; generations 1, 2, 3, 4, 12, and stability at generation 31.

Photos A–D: Life cycle of two "gliders". The glider returns to its original configuration at a new position in four generations.

Photos E–H: Life cycle of the "spaceship". Like the glider, this figure returns to its original configuration in four generations.

Photos by Dennis Kitsz

sands of generations, as a small group of beings might develop in one corner, eventually traveling and overtaking another portion of the screen in what could be called a battle or perhaps imperialistic exploration or merely the mixing of great cultures.

Life afficionados will talk about Garden of Eden patterns. These are groups which must be created to exist; that is, they cannot be given birth by any other known combination of cells. But the greater enjoyment for me is becoming an observer in an ageless master plan—a sort of limited deity with control over a Garden of Eden, possessing the power to commit the universe to oblivion or make it grow full.

You can create and destroy at will, but to change the master plan is beyond your power. We can only observe as the generations march by, suspending time to save a few friends.

It is a programming challenge to develop a Game of Life that makes metaphors like these possible. To understand this challenge, it is worthwhile to attempt to produce a single generation from a seed pattern by hand. Let's take a look at three ways of programming Life on the TRS-80.

The first method of programming is to use an entire memory location for each cell. This means, unfortunately, that a grid of only 64 characters across by 16 characters deep can be used. Nevertheless, this is the easiest choice, and can be programmed in BASIC (Listing 1). Each generation of blocks takes two minutes and 10 seconds to produce.

The second method of programming Life is to use all the graphics cells that make up the TRS-80 video system. Each character location has been broken up into six graphics points, which are accessible through the SET and RESET functions in Level II BASIC. However, the SET and RESET commands are very slow. In order to demonstrate quickly the speed at which the built-in graphics of the TRS-80 function, enter the three short BASIC programs presented in Listings 2, 3 and 4.

The first of these executes in 60 seconds; the second, in 10 seconds; and the third, fastest of the BASIC options, in two seconds. Now, enter the program in Listing 5, which POKEs into place a program to perform the identical function executed by the previous BASIC programs; it returns to BASIC after a short delay.

The speed of machine language changes is considerably faster, because once we have put a cycle of instructions to the machine's central processing unit, we can avoid making the dozens of comparisons and calculations necessary to use the Level II BASIC interpreter in ROM.

This Game of Life has been written in machine or assembly language. ■

by Dennis Kitsz

```
10  CLS
20  DEFINT X,N,Q,A,B,C,D,F,G,H,I,J,K,L,M
30  DIM L(1024) : Q = 191 : K = 15359
40  GOSUB 300
50  FOR M = 15360 TO 16320 STEP 64 : POKE M,32 : NEXT M
60  FOR X = 15360 TO 16383 : N = 0
70  A = PEEK (X-65) : B = PEEK (X-64) : C = PEEK (X-63) : D = PEEK (X-1)
80  F = PEEK (X + 1) : G = PEEK (X + 63) : H = PEEK (X + 64) : I = PEEK (X + 65)
90  IF A = Q THEN N = N + 1
100 IF B = Q THEN N = N + 1
110 IF C = Q THEN N = N + 1
120 IF D = Q THEN N = N + 1
130 IF F = Q THEN N = N + 1
140 IF G = Q THEN N = N + 1
150 IF H = Q THEN N = N + 1
160 IF I = Q THEN N = N + 1
170 L(X-K) = N
180 NEXT X
200 FOR X = 15360 TO 16383
210 IF L(X-K) = 2 THEN 240
220 IF L(X-K) = 3 THEN POKE X,191 : GOTO 240
230 POKE X,32
240 NEXT X
250 GOTO 50
300 FOR X = 15360 TO 16383
310 J = RND(2) : IF J = 1 THEN POKE X,191
320 NEXT X
330 RETURN
```

Program Listing 1. Simplified Life in BASIC.

```
10 CLS
20 FOR X = 0 TO 47
30 FOR Y = 0 TO 127
40 SET (Y,X)
50 NEXT Y,X
60 GOTO 60
```

Program Listing 2. Screen white-out using SET and RESET functions

```
10 CLS
20 FOR X = 15360 TO 16383
30 POKE X,191
40 NEXT X
50 GOTO 50
```

Program Listing 3. Screen white-out using POKE commands.

```
10 CLS
20 CLEAR 100
30 FOR X = 1 TO 15
40 PRINT STRING$(64,191)
50 NEXT X
60 GOTO 60
```

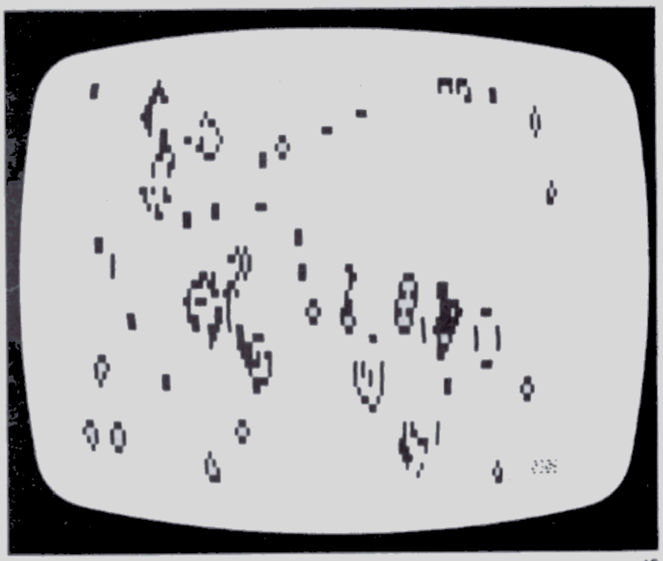
Program Listing 4. Screen white-out using PRINT STRING$ function

```
10  CLS
20  DIM A(30)
30  FOR X = 1 TO 27
40  READ A(X)
50  NEXT X
60  DATA 33,0,60,17,1,60,1,255,3,54,191,237,
    176,6,5
70  DATA 33,255,255.43,124,181,194,18,127,
    16,245,201
80  FOR X = 32512 TO 32538
90  POKE X,A(X-32511)
100 NEXT X
110 POKE 16526,0 : POKE 16527,127
120 M% = USR(0)
130 CLS
```

Program Listing 5. Screen white-out in machine language jumping from BASIC.

Photos 14–16: A large random universe, at birth; at generation 306; and finding stability at generation 696.

14



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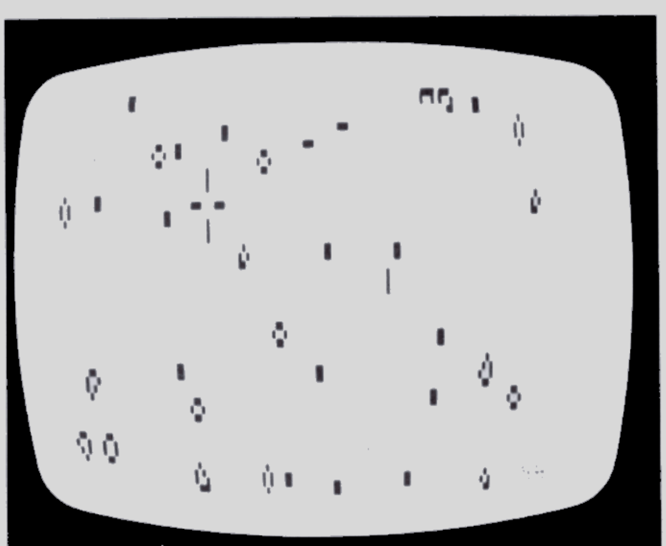

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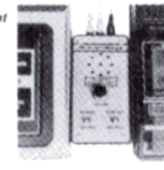
for the TRS-80 from Micro-Mega

CASSETTE CONTROL UNIT

• Speed up your cassette tape handling • Pinpoint program locations on tape with an audible monitor • Get protection from recording and playback glitches resulting from ground loops • Eliminate the tedious plugging and unplugging of recorder cables.



The Micro-Mega Cassette Control Unit does all this and more. You get instant manual control of the recorder at the flick of a switch. Want to find the beginning or end of a program? Flick another switch and you'll hear it. All cables remain plugged in all the time.

The Micro-Mega Cassette Control Unit does a lot to improve the appearance of your TRS-80 system, too. As shown, it's in a 2½" x 5" box which snuggles between the keyboard and your recorder. There is no need to move the recorder, and all cables come neatly into the unit. The Cassette Control Unit is tailored to the CTR-41 recorder, but may be used with most other recorders as well.

CASSETTE CONTROL UNIT. $37.95
Add $1.00 for postage and handling

CPU MONITOR

Ever find yourself with a blank screen wondering what your computer is up to? The Micro-Mega CPU Monitor can tell you, for example: • If your CPU is in a loop with no exit, • When a long sort is nearing completion, or • If a key bounces during keyboard input. The CPU Monitor lets you listen to all CSAVEs and CLOADs and will help you quickly find the correct recorder volume setting. If you have an expansion interface, you will always know whether the real-time clock is on or off because you can hear it.

The Micro-Mega CPU Monitor gives a voice to the Z-80 microprocessor in your TRS-80 by using AM radio circuitry to pick up the computational rhythms of the CPU, which are amplified and played through a loudspeaker. The pickup unit of the CPU Monitor, shown at left in the photo, goes under your TRS-80 keyboard. It is connected by a 36" cable to the speaker and control unit, which includes an on/off volume control and an LED "power-on" indicator. The Monitor is powered by an AC adapter, shown at right in the photo. No batteries are needed and no electrical connections to your TRS-80 are required.

By listening to the CPU Monitor, you will soon become familiar with the "personalities" of the programs you run and whether they are executing in a normal way. A dramatic use of the CPU Monitor is in the great enhancement which it provides for computer games. (See "Gaming Environment" below.)

CPU MONITOR. $47.95
Add $2.00 for postage and handling

THE GREEN-SCREEN

The eye-pleasing Green-Screen fits over the CRT of your TRS-80 Video Display and gives you improved contrast with reduced glare. You get bright, luminous green characters and graphics like those featured by very expensive CRT units.

The Green-Screen is closely matched to the color and texture of the TRS-80 Video Display and improves the overall appearance of your system. It is attached with adhesive strips, which do not mar your display unit in any way. The Micro-Mega Green-Screen gives improved video display visibility for all applications and is especially effective in creating dramatic, high-impact displays for computer games. (See "Gaming Environment" below.)

THE GREEN-SCREEN. $13.95
Add $1.00 for postage and handling

THE ULTIMATE STAR TREK PACKAGE

Tired of trivial computer games? This complete Star Trek package will provide you with endless fascination and challenge. In addition to the program cassette, it includes comprehensive instructions, a pad of "Voyage Log" record sheets, and a free-standing "Torpedo and Maneuvering Chart."

The package is built around the latest version of Lance Micklus' incomparable Star Trek III, a 13,000 byte program with a host of subtle and imaginative features, which include numerous dynamic and spectacular graphic displays. Star Trek III puts you in command of the Enterprise cruising in a galaxy of 192 quadrants filled with uncharted hazards, including hostile Klingons, pulsars, and black holes. You have at your disposal scanners, various weapons and defense systems, on-board computers, and a loyal crew. (You will need them all to survive the Klingons.)

Your mission is to rid the region of Klingons and to locate five inhabitable planets, all within 300 stardays, before returning to Star Fleet Headquarters where your overall effectiveness as a starship commander will be scored. High scores are possible only with careful planning and effective battle tactics. The "Voyage Log" sheets will guide your strategy, and the "Torpedo and Maneuvering Chart" will give you a vital edge in combat. (When you engage three Klingon ships you can't afford to miss.)

STAR TREK PACKAGE (for Level II, 16K only). $22.95
Add $1.00 for postage and handling

CREATE YOUR OWN SPECTACULAR GAMING ENVIRONMENT (and save $5.00)

The Enterprise is in battle trim with deflector shields at full power. As her captain, you are taking her into combat. The battle-stations siren rings in your ears and "CONDITION RED" flashes on your monitor screen You call for warp drive and key in the coordinates of the quadrant where your scanners have detected Klingon ships. As you select the warp factor, you hear the reassuring clicking of your navigational gear as it activates the warp drive.

Suddenly, you break out of hyperspace and your monitor displays the chilling sight of three Klingon Battle Cruisers floating on your screen! Their evil shapes glow in luminous green against the black void of space. Moments later, you hear the characteristic rasping sound of Klingon laser weapons, and, as you watch, high-energy beams come knifing toward the Enterprise in succession from each of the Klingon ships.

You have been hit! You hear the dismal sound of the damage control alarm as "DAMAGE TO WARP DRIVE" and "DAMAGE TO PHASERS" flash on your screen. The Klingons have stopped firing! The Enterprise is crippled, but your best weapon is still intact, and it's your turn now! You key in the command for photon torpedoes. As your screen again displays the position of the Klingon ships, you select a firing vector from your torpedo chart and key it in. Now you hear the buzz of your photon torpedo as you see it speeding toward a Klingon ship. It strikes him dead-center! As you watch, the Klingon Battle Cruiser disintegrates, accompanied by a satisfying crackling sound.

Does the above scenario sound far-fetched? Not at all. It's a small sample of what you will experience with Micro-Mega's Gaming Environment, which consists of: • The STAR TREK PACKAGE • The GREEN-SCREEN and • The CPU MONITOR. The fast-paced and dynamic action reflects the superb Star Trek III program together with the "Voyage Log" and "Torpedo Chart" of the Star Trek Package. All of the unique graphic displays are greatly enhanced by the Green-Screen. Finally, the uncanny sound effects are produced by the CPU Monitor, which faithfully picks up the FOR, NEXT loops and other CPU patterns, which create the distinctive siren sounds that accompany the ALERT and DAMAGE messages along with the harsher notes of the weapons salvos. Once you've tried it, you won't any longer be satisfied with silent computer games.

Remember that with the Gaming Environment you also get all of the other excellent features of the CPU Monitor and the Green-Screen for non-gaming applications. You also save $5.00 off the combined cost of the individual items.

GAMING ENVIRONMENT. $79.85
Add $3.50 for postage and handling

Terms: Check or money order, no CODs or credit cards, please. Add amount shown for postage and handling to price of the item. All items shipped within 48 hours by first class or priority mail. Virginia residents, add 4% sales tax.

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✓Reader Service—see page 162

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gram has not yet been activated.

At this point, a set of "seed" civilizations can be created. This article includes a BASIC listing that will create 20 seed populations. (See Listing 6.)

TRS-80's video system has two kinds of blanks, represented by decimal values 32 (a character space) and 128 (a graphics blank). Both these characters appear the same to the eye, but have entirely different results in the Life program. When clearing the screen for use with Life, it is essential that character 128 (hexadecimal 80) be used. The following subroutine will produce the desired effect:

```
10 CLS
20 FOR X = 15360 TO 16383
30 POKE X,128
40 NEXT X
```

Program Listing 8. Clears the screen before jumping to Life.

Now a seed population can be created on this blank field. Here is a section of Listing 6:

```
2300 GOSUB 9999: REM * CLEARS SCREEN WITH CHAR 128
2310 FOR X = 15817 TO 15860
2320 POKE X,191
2330 NEXT X
2340 M% = USR(0)
```

Following the screen-clearing, these lines will POKE a graphics pattern into place that looks like this:

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It is created from a dense bar of graphics cells, and will eventually follow the pattern shown in photos 18-21. Through the USR(0) command, the program now jumps to the machine language Game of Life routines.

The Action of the Program

The first action of the program is to save the BASIC stack pointer (line 280). The reason for this is that the program as a whole (the seed program and the Life program) will be using two stacks — one for the video display work area, and the other for the BASIC seed programs.

Next, the generation count is set to zero, and the upper and lower borders of the video workspace are blanked. This blanking is necessary because unwanted neighbors to cells in our real population may intrude upon the territory of our universe and produce mutant births.

Now the pattern on the screen is transferred to a scratchpad, or workspace, elsewhere in memory. Have you ever noticed the black streaks that detract from the continuity of the screen display when graphics are being drawn? There is a very short period of time when the video memory circuits must be taken over by the rest of the computer system in order to place information on the video screen, or, less often, to read information that is there.

The memory is taken out of the video scanning circuit for a very brief moment, so the display blanks out. The more times we need to dip into the video, the more black streaks there will be. In order to prevent our Life display from becoming a jittery mess, you can remove the information displayed as a block and place it elsewhere, where you can plunder it at will. The screen then remains passive until the altered block is transferred back to the monitor.

Two very important instructions appear in lines 610 and 760. These commands, which appear early in the program, load values into each of the two index registers available in the Z-80 microprocessor chip. In fact, without these two registers, you could not attain the speed of this game.

Program Listing 6. BASIC Seed Populations

```
10 CLS
15 - SPACESHIP
20 PRINT@460,"PLAYING GOD WITH LIFE:
                   *STARTS*
30 FORX=1TO2000:NEXT
40 PRINT"ENTER 1 FOR INSTRUCTIONS
       ENTER 2 FOR GRAPHICS CHARACTER LIST
       ENTER 3 FOR LIST OF SEED CHARACTER PROGRAMS"
50 PRINT:INPUT"ENTER 1, 2 OR 3";A
60 IFA=1GOTO100
70 IFA=2GOTO1000
80 IFA=3GOTO2000
100 CLS
110 PRINT"PLAYING GOD WITH LIFE MUST START WITH A BASE
     CIVILIZATION CREATED BY A SEED PROGRAM. THIS PROGRAM
     USES TRS-80'S GRAPHICS CHARACTERS SET, WHICH IS
     PRESENTED A BIT LATER IN THIS PROGRAM."
120 PRINT:PRINT"ASCII CHARACTER 128 -- CHR$(128) -- IS A
     GRAPHICS BLANK.ALL THE SEED PROGRAMS FIRST CLEAR THE
     SCREEN WITH THESE BLANKS,THEN PRODUCE A STARTING
     CIVILIZATION USING THE TRS-80 GRAPHICS  ";
121 PRINT"CHARACTERS.  FINALLY, THE SEED PROGRAMS JUMP INTO
     THE MACHINE LANGUAGE *LIFE* PROGRAM."
130 PRINT:PRINT"REMEMBER, YOU MUST HAVE ALREADY ENTERED THE
     *LIFE9* SYSTEMTAPE THAT PRECEDES THIS ";CHR$(34);
     "STARTS";CHR$(34);" SECTION, OR A FC ERROR?WILL BE
       GENERATED."
140 FORX=1TO10000:NEXT:CLS:GOTO40
1000 CLS
1010 FORX=128TO155STEP4
1020 PRINTX;CHR$(X),X+1;CHR$(X+1),X+2;CHR$(X+2),X+3;CHR$(X+3)
1025 PRINT
1030 NEXTX
1040 INPUT"PRESS ENTER TO CONTINUE";X
1045 CLS
1050 FORX=156TO183STEP4
1060 PRINTX;CHR$(X),X+1;CHR$(X+1),X+2;CHR$(X+2),X+3;
      CHR$(X+3):PRINT
1070 NEXTX
1080 INPUT"PRESS ENTER TO CONTINUE";X
1090 FORX=184TO191
1100 PRINTX;CHR$(X):PRINT
1110 NEXTX
1120 INPUT"ENTER 1 TO REVIEW, 2 TO RETURN";B
1130 IFB=1GOTO1000
1140 IFB=2GOTO40
2000 CLS:PRINT"ENTER THE NUMBER OF THE SEED PATTERN DESIRED:"
2010 PRINT"   1 - RANDOM                 11 - ARCH (PI)
              2 - BOX                    12 - LONG BARGE
              3 - LONG BAR               13 - LARGE BLOCK
              4 - SMALL RANDOM GROUP     14 - GLIDERS
              5 - TALL BAR
2020 PRINT"    6 - MIXED SEEDS             16 - TALL RANDOM
               7 - 4 RANDOM GROUPS         17 - TWO ARCHES 90 DEG.
               8 - FLASHERS &  GLIDERS 18 - 2 DIAGONAL RANDOMS
               9 - THIN SQUARES            19 - THICK SQUARES
2030 PRINT"        10 - SPARSE RANDOM          20 - SURPRISE"
2040 PRINT:INPUT"ENTER 1 THROUGH 20";C
2050 ONCGOTO2100,2200,2300,2400,2500,2600,2700,2800,2900,3000,
     3100,3200,3300,3400,3500,3600,3700,3800,3900,4000
2100 GOSUB9999
2110 FORX=15360TO16383
2120 Y=127+RND(64)
2130 POKEX,Y
2140 NEXTX
2190 M%=USR(0):GOTO2000
2200 GOSUB9999
2210 POKE15829,183:POKE15830,149
2290 M%=USR(0):GOTO2000
2300 GOSUB9999
2310 FORX=15817TO15860
2320 POKEX,191
2330 NEXTX
2390 M%=USR(0):GOTO2000
2400 GOSUB9999
2410 FORX=15700TO15716:Y=127+RND(64):POKEX,Y:NEXTX
2420 FORX=15764TO15780:Y=127+RND(64):POKEX,Y:NEXTX
2430 FORX=15828TO15844:Y=127+RND(64):POKEX,Y:NEXTX
2440 FORX=15892TO15908:Y=127+RND(64):POKEX,Y:NEXTX
2490 M%=USR(0):GOTO2000
2500 GOSUB9999
2510 FORX=61TO67
2520 FORY=3TO42
```

Load the first index register (IX) with the first memory cell in the workspace. Index register IY is crucial; its value is the same as that of the new stack pointer. Initialize the stack at 7AEF (recall line 320), and now push six fresh zero bytes onto it (lines 710 to 740). In this way you can manipulate individual bytes near the top of the stack at will. These bytes are left on the stack, and the stack grows as the program progresses, but you still retain control over the contents without digging through the stack and piling heaps of bytes all about.

This extensive manipulation of data is necessary because of the crude but serviceable graphics in the TRS-80. A byte of data is eight bits wide; bits 0 through 5 normally define ASCII characters and control codes (carriage returns, etc.), and bits 6 and 7 are ignored. But in the TRS-80, these most significant bits cause the video circuit to switch from ASCII mode to graphics mode.

A zero in both bits 6 and 7 will produce the expected letters and numbers; but if either or both of these bits goes high, the computer triggers a group of circuits which switch out of ASCII mode, and produce a small graphics block for each of bits 0 through 5 which is also high. It is a simple, functional video system, certainly not high-resolution, but assuredly better than an entire block per character.

A diagram of a video memory cell and the bits responsible for each "hexant" is given in Fig. 1.

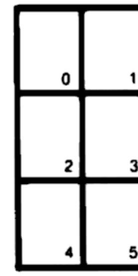

Fig. 1.

```
2530 SET(X,Y)
2540 NEXTY,X
2590 M%=USR(0):GOTO2000
2600 GOSUB9999
2610 FORX=15400TO15408:Y=127+RND(64):POKEX,Y:NEXTX
2620 FORX=15464TO15472:Y=127+RND(64):POKEX,Y:NEXTX
2630 FORX=16300TO16311:Y=127+RND(64):POKEX,Y:NEXTX
2640 FORX=16364TO16370:Y=127+RND(64):POKEX,Y:NEXTX
2650 FORX=15820TO15845:Y=127+RND(64):POKEX,Y:NEXTX
2690 M%=USR(0):GOTO2000
2700 GOSUB9999
2710 FORX=15360TO15370:Y=127+RND(64):POKEX,Y:NEXTX
2720 FORX=15424TO15434:Y=127+RND(64):POKEX,Y:NEXTX
2730 FORX=15413TO15423:Y=127+RND(64):POKEX,Y:NEXTX
2740 FORX=15477TO15487:Y=127+RND(64):POKEX,Y:NEXTX
2750 FORX=16373TO16383:Y=127+RND(64):POKEX,Y:NEXTX
2760 FORX=16309TO16319:Y=127+RND(64):POKEX,Y:NEXTX
2770 FORX=16320TO16330:Y=127+RND(64):POKEX,Y:NEXTX
2780 FORX=16256TO16266:Y=127+RND(64):POKEX,Y:NEXTX
2790 M%=USR(0):GOTO2000
2800 GOSUB9999
2810 POKE15993,130:POKE15994,155:POKE15857,182:POKE15858,144:
     POKE16309,167:POKE16310,129
2820 POKE15570,183:POKE15571,149:POKE16060,183:POKE16061,149:
     POKE15364,183:POKE15365,149
2830 POKE16160,183:POKE16161,149
2890 M%=USR(0):GOTO2000
2900 GOSUB9999
2910 FORX=20TO40:SET(X,5):SET(X,17):NEXTX
2920 FORY=5TO17:SET(20,Y):SET(40,Y):NEXTY
2930 FORX=77TO95:SET(X,28):SET(X,41):NEXTX
2940 FORY=28TO41:SET(77,Y):SET(95,Y):NEXTY
2990 M%=USR(0):GOTO2000
3000 GOSUB9999
3010 FORX=15360TO16383STEP3
3020 Y=127+RND(25)
3030 POKEX,Y
3040 NEXTX
3090 M%=USR(0):GOTO2000
3110 POKE15839,151:POKE15840,149
3120 M%=USR(0):GOTO2000
3200 GOSUB9999
3210 POKE15830,150:POKE15831,148:POKE15894,137:POKE15895,129
3290 M%=USR(0):GOTO2000
3300 GOSUB9999
3310 FORX=45TO85:FORY=9TO29:SET(X,Y):NEXTY,X
3390 M%=USR(0):GOTO2000
3400 GOSUB9999
3410 POKE15498,160:POKE15499,185:POKE15950,167:POKE15951,129
3490 M%=USR(0):GOTO2000
3500 GOSUB9999
3510 POKE15746,144:POKE15747,160:POKE15810,164:POKE15811,176:
     POKE15812,149
3590 M%=USR(0):GOTO2000
3600 GOSUB9999
3610 FORX=15392TO16383STEP64
3620 Y=127+RND(64):POKEX,Y:NEXTX
3630 FORX=15393TO16383STEP64
3640 Y=127+RND(64):POKEX,Y:NEXTX
3690 M%=USR(0):GOTO2000
3700 GOSUB9999
3710 POKE15820,151:POKE15821,149:POKE15859,183:POKE15860,145
3790 M%=USR(0):GOTO2000
3800 GOSUB9999
3810 FORX=15360TO16383STEP69:Y=127+RND(64):POKEX,Y:NEXTX
3820 FORX=15424TO16319STEP59:Y=127+RND(64):POKEX,Y:NEXTX
3890 M%=USR(0):GOTO2000
3900 GOSUB9999
3910 FORX=16TO36:FORY=2TO5:SET(X,Y):NEXTY,X
3920 FORX=16TO20:FORY=6TO9:SET(X,Y):NEXTY,X
3930 FORX=32TO36:FORY=6TO9:SET(X,Y):NEXTY,X
3940 FORX=16TO36:FORY=10TO13:SET(X,Y):NEXTY,X
3950 FORX=48TO57:FORY=24TO38:SET(X,Y):NEXTY,X
3960 FORX=50TO55:FORY=28TO34:RESET(X,Y):NEXTY,X
3990 M%=USR(0):GOTO2000
4000 GOSUB9999
4010 FORX=15360TO16383:Y=RND(255):POKEX,Y:NEXTX
4090 M%=USR(0):GOTO2000
9998 GOTO9998
9999 FORX=15360TO16383:POKEX,128:NEXTX:RETURN
READY
>_
```

Recall that the Game of Life rule requires that we look at each neighbor of a cell. If each block were a single byte-sized entity, we could evaluate its neighbors quickly and easily: The one above, the one below, left and right, and the four corners. But this TRS-80 bit system makes things quite nasty. If we label a cell X, and it lives in memory location A, what are its eight immediate neighbors? Well, there's more to know. What bit position does this upstart X occupy in a byte? Okay, let's arbitrarily say X resides comfortably in bit position zero, thus:

```
 A
x 1
2 3
4 5
```

Okay, seems easy. First neighbor, to the right, is bit 1; clockwise, the next is bit 3; then clockwise again it is bit 2. Pretty safe so far. Next neighbor clockwise is . . . hmmmm . . . memory location A minus one, uh . . . . bit 3. Better draw that:

```
A-1   A
0 1   x 1
2 3   2 3
4 5   4 5
```

Yes, fine. Next neighbor further clockwise is memory location A minus 1, bit 1. Still safe. But then, what about the next neighbor clockwise? It's a line above on the screen, and back a space. Since our screen is 64 characters wide, this is back 64 and back one more. Now we've got to look at bits in A minus 65 and probably, if intuition serves, in location A minus 64 too. We'd better draw it.

```
A-65   A-64
0 1    0 1
2 3    2 3
4 5    4 5

0 1    x 1
2 3    2 3
4 5    4 5

A-1    A
```

Yes, intuition is correct. We've got to check A minus 65, bit 5, and

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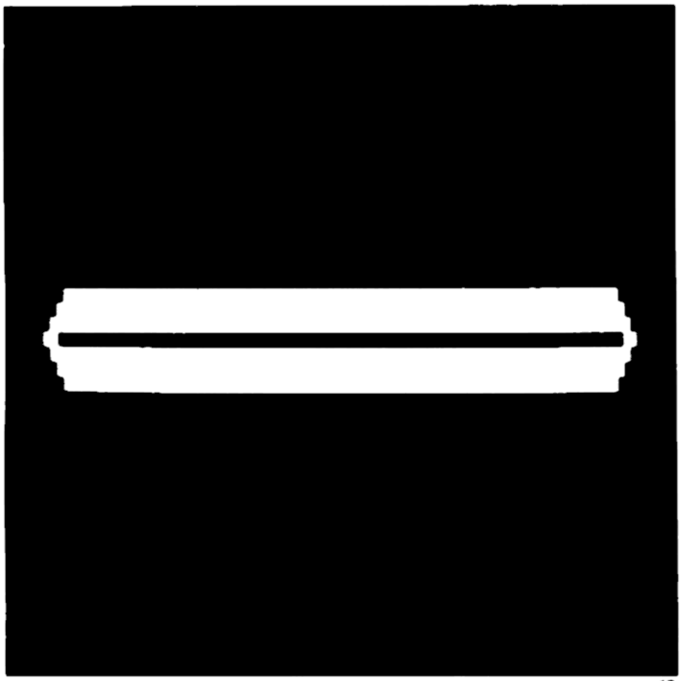
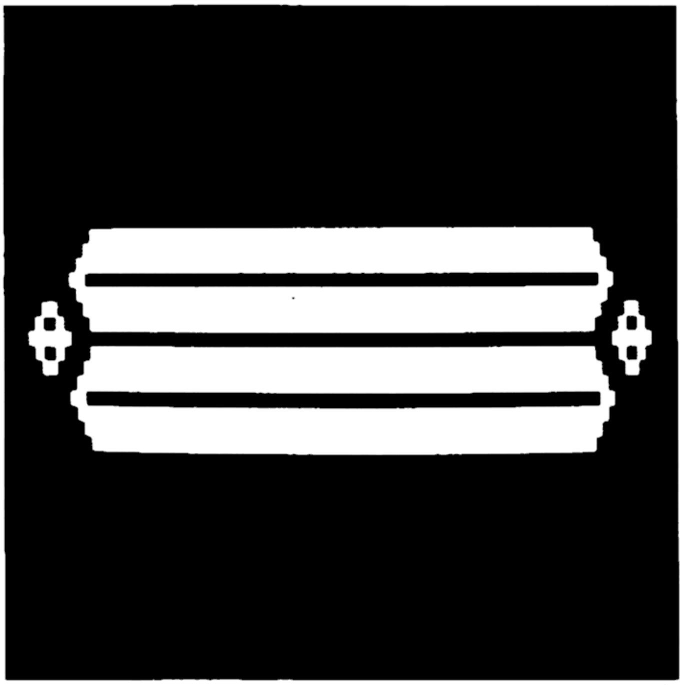


18



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A minus 64, bits 4 and 5. That's quite a lot of manipulation there, and there are six different bit possibilities for every memory location! And to make matters worse in terms of speed, a machine operation to check the presence of a bit is itself four bytes long.

Get a Cup of Coffee

If this were in my living room and not a magazine article, I would invite you to have a cup of coffee, sit back, and clear your mind. It took me three months and eight versions of the program to discover the key to speedy operation.

My solution to the fast Game of Life algorithm would not have been possible if the designers of the TRS-80 had chosen another of the popular microprocessor chips. The two index registers—16-bits wide—are needed, so also are relative jump instructions, bit test and manipulation, and an extensive stack movable anywhere in memory. The index register, you may recall, allows you to store and adjust data within a certain geography of the register's base value. You may, for example, change the contents of memory location IX, IX-32, IX + 17 and so forth. The relative jump instruction is one byte shorter than an absolute jump, saving considerable time in this program requiring thousands of jumps.

Finally, we need to preserve not only the BASIC stack (which is fairly large) for use with the seed programs, but also maintain an extensive stack of values analogous to the video pattern we are adjusting.

We know further that a check of all the cells in a given memory location must be made; thus, our algorithm for cell checking should probably be done within the context of one memory address at a time. If there are six cells in a video memory location with eight

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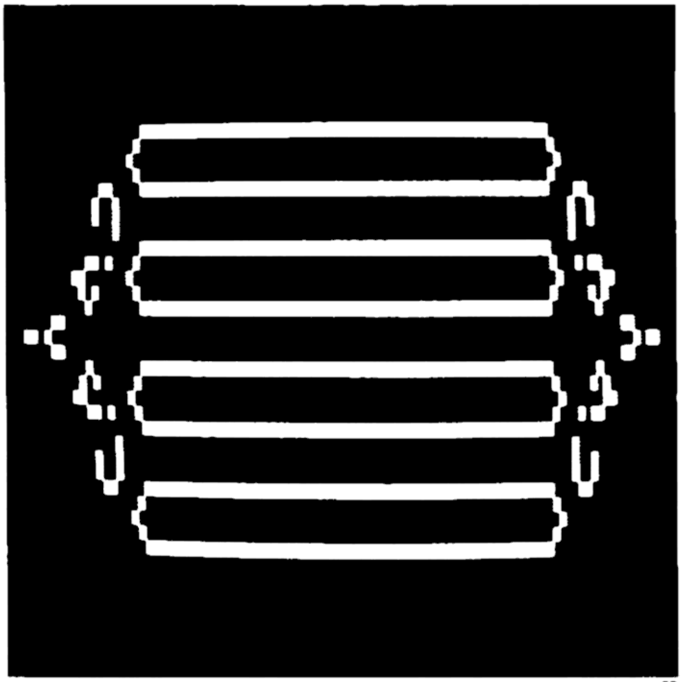

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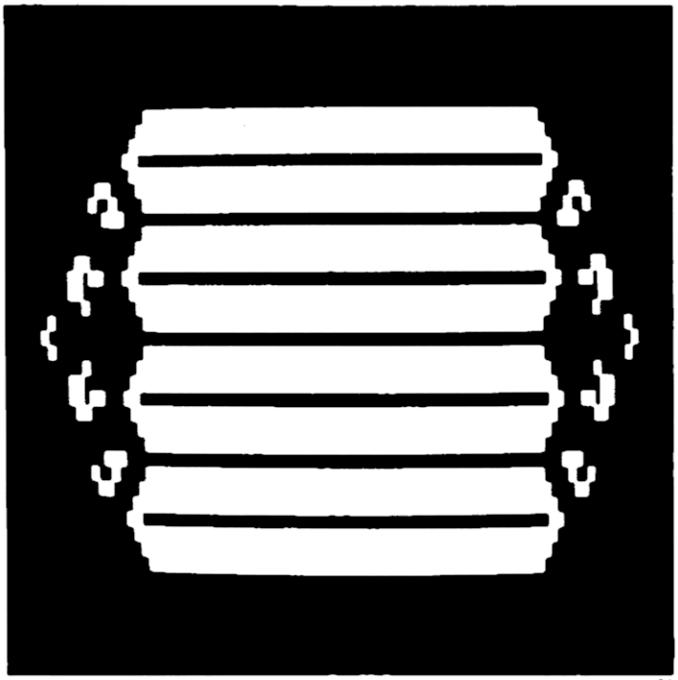

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Photos 18-21: A long bar universe created from several hundred cells, at birth; generations 2, 6, 13, and 14.

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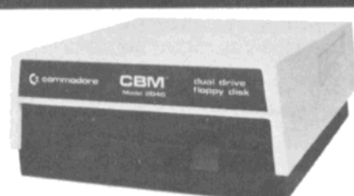

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neighbors each, that comes to a total of 48 evaluations.

Before your cup of coffee, we were attempting to test a cell and all of its neighbors. If we test cell X in bit 0 of memory location A, then bit 1 is among its neighbors. Later, we will need to know, for example, the neighbors of bit 2 in memory location A. Or the neighbors of bit 3. Or the neighbors of bit 5 in memory location A minus 64. If we make our cell checks independent of each other, we will be engaging in enormous redundancy. If cell X has eight neighbors, then doesn't it follow that cell X is itself the neighbor of eight other cells, including the ones just mentioned? Aha!

Examine the diagram below.

```
5  4 5  4

1  0 1  0
3  2 3  2
5  4 5  4

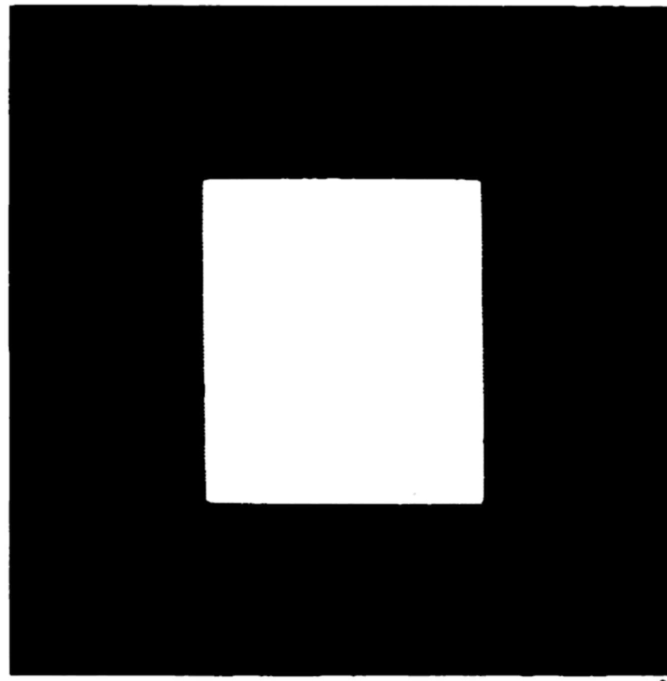
1  0 1  0
```

Here we have a video memory address together with all the individual cells that can be considered its immediate neighbors. In all, only 20 cells need to be examined to determine the fate of all six beings in that memory address. Let us now assign this memory address to register IX; all the needed addresses are well within the relative addressing range of IX: IX – 65, IX – 64, IX – 63, IX – 1, IX, IX + 1, IX + 63, IX + 64 and IX + 65.

Return again to the assembly listing, beginning at line 800. This is the test for bit 5 in address IX – 41 (the listing uses hexadecimal notation since the screen is numbered in even blocks of 40 hex). Twenty bit tests are made, identical to the pattern described above.

What is done with the result of each bit test? You could store the result, using standard instructions, elsewhere in memory, incrementng to the next or decrementing to the previous address as necessary. But this process consumes considerable time, and requires that flag resisters be saved, addition or subtraction be performed and so forth.

Instead, look at lines 710 through 760. Here, you may recall, six empty bytes were pushed onto the stack, and the IY register was given to the top (actually, to the bottom, as the Z-80 stack moves downward in memory) stack value. If each byte in the stack represents one bit or being, then IY can sum the neighbors of being (bit) 5, IY + 1 can hold the total neighbors for bit 4, and so on. This is a terrible waste of memory, you may insist; I agree. It is, however, the fastest way of completing the Game of Life computations using the 80's complex graphic bit system.



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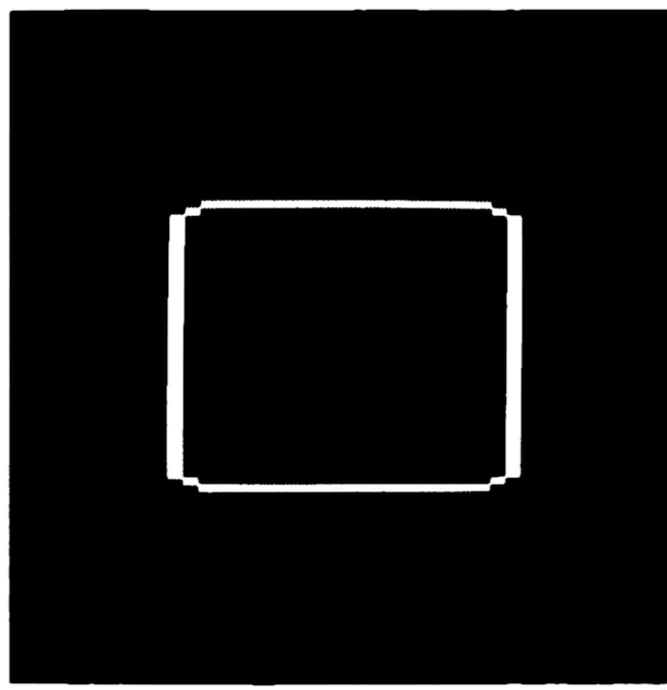

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Is Your Neighbor Alive?

Let's follow this process through. Bit 5 of IX – 41 is tested. If the neighbor is alive (result of the bit test equals one), increment the value stored in IY + 5. If not, skip it, going on to test bit 4 of IY – 40. If this neighbor is alive, increment the value stored in IY + 5 and IY + 4. Why in two locations? Because bit 4 of IY – 40 is neighbor to two cells in our memory location, cell 0 and cell 1. If this neighbor is not alive, skip to the next test.

Time for more coffee. Just to be sure, follow each bit test in lines 800 through 1670 of the assembly listing. Test a bit. Is it alive? If so, add one to the stack byte representing the memory cells to which it is a neighbor. If not, go on. Make 20 tests. When all the checks ar complete, the six-byte stack will contain the total number of neighbors for each bit in the memory address under observation. Finally (line 1680), the memory address under test is advanced. The jump to HOLD shown in line 1700 is one of the special features of Playing "God" with Life, so for the moment, ignore this command.

At line 1740, the BC register is decremented and tested; if all 1,024 bytes (400 hex) video memory locations have been checked, the process ends. If not, we go back to line 670 and PUSH six more zero bytes onto the stack, each representing a bit in our next universe location. Earlier I mentioned that an extensive movable stack is important to the operation of this Life algorithm; with six bytes assigned to each universe location, and 1,024 locations to examine, this results in a fairly monumental stack more than 6K bytes deep!

When the examination process is complete, how do we make our changes? First, let's see where we are. You have the initial generation on the screen, a duplicate of it in a workspace, and 6,144 bytes of stack. Your object is to evaluate the stack values, a byte at a time, and alter their corresponding cells according to the result.

At the top of the stack is the last cell evaluated. We begin the generation change process at the last memory address in workspace, STORE + 3FF (line 1830). POP a register off the stack, and compare the first byte to 2. If it is 2, remembering Conway's rule,

Continue to page 50

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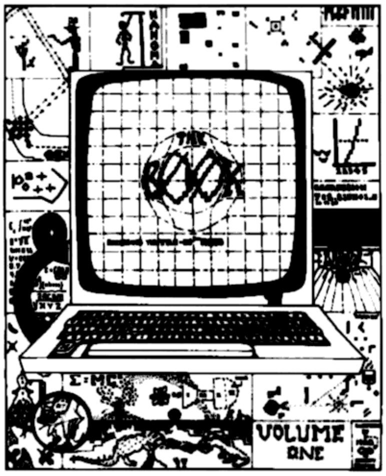
BACK TO BASIC

THE BOOK

ACCESSING THE TRS-80* ROM

If you ever do Assembly language programming, or you just want to know more about your TRS-80 ROM, "THE BØØK" is for you.



Volume I will give you access to over fifty machine language subroutines in the Radio Shack Level II BASIC. It includes information on the numeric data formats and a commented listing of the ROM routines.

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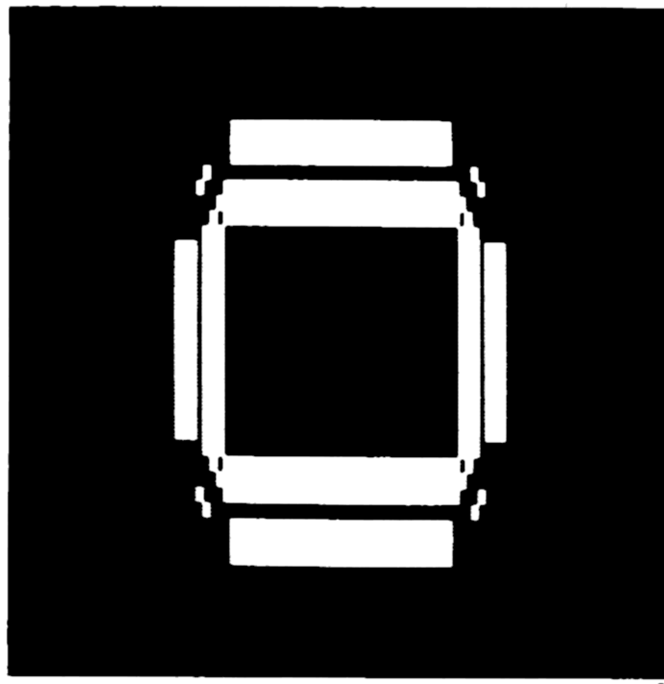
the current contents of a cell remain unaltered—no birth, no death. If it is not 2, compare it to a 3. If it is a three, then a cell must be given birth, as in line 1920. (If a live cell is already in place, this action has no effect, but still satisfies the Life rule.) A more exhaustive test is only redundant.

Finally, if our byte is neither 2 nor 3 (the number of neighbors), then of course it must be less than 2 (lonely) or greater than 3 (overpopulated) and Conway's rule stipulates that in such a circumstance, the cell cannot live. Line 1900 resets (turns off, or kills) this bit.

Line 1930 examines the next byte in the same terms. Although the POP-and-test pattern is identical for all three byte pairs, a CALL to subroutine is not used in the interest of speed. In fact, in the entire Playing "God" with Life program, memory is almost always sacrificed in the interest of speed. This program uses six times the

Continue to page 52



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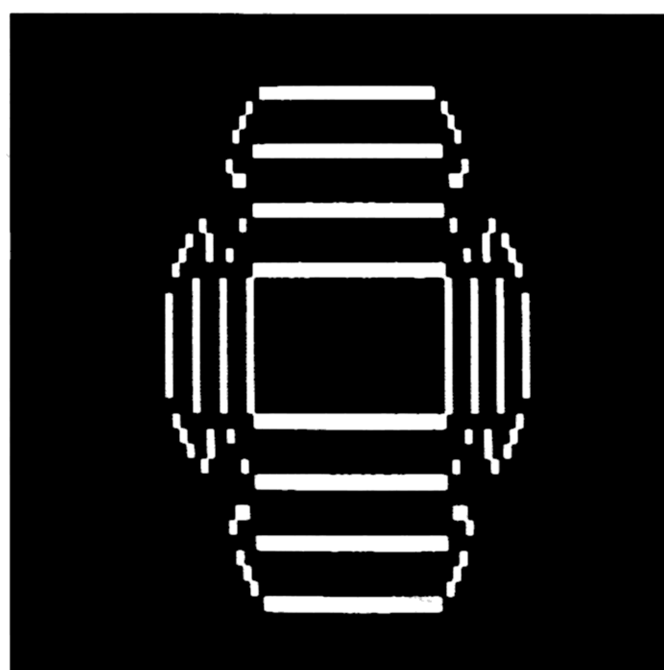

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memory that a slower program would. But for advanced games, the Level II 16K TRS-80 is fairly standard. Were this program a utility, the space would be crucial, but for Life, it's whatever makes the game most effective.

When six byte evaluations are completed, you have altered one memory address in your workspace. At line 2350, decrement the workspace value, and decrement the loop counter. When this process is complete (1,024 evaluations), it is just about time to restore the newly derived generation to the screen.

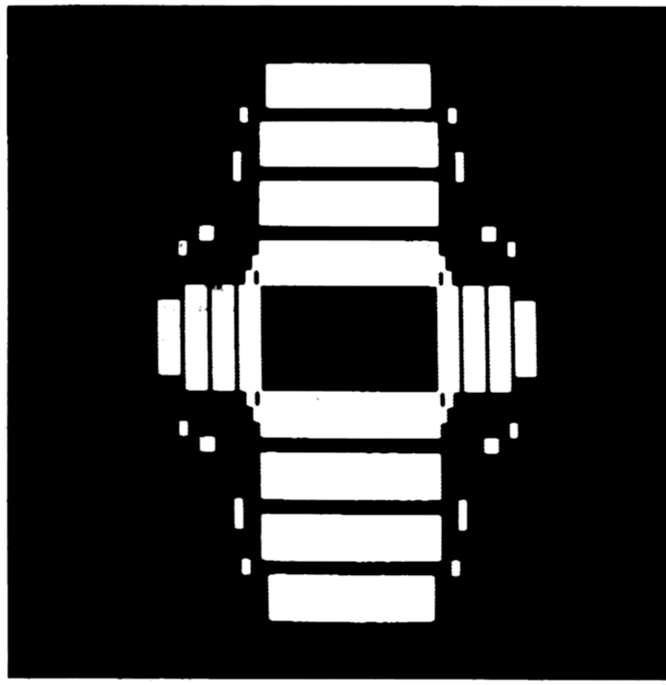
This is a flat world, this video screen, yet the memory itself is not set up that way. The display wraps around contiguous memory locations: 3C3F (the last location in the first row) is neighbor to 3C40 (the first location in the second row). Lines 2480 through 2550 reset a thin line of memory cells on one side of the screen (actually, at this point, in the workspace). This action provides the remainder of the "border of pestilence" set up earlier for the top and bottom rows of the display. Finally, at lines 2590 to 2620, the workspace is restored to the video monitor, and the new generation comes into view.

The balance of this program is taken up with the special features, including display hold, a generation count, return to the BASIC program, and the "god" control, in actuality only a cursor, flashing on and off over the top of the current contents of four contiguous video positions.

A check of the generation status flag is made beginning at line 2660. If the user selects a generation count display when the question is posed in the original instructions, the generation counter is incremented, converted to decimal, and finally to ASCII characters (lines 2710 through 3020). Since the numerals themselves can influence future generations, it is necessary to sweep clear a path around them. This is done in lines 3070 to 3180, where the bordering bits are reset.

Earlier, we ignored a command to jump to the HOLD routine before re-evaluating the generation. You can depress letter H on the keyboard to freeze the current display on the screen (lines 3220 through 3250); or you can return to BASIC by depressing letter X, after first restoring its original stack pointer (lines 3260 through 3300). Finally, you can "play god" by pressing the G, and the program is diverted to a series of routines beginning at line 3430.

This controlling cursor is initiated at the top left of the screen (lines 3430 through 3520). A short delay allows a comfortable flashing rate. The keyboard is then scanned for three groups of commands: motion commands (the four keyboard arrows); activity commands (bear or kill, letters B or K); and the cancel command (return to mortality, letter M).



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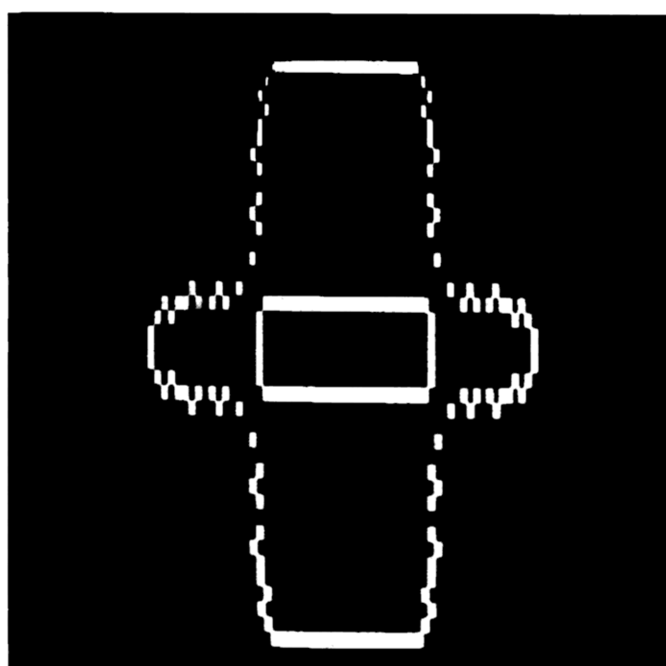

27

Photos 22 - 27: A symmetrical block (the 4:3 ratio of graphics blocks in the TRS-80 accounts for the vertical elongation), at birth; generation 1, 4, 7, 8, and 9.

4 SPEED OPTIONS FOR YOUR TRS—80!

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Upon the choice of bear or kill, an asterisk appears, isolating the six points in one memory location. Pressing the appropriate number (0 through 5) will set or reset that bit (lines 4090 through 4770), changing one cell on the screen. Pressing M (mortality) returns to the start of the generation checks, so that any change wrought by the cursor will be incorporated into the next generation of beings.

Flaws, Frustrations and Bedevilment

The individual graphics block visible on the screen is actually a matrix of three dots by four dots. Because of this, symmetrical images will appear vertically elongated. Also, the universe is nearly twice as wide as it is high. Both these flaws are inherent to the TRS-80's video graphics system.

One additional game variable is that the controlling cursor can march omnipotently through any part of memory. Holding the down arrow causes the cursor to disappear off the bottom of the video screen. This little bedevilment will allow "god" to be marched through any part of memory, and the bear or kill commands can be used in any part of RAM (or even on the memory-addressed ports). This invisible action can crash a program or wreak any kind of havoc—something I consider a nice touch.

If your preference is speed over size, it is easy to revise this program to use the 32-character mode. Remember, of course, that alternate, even-numbered memory locations are addressed in this video format, and that the location of the large-character flag is port 255, bit 3 (1 = on, 0 = off). Normal video is always restored whenever the Life program returns to BASIC. With these alternatives, the program's speed will be doubled to nearly 150 generations per minute.

Another modification, not to the software, but to the hardware, yields something I have found very pleasant to watch: Surplus monitors with the slow green phosphor are available in the $40 range, and although it is nearly impossible to read normal (64 character per line) text with them, the Life displays appear with high resolution, and the slow phosphor imparts an eerie, organic appearance.

Acknowledgments and Conclusion

Thanks are due to Philip K. Hooper, a programmer and mathematician, for his inspiring version of Life and Serpent for the KIM; and to Claire Manfredonia, who suggested that a deity could visit this electronic universe of beings to intervene with fate.

I have received a few comments regarding my use of the "god" cursor. No offense was intended; rather, I feel that control even when playing a game, should be approached with caution and even fear. It is surprising to consider the amount of violence embedded and assumed a part of computer games. ■

Bibliography

The subject of Conway's Game of Life has been covered well in other sources over the past decade. The following articles are selected from among the dozens published since the game's introduction:

"Mathematical Games: The Fantastic Combinations of John Conway's New Solitaire Game, 'Life'", Martin Gardner, *Scientific American*, October 1970, pp. 120ff.

"Mathematical Games: On Cellular Automata, Self-Reproduction, the Garden of Eden and the Game 'Life'", Martin Gardner, *Scientific American*, February 1971, pp. 112ff.

The following references are from *Byte*, December 1978:

"Life with Your Computer", Justin Milliun, pp. 45-50; "Some Facts of Life", David J. Buckingham, pp. 54-67; "Programming Quickies: Life", William Englander, pp. 76-82; "One-Dimensional Life", Jonathan K. Millen, pp. 68-74.

"Life Algorithms", Mark D. Niemiec, *Byte*, January 1979, pp. 90-97.

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COMPLETE ASSEM

Playing "God"

```
          00100 ;
          00110 ; PLAYING GOD WITH LIFE
          00120 ; BY DENNIS BATHORY KITSZ
          00130 ; VERSION 1.9.3, 5 DECEMBER 1979
          00140 ;
          00150 ; SPECIAL THANKS TO
          00160 ; PHILIP K. HOOPER
          00170 ; CLAIRE MANFREDONIA
          00180 ;
3C00           00190 VIDEO   EQU     3C00H
5D00           00200 STORE   EQU     5D00H
               00210 ;
               00220 ; PRINT LOAD MESSAGE ON SCREEN
               00230 ;
3C00           00240         ORG     VIDEO
               00245 *LIST OFF
               00265 *LIST ON
               00270 ;
               00280 ; SAVE STACK, SET UP NEW STACK
               00290 ;
7B00           00300         ORG     7B00H
7B00 ED73FE7F  00310         LD      (7FFEH),SP
7B04 31EF7A    00320         LD      SP,7AEFH
               00330 ;
               00340 ; SET GENERATION COUNT TO 0
               00350 ;
7B07 21F27A    00360         LD      HL,7AF2H
7B0A 3600      00370         LD      (HL),0
7B0C 23        00380         INC     HL
7B0D 3600      00390         LD      (HL),0
               00400 ;
               00410 ; BLANK UPPER AND LOWER BORDERS
               00420 ;
7B0F 21C05C    00430 '       LD      HL,STORE-40H
7B12 0640      00440         LD      B,40H
7B14 3680      00450 BLANK   LD      (HL),80H
7B16 23        00460         INC     HL
7B17 10FB      00470         DJNZ    BLANK
7B19 210061    00480         LD      HL,STORE+400H
7B1C 0640      00490         LD      B,40H
7B1E 3680      00500 BLINK   LD      (HL),80H
7B20 23        00510         INC     HL
7B21 10FB      00520         DJNZ    BLINK
               00530 ;
               00540 ; TRANSFER VIDEO TO WORKSPACE
               00550 ; THIS ACTION PREVENTS SCREEN "HASH"
               00560 ;
7B23 21003C    00570 PHIL    LD      HL,VIDEO
7B26 11005D    00580         LD      DE,STORE
7B29 010004    00590         LD      BC,400H
7B2C EDB0      00600         LDIR
7B2E DD21005D  00610         LD      IX,STORE
               00620 ;
               00630 ; SET UP SCREEN POSITIONS TO CHECK
               00640 ;
7B32 D9        00650 LIFE    EXX
7B33 010004    00660         LD      BC,400H
7B36 D9        00670 START   EXX
               00680 ;
               00690 ; START WITH FRESH BYTE FIELD
               00700 ;
7B37 110000    00710         LD      DE,0
7B3A D5        00720         PUSH    DE
7B3B D5        00730         PUSH    DE
7B3C D5        00740         PUSH    DE
7B3D ED73FC7F  00750         LD      (7FFCH),SP
7B41 FD2AFC7F  00760         LD      IY,(7FFCH)
               00770 ;
               00780 ; START CHECK OF 20 CELL POSITIONS
               00790 ;
7B45 DDCBBF6E  00800         BIT     5,(IX-41H)
7B49 2803      00810         JR      Z,CL01
7B4B FD3405    00820         INC     (IY+5)
7B4E DDCBC066  00830 CL01    BIT     4,(IX-40H)
7B52 2806      00840         JR      Z,CL02
7B54 FD3405    00850         INC     (IY+5)
7B57 FD3404    00860         INC     (IY+4)
7B5A DDCBC06E  00870 CL02    BIT     5,(IX-40H)
7B5E 2806      00880         JR      Z,CL03
7B60 FD3405    00890         INC     (IY+5)
7B63 FD3404    00900         INC     (IY+4)
7B66 DDCBC166  00910 CL03    BIT     4,(IX-3FH)
7B6A 2803      00920         JR      Z,CL04
7B6C FD3404    00930         INC     (IY+4)
7B6F DDCBFF4E  00940 CL04    BIT     1,(IX-1)
7B73 2806      00950         JR      Z,CL05
7B75 FD3405    00960         INC     (IY+5)
7B78 FD3403    00970         INC     (IY+3)
7B7B DDCBFF5E  00980 CL05    BIT     3,(IX-1)
7B7F 2809      00990         JR      Z,CL06
7B81 FD3405    01000         INC     (IY+5)
7B84 FD3403    01010         INC     (IY+3)
7B87 FD3401    01020         INC     (IY+1)
7B8A DDCBFF6E  01030 CL06    BIT     5,(IX-1)
7B8E 2806      01040         JR      Z,CL07
7B90 FD3403    01050         INC     (IY+3)
7B93 FD3401    01060         INC     (IY+1)
7B96 DDCB0046  01070 CL07    BIT     0,(IX)
7B9A 2809      01080         JR      Z,CL08
7B9C FD3404    01090         INC     (IY+4)
7B9F FD3403    01100         INC     (IY+3)
7BA2 FD3402    01110         INC     (IY+2)
7BA5 DDCB004E  01120 CL08    BIT     1,(IX)
7BA9 2809      01130         JR      Z,CL09
7BAB FD3405    01140         INC     (IY+5)
7BAE FD3403    01150         INC     (IY+3)
7BB1 FD3402    01160         INC     (IY+2)
7BB4 DDCB0056  01170 CL09    BIT     2,(IX)
7BB8 280F      01180         JR      Z,CL10
7BBA FD3405    01190         INC     (IY+5)
7BBD FD3404    01200         INC     (IY+4)
7BC0 FD3402    01210         INC     (IY+2)
7BC3 FD3401    01220         INC     (IY+1)
7BC6 FD3400    01230         INC     (IY)
7BC9 DDCB005E  01240 CL10    BIT     3,(IX)
7BCD 280F      01250         JR      Z,CL11
7BCF FD3405    01260         INC     (IY+5)
7BD2 FD3404    01270         INC     (IY+4)
7BD5 FD3403    01280         INC     (IY+3)
7BD8 FD3401    01290         INC     (IY+1)
7BDB FD3400    01300         INC     (IY)
7BDE DDCB0066  01310 CL11    BIT     4,(IX)
7BE2 2809      01320         JR      Z,CL12
7BE4 FD3403    01330         INC     (IY+3)
7BE7 FD3402    01340         INC     (IY+2)
7BEA FD3400    01350         INC     (IY)
7BED DDCB006E  01360 CL12    BIT     5,(IX)
7BF1 2809      01370         JR      Z,CL13
7BF3 FD3403    01380         INC     (IY+3)
7BF6 FD3402    01390         INC     (IY+2)
7BF9 FD3401    01400         INC     (IY+1)
7BFC DDCB0146  01410 CL13    BIT     0,(IX+1)
7C00 2806      01420         JR      Z,CL14
7C02 FD3404    01430         INC     (IY+4)
7C05 FD3402    01440         INC     (IY+2)
7C08 DDCB0156  01450 CL14    BIT     2,(IX+1)
7C0C 2809      01460         JR      Z,CL15
7C0E FD3404    01470         INC     (IY+4)
7C11 FD3402    01480         INC     (IY+2)
7C14 FD3400    01490         INC     (IY)
7C17 DDCB0166  01500 CL15    BIT     4,(IX+1)
7C1B 2806      01510         JR      Z,CL16
7C1D FD3402    01520         INC     (IY+2)
```

Instructions for Play

Instructions for Playing "God" with Life

This listing may be entered using the Radio Shack Editor/Assembler in order to produce the Life object code. A machine with 16K memory is sufficient to hold this source listing.

After entry of this listing is complete, an object code may be produced; owners of EDTASM 1.1 will get seven FIELD OVERFLOW error messages on lines 800, 830, 870, 910, 940, 980 and 1030 indicating a negative offset for IX. However, the line will assemble correctly, and this error message may be ignored; later versions of EDTASM have corrected this flaw.

After the object code has been produced, be sure to save several copies of both it and the source code for future reference or modifications.

In order to load and run Playing "God" with Life:

1. Power-up the TRS-80, or type SYSTEM [ENTER] /0 [ENTER].
2. Respond to MEMORY SIZE? with 23700 [ENTER].
3. Insert the object tape, type SYSTEM [ENTER], and respond to the *? prompt with the name you used to assemble the object code. (I use "LIFE9").
4. If all is well, the screen will read:

** LOADING LIFE9 *** WAIT FOR "GOOD LOAD" *** THEN ENTER "/" **

5. When the tape has finished loading, the screen will display:

***** GOOD LOAD *****

6. Type a slash (/) and [ENTER].

The screen will clear, followed by the introductory text. When you have finished reading the text, you have the opportunity to call for an on-screen generation count:

GENERATION COUNT? ENTER 1 FOR ON-SCREEN COUNT, 0 FOR NO COUNT

Press 1 or 0 (ENTER not necessary), then:

ENTER 0 TO RETURN TO BASIC, THEN LOAD OR PROGRAM CIVILIZATIONS.

Press 0 [ENTER]

Now you may either:

BLY LISTING FOR with Life

```
7C20 FD3400   01530          INC     (IY)
7C23 DDCB3F4E 01540 CL16     BIT     1,(IX+3FH)
7C27 2803     01550          JR      Z,CL17
7C29 FD3401   01560          INC     (IY+1)
7C2C DDCB4046 01570 CL17     BIT     0,(IX+40H)
7C30 2806     01580          JR      Z,CL18
7C32 FD3401   01590          INC     (IY+1)
7C35 FD3400   01600          INC     (IY)
7C38 DDCB404E 01610 CL18     BIT     1,(IX+40H)
7C3C 2806     01620          JR      Z,CL19
7C3E FD3401   01630          INC     (IY+1)
7C41 FD3400   01640          INC     (IY)
7C44 DDCB4146 01650 CL19     BIT     0,(IX+41H)
7C48 2803     01660          JR      Z,CL20
7C4A FD3400   01670          INC     (IY)
7C4D DD23     01680 CL20     INC     IX
7C4F D9       01690          EXX
7C50 C33C7D   01700          JP      HOLD
              01710 ;
              01720 ; SEE IF ALL POSITIONS CHECKED
              01730 ;
```

1) Enter your own program in BASIC, or
2) Enter the STARTS program (Listing 6).

Notes on Writing Your Own Program:

1. Use POKE statements for graphics, never PRINT or PRINT@. You may POKE graphics on the video display from locations 15360 to 16383. For example, POKE 15392,191, will give a graphics block (191) a seat halfway into the top line. SET and RESET may also be used.

2. Use ASCII character 128 for a space, *not* CLS. (Listing 8).

3. The last program statement before Life must be M% = USR(0), although any variable may be used in place of M%. The correct starting address for Life has been put in place by the Life system program (see text).

Summary of using the god cursor control:

1. Press G: Mortal time is suspended and GOD → flashes on the screen.
2. Move GOD → up, down, left or right by using the four keyboard arrows; be careful if you go off the screen (see text).
3. When GOD → is pointed at a block of cells: Press B to enter the BIRTH mode, or Press K to enter the KILL mode. An asterisk (*) will appear as a prompt.
4. Press 0, 1, 2, 3, 4, or 5 to BEAR or KILL a cell. (Fig. 2.)
5. You may:

Press	B or K	plus 0 through 5 again
Move	GOD→	with the 4 arrows, or
Press	M	to return to mortal time; Life continues

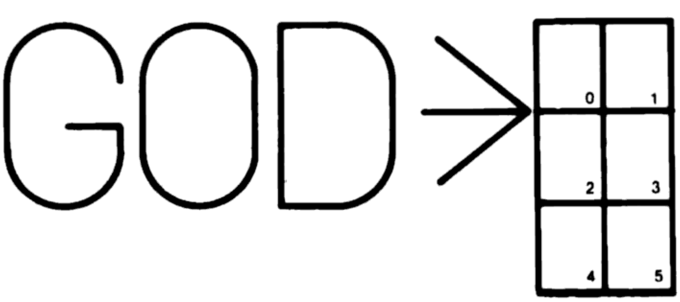

Fig.2. Note that cells 4 and 5 are below the baseline of the word.

```
7C53 0B       01740 FATSO    DEC     BC
7C54 78       01750          LD      A,B
7C55 B1       01760          OR      C
7C56 C2367B   01770          JP      NZ,START
7C59 010004   01780          LD      BC,400H
7C5C D9       01790          EXX
              01800 ;
              01810 ; MAKE GENERATIONAL CHANGES
              01820 ;
7C5D 21FF60   01830          LD      HL,STORE+3FFH
7C60 D1       01840 SCREN    POP     DE
7C61 7A       01850          LD      A,D
7C62 FE02     01860          CP      2
7C64 280A     01870          JR      Z,NXT1
7C66 FE03     01880          CP      3
7C68 2804     01890          JR      Z,$+6
7C6A CBA6     01900          RES     4,(HL)
7C6C 1802     01910          JR      $+4
7C6E CBE6     01920          SET     4,(HL)
7C70 7B       01930 NXT1     LD      A,E
7C71 FE02     01940          CP      2
7C73 280A     01950          JR      Z,NXT2
7C75 FE03     01960          CP      3
7C77 2804     01970          JR      Z,$+6
7C79 CBAE     01980          RES     5,(HL)
7C7B 1802     01990          JR      $+4
7C7D CBEE     02000          SET     5,(HL)
7C7F D1       02010 NXT2     POP     DE
7C80 7A       02020          LD      A,D
7C81 FE02     02030          CP      2
7C83 280A     02040          JR      Z,NXT3
7C85 FE03     02050          CP      3
7C87 2804     02060          JR      Z,$+6
7C89 CB96     02070          RES     2,(HL)
7C8B 1802     02080          JR      $+4
7C8D CBD6     02090          SET     2,(HL)
7C8F 7B       02100 NXT3     LD      A,E
7C90 FE02     02110          CP      2
7C92 280A     02120          JR      Z,NXT4
7C94 FE03     02130          CP      3
7C96 2804     02140          JR      Z,$+6
7C98 CB9E     02150          RES     3,(HL)
7C9A 1802     02160          JR      $+4
7C9C CBDE     02170          SET     3,(HL)
7C9E D1       02180 NXT4     POP     DE
7C9F 7A       02190          LD      A,D
7CA0 FE02     02200          CP      2
7CA2 280A     02210          JR      Z,NXT5
7CA4 FE03     02220          CP      3
7CA6 2804     02230          JR      Z,$+6
7CA8 CB86     02240          RES     0,(HL)
7CAA 1802     02250          JR      $+4
7CAC CBC6     02260          SET     0,(HL)
7CAE 7B       02270 NXT5     LD      A,E
7CAF FE02     02280          CP      2
7CB1 280A     02290          JR      Z,NXT6
7CB3 FE03     02300          CP      3
7CB5 2804     02310          JR      Z,$+6
7CB7 CB8E     02320          RES     1,(HL)
7CB9 1802     02330          JR      $+4
7CBB CBCE     02340          SET     1,(HL)
7CBD 2B       02350 NXT6     DEC     HL
7CBE D9       02360          EXX
7CBF 0B       02370          DEC     BC
7CC0 78       02380          LD      A,B
7CC1 B1       02390          OR      C
7CC2 2002     02400          JR      NZ,$+4
7CC4 1804     02410          JR      MILB
7CC6 D9       02420          EXX
7CC7 C3607C   02430          JP      SCREN
              02440 ;
              02450 ; BLANK ONE BORDER OF BITS
              02460 ; THIS PREVENTS WRAPAROUND EFFECT
              02470 ;
7CCA 060F     02480 MILB     LD      B,0FH
7CCC 114000   02490          LD      DE,40H
7CCF DD21FF5C 02500          LD      IX,5CFFH
7CD3 DDCB008E 02510 ZAAZ     RES     1,(IX)
7CD7 DDCB009E 02520          RES     3,(IX)
7CDB DDCB00AE 02530          RES     5,(IX)
7CDF DD19     02540          ADD     IX,DE
7CE1 10F0     02550          DJNZ    ZAAZ
              02560 ;
              02570 ; RESTORE VIDEO FROM WORKSPACE
              02580 ;
7CE3 21005D   02590          LD      HL,STORE
7CE6 11003C   02600          LD      DE,VIDEO
7CE9 010004   02610          LD      BC,400H
7CEC EDB0     02620          LDIR
              02630 ;
              02640 ; CHECK GENERATION COUNT STATUS FLAG
              02650 ;
7CEE 21F47A   02660          LD      HL,7AF4H
7CF1 7E       02670          LD      A,(HL)
7CF2 FE01     02680          CP      1
7CF4 C2387D   02690          JP      NZ,NOCNT
              02700 ;
              02710 ; COUNT AND CONVERT TO ASCII
              02720 ;
7CF7 0602     02730          LD      B,2
7CF9 11FF3F   02740          LD      DE,3FFFH
7CFC 21F27A   02750          LD      HL,7AF2H
7CFF 7E       02760          LD      A,(HL)
7D00 3C       02770          INC     A
7D01 27       02780          DAA
7D02 77       02790          LD      (HL),A
7D03 3007     02800          JR      NC,$+9
7D05 3F       02810          CCF
7D06 23       02820          INC     HL
7D07 7E       02830          LD      A,(HL)
7D08 3C       02840          INC     A
7D09 27       02850          DAA
7D0A 77       02860          LD      (HL),A
7D0B 2B       02870          DEC     HL
7D0C AF       02880          XOR     A
7D0D ED67     02890          RRD
7D0F C630     02900          ADD     A,30H
7D11 12       02910          LD      (DE),A
7D12 D630     02920          SUB     30H
7D14 ED67     02930          RRD
7D16 C630     02940          ADD     A,30H
7D18 1B       02950          DEC     DE
7D19 12       02960          LD      (DE),A
```

```
7D1A D630               SUB     30H
7D1C ED67               RRD
7D1E 1B                 DEC     DE
7D1F 23                 INC     HL
7D20 05                 DEC     B
7D21 20E9               JR      NZ,$-15H
                ;
                ; CLEAR BLANKS AROUND NUMERALS TO AVOID
                ; INTERACTION WITH GRAPHICS BITS
                ;
7D23 21FB3F             LD      HL,VIDEO+3FBH
7D26 CB8E               RES     1,(HL)
7D28 CB9E               RES     3,(HL)
7D2A CBAE               RES     5,(HL)
7D2C 0604               LD      B,4
7D2E 21BF3F             LD      HL,VIDEO+3BFH
7D31 CBA6       BLUNK   RES     4,(HL)
7D33 CBAE               RES     5,(HL)
7D35 2B                 DEC     HL
7D36 10F9               DJNZ    BLUNK
7D38 D9         NOCNT   EXX
7D39 C3237B             JP      PHIL
                ;
                ; KEYBOARD SCAN FOR HOLD, GOD, BASIC
                ;
7D3C 210238     HOLD    LD      HL,3802H
7D3F 3E01               LD      A,1
7D41 BE                 CP      (HL)
7D42 28F8               JR      Z,$-6
7D44 210838             LD      HL,3808H
7D47 BE                 CP      (HL)
7D48 2005               JR      NZ,$+7
7D4A ED7BFE7F           LD      SP,(7FFEH)
7D4E C9                 RET
7D4F 210138             LD      HL,3801H
7D52 3E80               LD      A,80H
7D54 BE                 CP      (HL)
7D55 2807               JR      Z,$+9
7D57 C3537C             JP      PATSO
7D5A 23         CARRY   INC     HL
7D5B 34                 INC     (HL)
7D5C 2B                 DEC     HL
7D5D C9                 RET
                ;
                ; FLASHING "GOD" SEQUENCE STARTS
                ;
7D5E DD21003C           LD      IX,VIDEO
7D62 DDE5       GODB    PUSH    IX
7D64 E1                 POP     HL
7D65 11F87A             LD      DE,7AF8H
7D68 010400             LD      BC,4
7D6B EDB0               LDIR
7D6D DD360047           LD      (IX),47H
7D71 DD36014F           LD      (IX+1),4FH
7D75 DD360244           LD      (IX+2),44H
7D79 DD36035E           LD      (IX+3),5EH
7D7D CD827D             CALL    DELAY
7D80 1809               JR      SCANA
                ;
                ; DELAY ROUTINE PLACED BEFORE ACTION
                ; PRODUCES DELIBERATE FRUSTRATION
                ;
7D82 21001A     DELAY   LD      HL,1A00H
7D85 2B                 DEC     HL
7D86 7C                 LD      A,H
7D87 B5                 OR      L
7D88 20FB               JR      NZ,$-3
7D8A C9                 RET
                ;
                ; SCAN FOR MOTION OF "GOD" CONTROL
                ;
7D8B 214038     SCANA   LD      HL,3840H
7D8E 3E08               LD      A,8
7D90 BE                 CP      (HL)
7D91 CA827E             JP      Z,UPAR
7D94 07                 RLCA
7D95 BE                 CP      (HL)
7D96 CA917E             JP      Z,DNAR
7D99 07                 RLCA
7D9A BE                 CP      (HL)
7D9B CAA07E             JP      Z,BCKAR
7D9E 07                 RLCA
7D9F BE                 CP      (HL)
7DA0 CA777E             JP      Z,FRTAR
                ;
                ; SCAN KEYBOARD FOR KILL, BEAR, MORTALITY
                ;
7DA3 210238     EDIT    LD      HL,3802H
7DA6 3E08               LD      A,8
7DA8 BE                 CP      (HL)
7DA9 2814               JR      Z,$+16H
7DAB 2D                 DEC     L
7DAC 0F                 RRCA
7DAD BE                 CP      (HL)
7DAE 2813               JR      Z,$+15H
7DB0 23                 INC     HL
7DB1 3E20               LD      A,20H
7DB3 BE                 CP      (HL)
7DB4 CAAB7E             JP      Z,HELD
7DB7 CD627E             CALL    ONCE
7DBA CD827D             CALL    DELAY
7DBD 18A3               JR      GODB
7DBF 0600               LD      B,0
7DC1 1802               JR      $+4
7DC3 0601               LD      B,1
7DC5 21F07A             LD      HL,7AF0H
7DC8 DD7E05             LD      A,(IX+5)
7DCB 77                 LD      (HL),A
7DCC DD36052A           LD      (IX+5),2AH
                ;
                ; SCAN FOR BIT TO KILL OR BEAR
                ;
7DD0 211038     POOO    LD      HL,3810H
7DD3 3E01               LD      A,1
7DD5 BE                 CP      (HL)
7DD6 2823               JR      Z,BIT0
7DD8 07                 RLCA
7DD9 BE                 CP      (HL)
7DDA 282F               JR      Z,BIT1
7DDC 07                 RLCA
7DDD BE                 CP      (HL)
7DDE 283B               JR      Z,BIT2
7DE0 07                 RLCA
7DE1 BE                 CP      (HL)
7DE2 2847               JR      Z,BIT3
7DE4 07                 RLCA
7DE5 BE                 CP      (HL)
7DE6 2853               JR      Z,BIT4
7DE8 07                 RLCA
7DE9 BE                 CP      (HL)
7DEA 285F               JR      Z,BIT5
7DEC 210238             LD      HL,3802H
7DEF BE                 CP      (HL)
7DF0 20DE               JR      NZ,POOO
7DF2 2AF07A             LD      HL,(7AF0H)
7DF5 DD7505             LD      (IX+5),L
7DF8 C3AB7E             JP      HELD
                ;
                ; START ROUTINES TO KILL OR BEAR BITS
                ;
7DFB AF         BIT0    XOR     A
7DFC B0                 OR      B
7DFD 2006               JR      NZ,$+8
7DFF DDCB0486           RES     0,(IX+4)
7E03 1854               JR      STAR
7E05 DDCB04C6           SET     0,(IX+4)
7E09 184E               JR      STAR
7E0B AF         BIT1    XOR     A
7E0C B0                 OR      B
7E0D 2006               JR      NZ,$+8
7E0F DDCB048E           RES     1,(IX+4)
7E13 1844               JR      STAR
7E15 DDCB04CE           SET     1,(IX+4)
7E19 183E               JR      STAR
7E1B AF         BIT2    XOR     A
7E1C B0                 OR      B
7E1D 2006               JR      NZ,$+8
7E1F DDCB0496           RES     2,(IX+4)
7E23 1834               JR      STAR
7E25 DDCB04D6           SET     2,(IX+4)
7E29 182E               JR      STAR
7E2B AF         BIT3    XOR     A
7E2C B0                 OR      B
7E2D 2006               JR      NZ,$+8
7E2F DDCB049E           RES     3,(IX+4)
7E33 1824               JR      STAR
7E35 DDCB04DE           SET     3,(IX+4)
7E39 181E               JR      STAR
7E3B AF         BIT4    XOR     A
7E3C B0                 OR      B
7E3D 2006               JR      NZ,$+8
7E3F DDCB04A6           RES     4,(IX+4)
7E43 1814               JR      STAR
7E45 DDCB04E6           SET     4,(IX+4)
7E49 180E               JR      STAR
7E4B AF         BIT5    XOR     A
7E4C B0                 OR      B
7E4D 2006               JR      NZ,$+8
7E4F DDCB04AE           RES     5,(IX+4)
7E53 1804               JR      STAR
7E55 DDCB04EE           SET     5,(IX+4)
                ;
                ; ROUTINES TO DELETE STAR AND
                ; RESTORE ORIGINAL IMAGE HIDDEN BY "GOD"
                ;
7E59 2AF07A     STAR    LD      HL,(7AF0H)
7E5C DD7505             LD      (IX+5),L
7E5F C3A37D             JP      EDIT
7E62 ED4BF87A   ONCE    LD      BC,(7AF8H)
7E66 DD7100             LD      (IX),C
7E69 DD7001             LD      (IX+1),B
7E6C ED4BFA7A           LD      BC,(7AFAH)
7E70 DD7102             LD      (IX+2),C
7E73 DD7003             LD      (IX+3),B
7E76 C9                 RET
                ;
                ; ROUTINES TO PRODUCE MOTION OF "GOD"
                ;
7E77 CD627E     FRTAR   CALL    ONCE
7E7A DD23               INC     IX
7E7C CD827D             CALL    DELAY
7E7F C3627D             JP      GODB
7E82 CD627E     UPAR    CALL    ONCE
7E85 0640               LD      B,40H
7E87 DD2B               DEC     IX
7E89 10FC               DJNZ    $-2
7E8B CD827D             CALL    DELAY
7E8E C3627D             JP      GODB
7E91 CD627E     DNAR    CALL    ONCE
7E94 0640               LD      B,40H
7E96 DD23               INC     IX
7E98 10FC               DJNZ    $-2
7E9A CD827D             CALL    DELAY
7E9D C3627D             JP      GODB
7EA0 CD627E     BCKAR   CALL    ONCE
7EA3 DD2B               DEC     IX
7EA5 CD827D             CALL    DELAY
7EA8 C3627D             JP      GODB
7EAB CD627E     HELD    CALL    ONCE
7EAE 31EF7A             LD      SP,7AEFH
7EB1 C3237B             JP      PHIL
                ;
                ; ROUTINES TO DISPLAY SCREEN TEXT
                ; AT BEGINNING OF PROGRAM, INCLUDING
                ; DELAYS, GENERATION COUNT CHOICE,
                ; AND RETURN TO BASIC CONTROL
                ;
6200                    ORG     6200H
                ;
                ; CLEAR SCREEN AND HOLD CLEAR
                ;
6200 CD5C62             CALL    PLOP
6203 0610               LD      B,10H
6205 CD827D     STAY1   CALL    DELAY
6208 10FB               DJNZ    STAY1
                ;
                ; DISPLAY FIRST TWO LINES OF TEXT
                ;
620A 21F762             LD      HL,PLAY
620D 11153C             LD      DE,VIDEO+15H
6210 011500             LD      BC,15H
6213 EDB0               LDIR
6215 21523C             LD      HL,VIDEO+52H
6218 061B               LD      B,1BH
621A 363D       QLSE    LD      (HL),3DH
621C 23                 INC     HL
```

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SORT	16K	33	SORT	340K	1081
SORT	32K	49	SORT	680K	2569
SORT	85K	173	SORT and MERGE	85K SORT + 1275K Merge	1757
SORT	170K	445			

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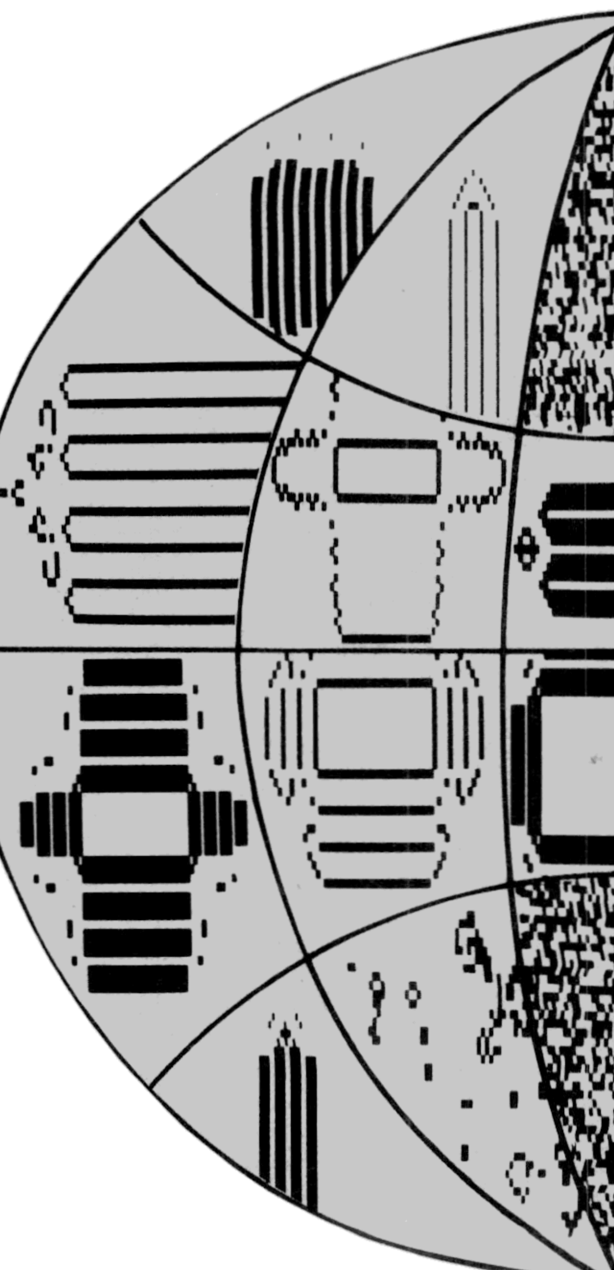
```
621D 10FB     05430          DJNZ    QLSE
621F 210C63   05440          LD      HL,COPY
6222 11C03C   05450          LD      DE,VIDEO+0C0H
6225 014000   05460          LD      BC,40H
6228 EDB0     05470          LDIR
              05480 ;
              05490 ; DISPLAY NEXT GROUP OF LINES WITH
              05500 ; DELAY FROM LETTER TO LETTER
              05510 ;
622A 214C63   05520          LD      HL,INSTR
622D 11403D   05530          LD      DE,VIDEO+140H
6230 06FF     05540          LD      B,0FFH
6232 CD3C62   05550          CALL    WRDS
6235 06C1     05560          LD      B,0C1H
6237 CD3C62   05570          CALL    WRDS
623A 180C     05580          JR      HERE
623C 7E       05590 WRDS     LD      A,(HL)
623D 12       05600          LD      (DE),A
623E E5       05610          PUSH    HL
623F CD827D   05620          CALL    DELAY
6242 E1       05630          POP     HL
6243 23       05640          INC     HL
6244 13       05650          INC     DE
6245 10F5     05660          DJNZ    WRDS
6247 C9       05670          RET
6248 210C65   05680 HERE     LD      HL,PLUS
624B 11403F   05690          LD      DE,VIDEO+340H
624E 06BF     05700          LD      B,0BFH
6250 CD3C62   05710          CALL    WRDS
6253 0650     05720          LD      B,50H
6255 CD827D   05730 STAY2    CALL    DELAY
6258 10FB     05740          DJNZ    STAY2
625A 180E     05750          JR      POKE
              05760 ;
              05770 ; CLEAR SCREEN SUBROUTINE
              05780 ;
625C 01FF03   05790 PLOP     LD      BC,3FFH
625F 21003C   05800          LD      HL,VIDEO
6262 11013C   05810          LD      DE,VIDEO+1
6265 3680     05820          LD      (HL),80H
6267 EDB0     05830          LDIR
6269 C9       05840          RET
              05850 ;
              05860 ; PUT "USR(0)" ADDRESS IN PLACE
              05870 ;
626A 218E40   05880 POKE     LD      HL,408EH
626D 3600     05890          LD      (HL),0
626F 23       05900          INC     HL
6270 367B     05910          LD      (HL),7BH
6272 CD5C62   05920          CALL    PLOP
              05930 ;
              05940 ; DISPLAY GENERATION COUNT PROMPT
              05950 ;
6275 21BA62   05960          LD      HL,GEN
6278 11003D   05970          LD      DE,VIDEO+100H
627B 013D00   05980          LD      BC,3DH
627E EDB0     05990          LDIR
              06000 ;
              06010 ; SCAN KEYBOARD FOR RESPONSE
              06020 ;
6280 211038   06030          LD      HL,3810H
6283 3E01     06040          LD      A,1
6285 BE       06050          CP      (HL)
6286 2806     06060          JR      Z,$+08H
6288 3C       06070          INC     A
6289 BE       06080          CP      (HL)
628A 2809     06090          JR      Z,$+0BH
628C 18F2     06100          JR      $-0CH
              06110 ;
              06120 ; SET UP GENERATION COUNT STATUS FLAG
              06130 ;
628E 21F47A   06140          LD      HL,7AF4H
6291 3600     06150          LD      (HL),0
6293 1805     06160          JR      CLOD
6295 21F47A   06170          LD      HL,7AF4H
6298 3601     06180          LD      (HL),1
              06190 ;
              06200 ; DELAY FOLLOWED BY RETURN TO BASIC
              06210 ; PROMPT AND KEYBOARD SCAN
              06220 ;
629A 0610     06230 CLOD     LD      B,10H
629C CD827D   06240 CLID     CALL    DELAY
629F 10FB     06250          DJNZ    CLID
62A1 CD5C62   06260          CALL    PLOP
62A4 21CB65   06270          LD      HL,BASC
62A7 11003D   06280          LD      DE,VIDEO+100H
62AA 013F00   06290          LD      BC,03FH
62AD EDB0     06300          LDIR
62AF 211038   06310 DOLC     LD      HL,3810H
62B2 3E01     06320          LD      A,1
62B4 BE       06330          CP      (HL)
62B5 20F8     06340          JR      NZ,DOLC
              06350 ;
              06360 ; RETURN TO BASIC CONTROL
              06370 ;
62B7 C3191A   06380          JP      1A19H
              06390 ;
              06400 ; THE LINES OF TEXT FOLLOW AS A BLOCK
              06410 ;
              06420 GEN      DEFM    'GENERATION COUNT? ENTER 1 FOR '
              06430          DEFM    'ON-SCREEN COUNT, 0 FOR NO COUNT'
              06440 PLAY     DEFM    'PLAYING GOD WITH LIFE'
              06470 INSTR    DEFM    '"PLAYING GOD WITH LIFE" IS A '
              06480          DEFM    'MATHEMATICAL PASTIME.  THERE ARE NO'
              06490          DEFM    'WINNERS OR LOSERS.  YOU BECOME '
              06500          DEFM    'THE OBSERVER IN AN AGELESS MASTER'
              06510          DEFM    'PLAN -- A SORT OF LIMITED DEITY '
              06520          DEFM    'WITH CONTROL OVER YOUR GARDEN OF'
              06530          DEFM    'EDEN, POSSESSING THE POWER TO '
              06540          DEFM    'COMMIT THE UNIVERSE TO OBLIVION OR'
              06550          DEFM    'TO CREATE OR DESTROY INDIVIDUALS '
              06560          DEFM    'AT WILL.  BUT FOR YOU TO CHANGE'
              06570          DEFM    'THE MASTER PLAN IS OUTSIDE '
              06580          DEFM    'YOUR POWER.   YOU ONLY OBSERVE AS THE'
              06590          DEFM    'GENERATIONS MARCH BY, SUSPENDING '
              06600          DEFM    'TIME TO SAVE A FEW FRIENDS.....'
              06610 PLUS     DEFM    'CONTROL WILL BE RETURNED TO YOU '
              06620          DEFM    'AND BASIC IN TWENTY SECONDS, AND'
              06630          DEFM    'IF YOU REFER TO YOUR "PLAYING GOD '
              06640          DEFM    'WITH LIFE" INSTRUCTION SHEETS,'
              06650          DEFM    'YOU WILL BE ABLE TO CREATE '
              06660          DEFM    'YOUR UNIVERSE AND ITS CIVILIZATIONS.'
              06670 BASC     DEFM    'ENTER 0 TO RETURN TO BASIC, '
              06680          DEFM    'THEN LOAD OR PROGRAM CIVILIZATIONS.'
              06690 ;
              06700 ; DISPLAY "GOOD LOAD" AT END OF LOAD
              06710 ; TO ASSURE USER OF GOOD LOAD (WHAT ELSE?)
              06720 ;
              06730          ORG     3C56H
              06740          DEFM    '***** GOOD LOAD *****'
              06750          END     6200H

DOLC    62AF        HELD    7EAB        CL18    7C38
BASC    65CB        EDIT    7DA3        CL17    7C2C
CLID    629C        FRTAR   7E77        CL16    7C23
CLOD    629A        BCKAR   7EA0        CL15    7C17
GEN     62BA        DNAR    7E91        CL14    7C08
POKE    626A        UPAR    7E82        CL13    7BFC
STAY2   6255        SCANA   7D8B        CL12    7BED
PLUS    650C        DELAY   7D82        CL11    7BDE
HERE    6248        GODB    7D62        CL10    7BC9
WRDS    623C        CARRY   7D5A        CL09    7BB4
INSTR   634C        BLUNK   7D31        CL08    7BA5
COPY    630C        NOCNT   7D38        CL07    7B96
QLSE    621A        ZAAZ    7CD3        CL06    7B8A
PLAY    62F7        MILB    7CCA        CL05    7B7B
STAY1   6205        NXT6    7CBD        CL04    7B6F
PLOP    625C        NXT5    7CAE        CL03    7B66
STAR    7E59        NXT4    7C9E        CL02    7B5A
BIT5    7E4B        NXT3    7C8F        CL01    7B4E
BIT4    7E3B        NXT2    7C7F        START   7B36
BIT3    7E2B        NXT1    7C70        LIFE    7B32
BIT2    7E1B        SCREN   7C60        PHIL    7B23
BIT1    7E0B        FATSO   7C53        BLINK   7B1E
BIT0    7DFB        HOLD    7D3C        BLANK   7B14
POOO    7DD0        CL20    7C4D        STORE   5D00
ONCE    7E62        CL19    7C44        VIDEO   3C00
```



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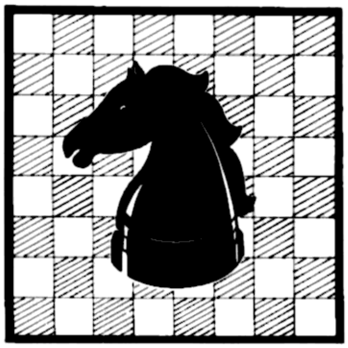

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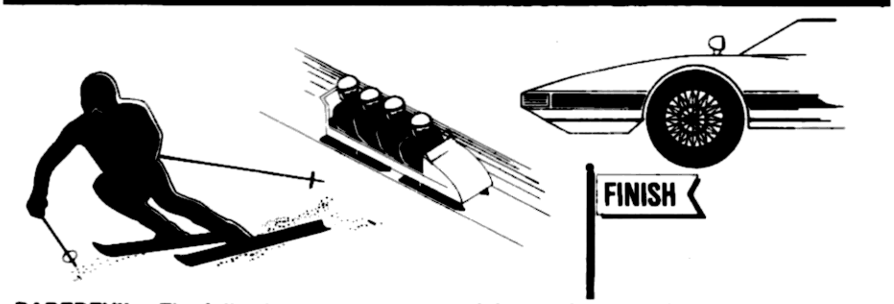

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•**Auto Race** – You attempt to steer your car past the car driven by the computer. The course is tricky, so be careful.

•**RACE** – Steering a car around this course is a real challenge, it has potholes and some very tricky curves. But that is not all, because the road becomes gradually narrower!

Don't be charmed by these innocent-looking titles. None of these contests are easy, in fact they all become very difficult, and you will be hard-pressed all the way! For the TRS-80 Level II 16K. **Order No.0082R. $9.95.**

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This package is excellent for students, businessmen, scientists, and anyone who is interested in learning the Russian language. For the TRS-80 Level II 16K. **Order No. 0136R $9.95.**

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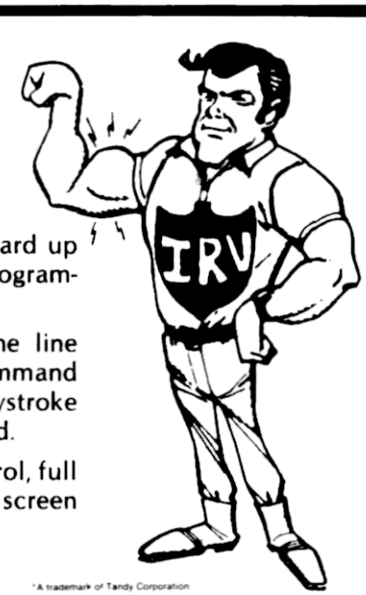

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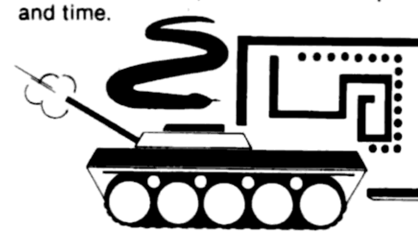

•**Mission Impossible** — This program requires both skill and luck to accomplish your mission in this real-time simulation. Your objective is to drive your tank into a prison courtyard, rescue a jailed prisoner and escape. Sound easy? It's not!
•**Trap** — This is a two-player game, in which you must maneuver your opponent into a position where he is hopelessly trapped. Good luck!
•**Wipeout** — A two-player game in which your mobile gun accumulates points by destroying as many obstacles as possible on a battlefield.
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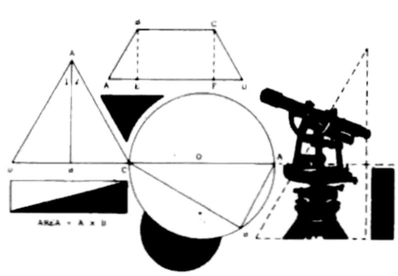
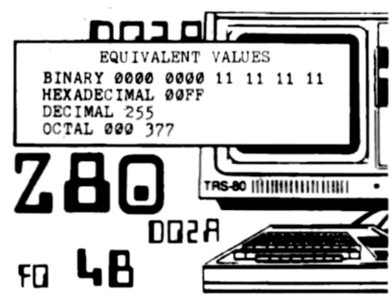


SURVEYOR'S APPRENTICE This three part package will display on-screen diagrams of rectangles, circles, triangles, parallelograms, trapezoids and polygons, giving you the formulas to compute the area for each figure, and it will give you examples of how to do the problems. The program will also quiz you and tell you how well you're doing.

These programs are a terrific supplement for any high school geometry course for work both in and out of the classroom. For the TRS-80 Level II 16K. **Order No.0127R. $9.95.**



PROGRAMMER'S CONVERTER Have you always wanted to try your hand at Z80 assembly language, but were intimidated by all of those F0's, 4B's and D02A's? Once you begin using hexadecimal numbering you'll wonder how you did without it!
This package contains these three programs:
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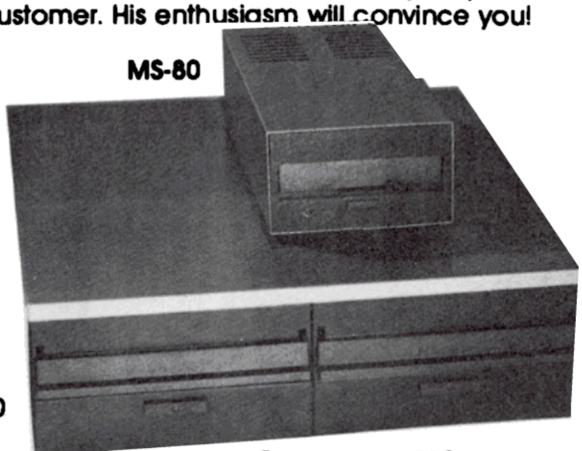

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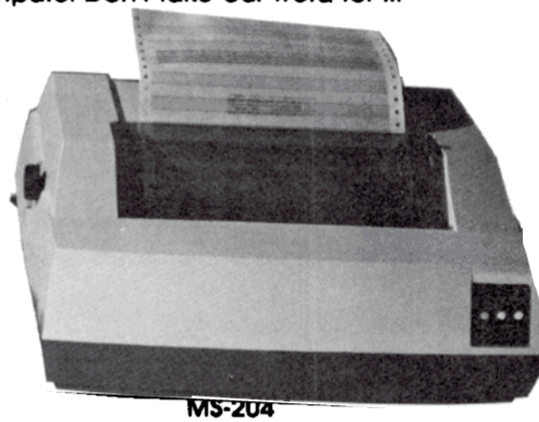

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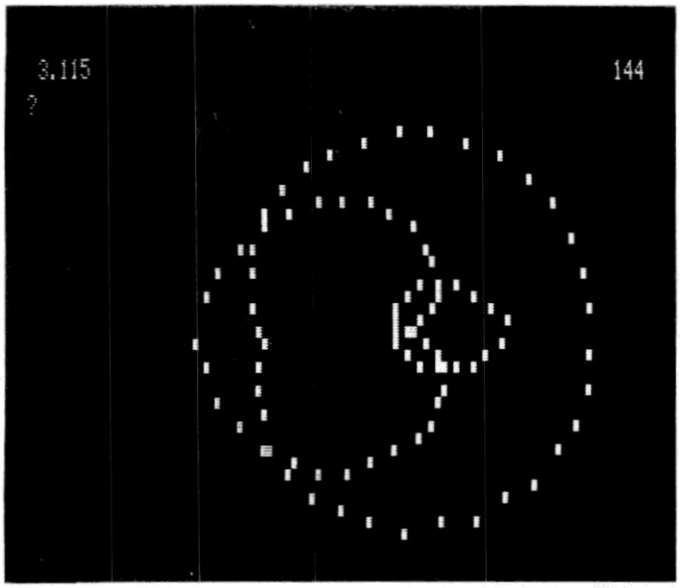

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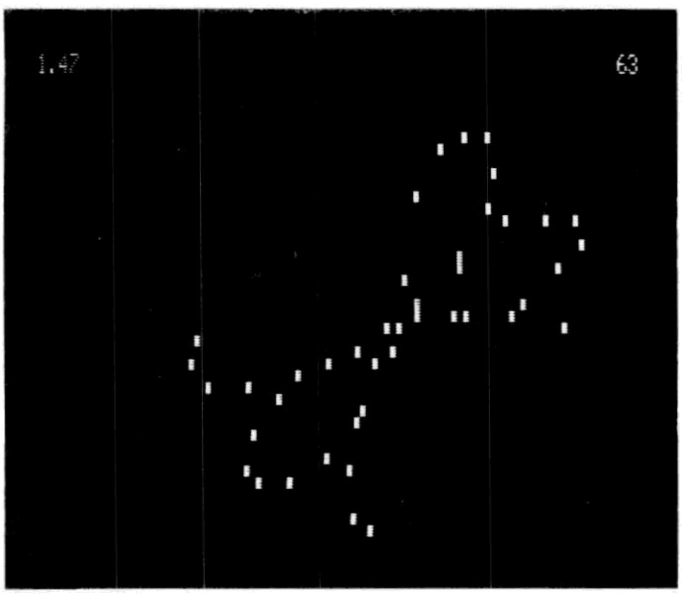

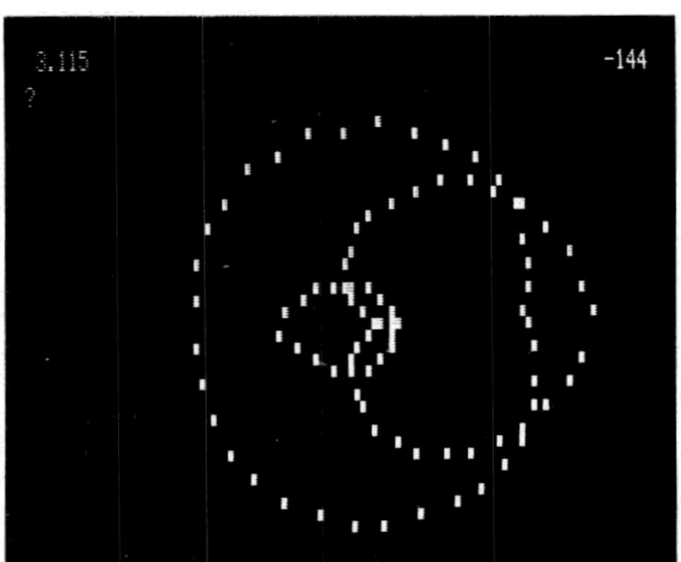

Adventures in Roseland

This general equation J = a SIN X, if properly translated into a program that your TRS-80 can digest, paints a three leafed rose onto your monitor screen.

Program Listing 1 gives a programming possibility. After you have run the program and examined the scenery, the question "Why bother?" may come up.

Pattern After Pattern

For a partial answer, make the following changes and additions to Listing 1.

```
5 G=0
15 G=G+1: PRINT [a] 50,G
30 R=35•SIN(G•J)
80 INPUT Z$
90 GOTO 10
```

You now have a program that produces pattern after pattern, because of the changing value of G, each time the program runs. Line 80 is merely a way to put in a controlled pause.

When one pattern has been generated, you may examine it for as long as you wish, hitting ENTER to get the next one.

The print statement in line 15 is an index that will help you make a record of any pattern that happens to strike your fancy.

Running the revised listing, you will see that when G is an even number, the rose has petals equal to 2•G, and when G is odd, the petal count equals G. Note also that when G is odd, the figure is first traced and then retraced by the program.

If you are going to run any number of these patterns, I suggest you alter the STEP in line 20 to read .035. This cuts the print time in half without too much damage to the image.

After you have played with the program for a bit, jump past the rose petal section by changing line 5 to read G = 29. Remember that as the patterns form, you can stop them as desired using SHIFT [A].

You will notice that some of the patterns are predominantly circular, while others are spirals. Some are cluttered looking and others quite sharply defined.

You can expand them by setting the value in line 5 to such constants as 99, 199 or 299 to find new patterns. For more visual fun with your TRS-80, set

```
10 CLS
20 FOR J=0 TO 6.28 STEP .0175
30 R=35•SIN(3•J)
40 X=(R•COS(J))®64
50 Y=(R•SIN(J))®47
60 SET(X,471(Y/2))
70 NEXT J
```

Program Listing 1.

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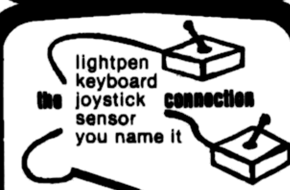

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THE MICRO CLINIC • 17375 Brookhurst • No. 114 • Fountain Valley CA 92708 the value of G in line 5 to 29. Line 20 should read:

```
20 FOR J = 0 TO 3.14 STEP .035
```

This line eliminates some of the clutter you may have noticed in the patterns and also speeds up the printing of the image.

When G = 35 you see an image of five tangent circles. If G = 44 you have a gaggle of four circles. When G = 36 you see a stylized eagle inside a spiral segment.

We already have index G as a guide. Add another index so you can see what I see in the following examples.

Change line 30 to read:

```
30 R = 35*SIN(G*J): PRINT@0, J
```

Start the program running again by setting G in Line 5 to equal 28. The first time you run the program G will equal 29. If you stop the pattern when J = 1.12, you should see what might be interpreted as a barbell weight.

If G = 33 and J = 1.575, you may see a dinosaur.

If G = 63 and J = 1.47, you will hopefully see Snoopy the dog.

If G = 116 and J = 1.435, you will see a running dog.

Here are some other fantasies available by altering G. G = 143, is a stylized Darth Vadar, and G = 144 gives you a close approximation of the human eye as shown in a cross section of an anatomy book.

Negative Values

You can also use negative values for G. In this last image, let G = – 144. The pattern is identical except it has been rotated so that it is now the mirror image of the positive G input.

Since we are dealing with circular functions, this displacement can be left to right as in this example, or top to bottom (G = and G = – 1).

You can also get a combination of shifts, such as both right to left and top to bottom, as when G = 36 or G = – 36. There are times when altering the symmetry makes the image more realistic. For example, if G = 33 and J = 1.115, you see what looks like a running horse. If you alter line 30 to read,

```
30 R = 45*SIN(G*J)
```

the running horse becomes more realistic.

This program is a nice way to introduce some imaginative people to the TRS-80. It is one sure way to get rid of the comment, "Shucks, I can do that with my calculator". ■

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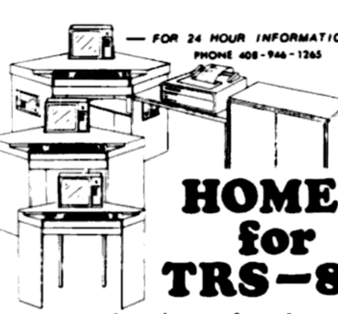

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Randomness

Todd L. Carpenter
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At the heart of most game programs is a statement of chance, the RANDOM statement. Having the ability to look at the shape of the RANDOM distribution, can give you the power of shaping the distribution to suit your purposes.

Graphics displays on the TRS-80 certainly have their limitations, but there is one type of display the TRS-80 handles rather nicely—the bar graph. If you are interested in the statement Y = RND(X), it is important for you to understand the distribution characteristics of Y over its range (1 to X). A bar graph can display this with a touch of elegance.

Is RANDOM Really Random

I had written a custom Star Trek program (hasn't everyone?) for my Level I, 16K machine. After playing with it for several

Program Listing.

```
100 REM  **  RANDOM DISTRIBUTION GRAPHICS PROGRAM  **
110 REM  **                                        **
120 REM  **  TODD 1. CARPENTER                     **
130 REM  **  10/01/79                              **
140 REM  **                                        **
150 :
300 CLS
310 P.: P."INPUT X                 FOR THE RND(X) STATEME
    NT.  IT"
320 P.     "                       MUST BE A POSITIVE NUM
    BER:"
330 P.: P."                        0  <=  RND(X)  <=  X"
340 P.A.74,"";: INPUT X
400 CLS
410 P.: P."# OF TRIALS             INPUT THE DESIRED NUMB
    ER OF TRIALS."
420 P.     "                       THE GREATER THE NUMBER
    OF TRIALS,"
430 P.     "                       THE SMOOTHER THE GRAPH
    ."
440 P.A.77,"";: INPUT C
450 CLS
460 :
470 :
500 P.A.348,"THINKING";
510 K=0: F=50
520 FOR I=0 TO 50
530   A(I)=0
540 NEXT I
550 X=INT(X)
560 IF X<=0 THEN 300
570 :
580 :
710 REM  **  CALCULATE RND(X) VALUES  **
720 REM  **  MAX VALUE STATEMENT  **
725 REM  ***************************
730           M=2*X
740 REM  ***************************
760 L=M
770 IF M<50 THEN M=50
775 IF M>50 THEN M=(INT((M-1)/50)+1)*50
780 N=M/50
790 FOR I=1 TO C
800   REM  **  RND(X) STATEMENT  **
805   REM  ************************
810            Y=RND(X)+RND(X)
820   REM  ************************
830   B=INT(Y*50/M)
840   IF B<0 THEN 870
850   A(B)=A(B)+1
860   IF K<A(B) THEN K=A(B)
870 NEXT I
880 :
890 :
1000 REM  **  PLOT X-AXIS  **
1010 CLS
1020 J=INT(K/32)+1
1030 FOR I=16 TO 123
1040   SET (I,38)
1050   IF INT(I/10)=I/10  THEN SET (I,39)
1060 NEXT I
1070 :
1080 :
1100 REM  **  LABEL X-AXIS  **
1110 FOR I=0 TO 10
1120   P.A.905+5*I,5*I*N;
1130 NEXT I
1140 :
1150 :
1200 REM  **  LABEL Y-AXIS  **
1210 FOR I=0 TO 5
1220   P.A.770-I*128,J+J*6*I;
1230 NEXT I
1240 :
1250 :
1300 REM  **  PLOT Y-AXIS  **
1310 FOR I=6 TO 38
1320   IF INT((I-2)/6)=(I-2)/6 THEN SET (15,I-1)
1330   SET (16,I): SET (17,I)
1340 NEXT I
1350 :
1360 :
1400 REM  **  HEADING AND LABELS  **
1410 P.A.29,"RANDOM DISTRIBUTION";
1420 P.A.83,"X=";X;"    ";C;"TRIALS      MAX VALUE=";L;
1430 P.A.64,"# OF TRIALS";
1440 P.A.976,"EACH BAR IS A";N;"VALUE RND(X) BIN";
1450 :
1460 :
2000 REM  **  PLOT GRAPH  **
2010 FOR I=0 TO 50
2020   IF A(I)<J THEN 2060
2030   FOR H=1 TO INT(A(I)/J)
2040     SET (20+2*I,38-H)
2050   NEXT H
2060 NEXT I
2070 :
5000 P.A.960,"";
6000 INPUT I
7000 GOTO 300
9999 REM  **  END  **
```

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TING - TONG

by Ray Daly

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Acorn produces several games for the TRS-80*. These include: *Codebreaker, Star Warp & Lunar Lander, Word Challenge. Bandito, Block'em,* and *Ting-Tong* priced at $9.95. *Pigskin, Quad* and *Star Trek Two* are available for $14.95. Ask for these and other quality Acorn programs at your local computer store.

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weeks, I noticed that the majority of the Klingons were always located near the center of the galaxy. Rarely did I ever find a Klingon in any of the perimeter quadrants. I thought I had used a simple Y = RND(X) statement in distributing the Klingons; but it seemed that either my RANDOM statement was not truly random or the Klingons had succeeded in outsmarting Captain Carpenter. I chose to pursue the former suspicion because, after all, the Klingons are the bad guys and they could not outsmart me—could they?

I set out to write a simple program that would show me once and for all whether or not the RANDOM statement really gave me a uniform random distribution. The purpose of the program was to display in a single picture the distribution of the RND(X) statement. The ability to see the RANDOM distribution would enable me to determine immediately the actual randomness of the statement.

I was prepared to make a shattering discovery that Radio Shack had goofed in their design of the RND(X) statement. But why had no one else discovered this biased RANDOM statement? Perhaps, I thought, the bias was slight, and I had discovered it only because my program used the RANDOM statement over 4,000 times in distributing the elements of the galaxy. As you will see, it was Captain Carpenter who had goofed, not Radio Shack.

Random Shaping

After a closer examination of my Star Trek Program I discovered that I had inadvertently used a combination of RANDOM statements. How could I test the distribution of this combination? After a few generalizations in my program I was ready to run an analysis on any combination of RANDOM statements that could start with "Y =". I proceeded to test my Klingon distribution. Sure enough, they were doing just what I had been telling them to do, concentrating in the middle. In separate parts of the program, I had mistakenly used what amounted to the sum of two RANDOM statements and gotten a dice-like distribution. See Fig. 1.

As all craps players should know, when rolling two dice, more sevens turn up than twos or twelves. In fact, six times as many sevens turn up.

The advantage of seeing any RANDOM distribution before ENTERing it, is that the shape of a distribution can be selected to fit an application. Once you know how to generate some

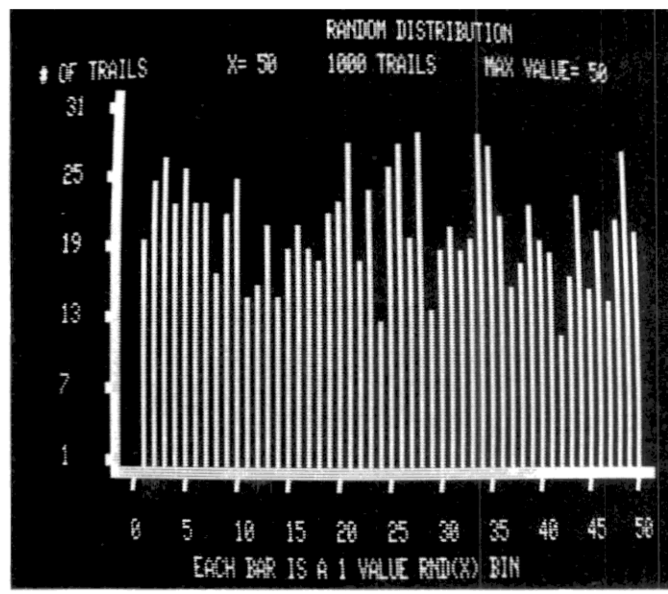


Photo 1

Photos by Yuan Chang Lo

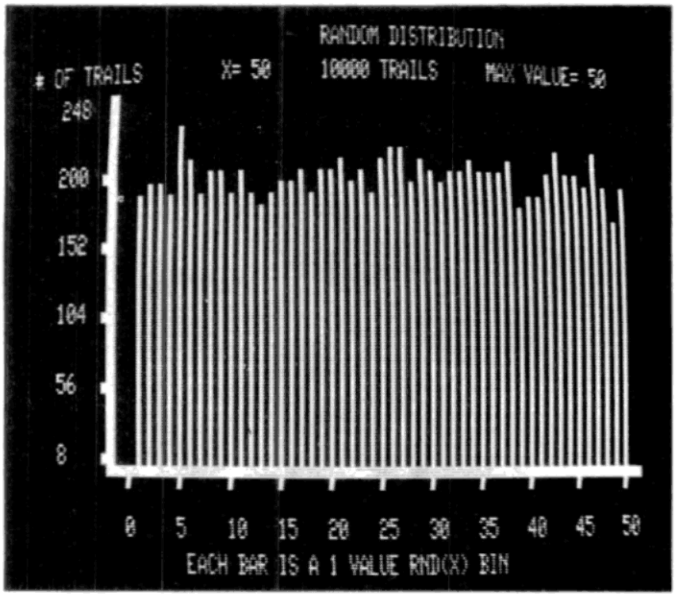


Photo 2

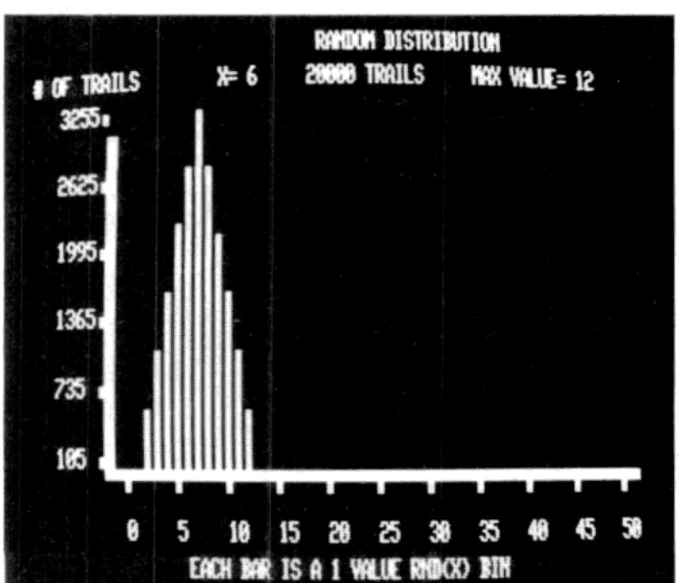
simple shapes, the next steps seem easier.

Program Inputs

The program (See Program Listing) starts by asking for the value of X in the RND(X) statement. It can be any number greater than zero and preferably an integer (although the machine will accept a decimal value and find the integer value itself). For the case of the simplest RANDOM statement, Y = RND(X), the function Y is uniformly distributed from 1 to X. This means that for a single trial, the probability is the same for getting any integer value from 1 to X. For example, X = 6 is analogous to the case of rolling one die. With six faces, the probability that any particular face comes up is 1/6. See Fig. 2.

Next, input the number of trials to be made. For our example this would be the number of rolls of the single die.

The greater the number of trials performed the more the graph will be delineated. The number of trials made must be large compared to the entered value of X. As a rule of thumb I make the number of trials at least 20 times the maximum



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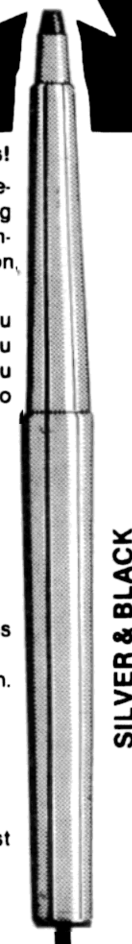

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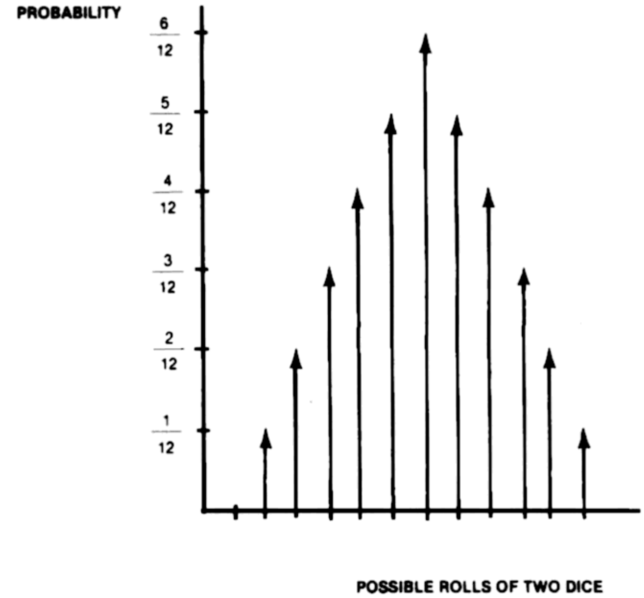

value that Y can be. In this case, make Y equal to X or 6.

You are now ready to take a peek at Photo 1 which shows a graph of the function, Y = RND(50). There were 1,000 trials, the minimum rule of thumb value, used to determine this graph. (Fifty values times 20 trial outcomes per value, equals 1,000 total trials.) As you can see it yeilds quite an uneven distribution.

I chose to use the number of trial outcomes for the vertical axis rather than probability in this case. But, either way the shape of the graph is the same.

Now consider Photo 2. I ran the same distribution, but this time with 10,000 trials. As you would expect, the average number of values per "bin" is now 10 times what it was in the previous example, or 200. I have coined the word bin to refer to each bar of the graph. A bar getting larger can be thought of as a bin being filled.

Changing the Distribution

There are two important statements in the program. They are the RANDOM statement and the MAX VALUE statement. The RANDOM statement is at line 810 and contains the expression which determines the shape of the distribution. This statement must be edited manually when-

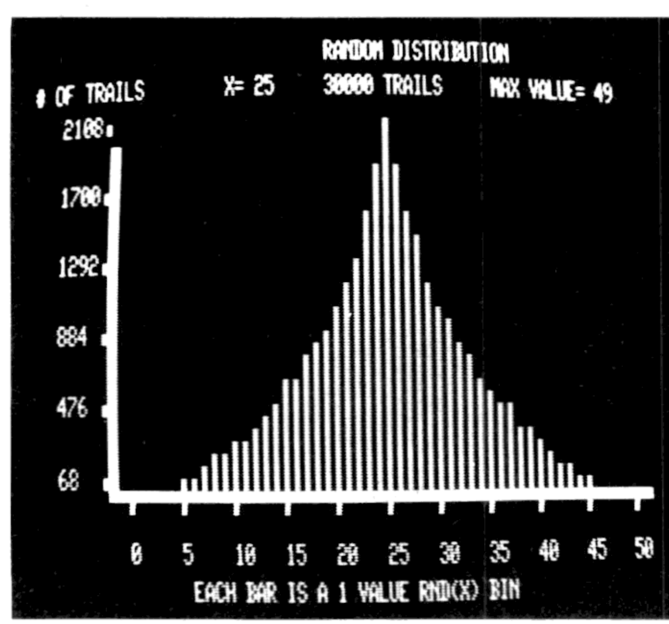

Photo 4

ever a new expression is desired. The MAX VALUE statement is at line 730, and defines the variable M which must be set equal to the largest possible value Y can be in the RANDOM statement. In the listing shown, Y = RND(X) + RND(X), so M = X + X. For instance, if line 810 reads Y = X − RND(X), line 730 would read M = X − 1. (When a term is subtracted, use its minimum value.)

Photo 3 shows the distribution of the equation in the program listing. I chose to enter X = 6, so I would be able to extend the dice rolling analogy. This time I rolled two dice and

approximated by using a large sum of simple RND(X) statements. I used six terms here.

As more and more sophisticated functions are used, a definite limitation crops up. A simple statement like Y = RND(X) takes about six times as long to execute as a FOR-NEXT loop pair, and the statement Y = RND(RND(X)) takes about 10 times as long. In other words, this program can take quite a long time to run through 30,000 trials. With that in mind, it's wise to start testing a new function with the minimum rule of thumb number of trials. If Y = RND(RND(X)*2),

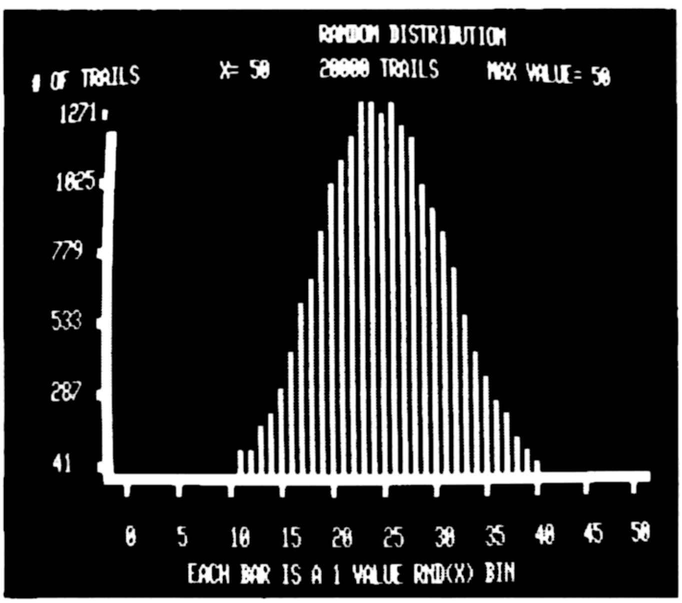

Photo 5

got a distribution such that the most likely number to come up, seven, was in the center. This is essentially how my Klingons were distributing themselves.

Now, we move on to some more complicated distributions. Photo 4 shows a graph of the distribution, Y = X + RND (RND(X)) − RND(RND(X)), where M = X + X − 1. This was run with 30,000 trials and quite a smooth graph was obtained. On my Level I, 16K machine, the largest number of passes allowable through a FOR-NEXT loop is 32767, so this is the largest number of trials I can enter.

Photo 5 shows a normal distribution, for those of you interested in statistics. It can be

M = X*2, and you enter X = 50, then you should enter the number of trials as 2,000 (20 times M). This will not produce a very smooth graph, but will take only about 1/15th as much time to run. Usually this is about two to three minutes.

Auto Scaling

This brings up one last significant feature of the program. You have seen how the vertical axis scales itself depending on the maximum number of trial outcomes per bin. The same thing applies to the horizontal axis. You are not limited to a maximum value of 50. It can be 51 or 135 or 1,000 or whatever you like.

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With DEBUG-S/S you may run your program in slow motion or single step and observe your Z-80* registers dynamically and/or observe your message printing on the screen one-character-at-a-time!

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DEBUG-S/S uses a convenient split screen display system. The upper right section of the screen automatically displays upon entry to DEBUG-S/S from the user's program. This section shows the user's next instruction in hexadecimal and disassembled symbolic form, and also shows the user's major Z-80* registers. The left portion of the screen is for the user's display or a scratch pad area for memory dumps. The lower right section of the screen is where DEBUG-S/S commands are entered and echoed for the user's inputs.

TRANSPARENT MODE

DEBUG-S/S may be operated in a transparent mode which leaves the entire screen showing all of the user's display data upon entry to DEBUG-S/S, except for the letter D displayed on the upper right corner of the screen indicating that DEBUG-S/S has been entered. If the user now wishes to examine his Z-80* registers, he simply types D (Display).

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DEBUG-S/S uses a single byte breakpoint which means you may put a breakpoint in the first byte of any instruction in your program and not cause your program to crash because of the breakpoint insertion. Your breakpoint will stay active until you reset it or redefine it. This allows you to run through loops in your program repeatedly without having to redefine your breakpoint each time. You may enter any number of one byte pseudo breakpoints simultaneously in your program manually with the Memory command.

POWERFUL COMMANDS

Examples of DEBUG-S/S commands are: Jump - Go - Breakpoint - Memory examine/modify - Hex Dump - ASCII Dump - Symbolic Instruction Dump - Single Step - Automatic Step start/stop - Increase/Decrease Auto Step rate - Clear Screen and save cursor position - Clear Screen and home cursor position, plus other commands.

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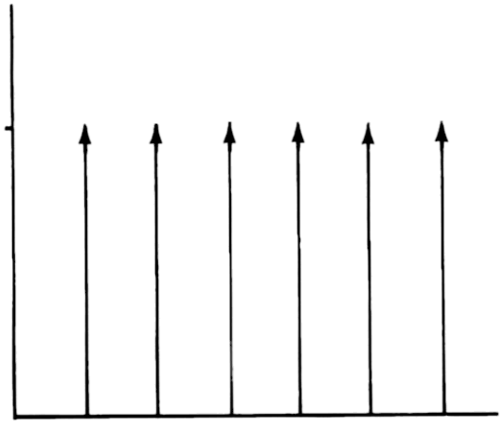

POSSIBLE ROLLS OF ONE DIE

If the graph shape is all that is desired, this can generally be accomplished with 50 as a maximum value.

If you decide that some larger number is more convenient, then the axis will be automatically scaled. There will never be more than 50 bins in which to accumulate trial points, but if the maximum value is 64, for example, the axis will be scaled down by a factor of two. This makes each bin a two-value, rather than single-value bin.

Now you have an elegantly simple program that lets you see what the RANDOM statement can do. Thanks to this program, my Klingons have been controlled, the galaxy has been saved, and Starfleet Command will not have to give me a desk job.■

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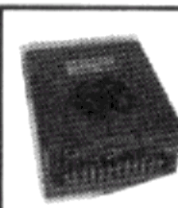

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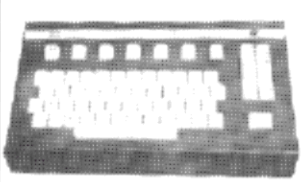

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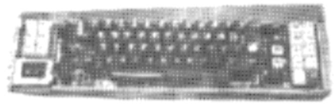

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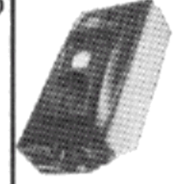

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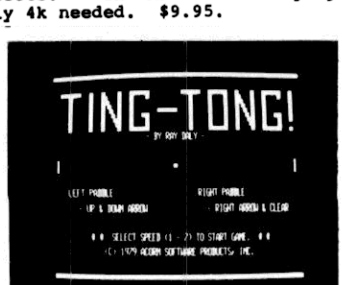

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Doodle Bug

R. Daniel Bishop
Department of Chemistry
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Some people are habitual doodlers. Give them a pen or pencil and, without being aware of their actions, they begin sketching or scribbling on anything that might be handy. Their addiction seems to be uncontrollable in certain locations, such as near telephones, and at specific times, such as during long business meetings or conferences. Some even doodle on napkins in restaurants! I know these things because I, too, am a compulsive doodler. Long ago I gave up all hope of ever reforming myself.

It thus should come as no surprise that one of the programs I just had to complete for my TRS-80 was Doodle, a program designed to promote uninhibited doodling using the graphics capability of the microcomputer. Furthermore, in the event that a productive sketch were to take birth during the doodle process, I derived two subroutines to permit saving the video display, either on disk or on cassette tape, and two corresponding subroutines to permit recalling the stored data and recast the video display in its entirety. Thus, a building floor plan, a circuit diagram or stylized drawings of equipment or building architecture can be stored for future redesign or viewing.

Once a design has been completed and stored, some simple program statements that employ the PRINT @ XXX, feature can be written temporarily into the redisplay subroutine. Then, when this subroutine is run, not only does the original sketch reappear on the screen, but also the alphanumeric information shows up. This new display can then be saved using the save subroutine, thus allowing complex graphics displays with accompanying labels and captions to be stored.

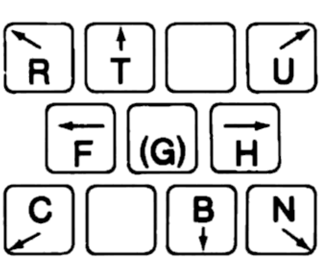


Fig. 1. Eight direction keys used to control development of the sketch via keyboard input.

The Program

Two sets of keys are used to provide direct keyboard control of the sketch and of the program. Fig. 1 shows the eight direction keys that are used for directing the movement of the graphics display points. With your middle finger on the G key, it is then quite natural for you to tap the T for upward movement, the H for movement to the right, the C for diagonal movement to the lower left, etc.

P	Pause. Halts the program until a new keyboard entry is made.
S	SAVE video sketch on disk.
Z	CSAVE video sketch on cassette.
G	Move cursor without leaving permanent display.
L	Erase current cursor position and proceed to next position (as determined by last direction key pressed).

Table 1. Five program control keys used to provide program control from the keyboard without interrupting the video display.

The program was initially designed to produce only one point each time a key was tapped. I soon decided to let the computer handle any repetitive functions, so that now each of the eight direction keys initiates a line drawn in the direction chosen. Tapping any of the other direction keys once redirects the line.

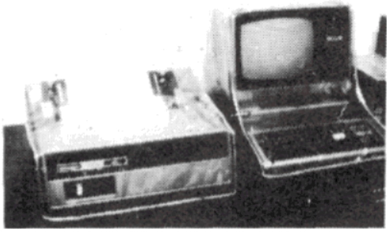
In addition to the eight direction keys, five control keys were chosen to allow program control to be initiated from the keyboard. These five control keys are listed in Table 1. Pressing the P causes the program to pause, thus halting the movement of the display point and stopping the line being generated by it.

The S and Z keys function only when the program is in the pause mode. Thus the P key must first be pressed, followed by either S or Z. The S directs the program to the save subroutine, which saves the video display on disk. Similarly, the Z key directs the program to the save subroutine, which saves the video display on cassette. To avoid a possible mix-up between these two, which would result in an error message and destruction of the sketch on display, it is advisable to incorporate only one of these options into your program, depending on the particular storage method you wish to use.

The G and L keys function only after a direction key has been depressed. The G key will cause the pointer to move in the direction determined by the last direction key to be pressed, but it will not leave a permanent display of the points. This allows for moving the cursor to any part of the screen without leaving a trace of its passage. Several unconnected figures can be sketched using the G key to move the cursor from one figure to the next.

The L key is used to erase points that have previously been set. Erasing is accomplished as follows:

1. Use an appropriate direction key and the G control key to



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position the cursor exactly where erasing is to begin.

2. Depress the appropriate direction key that would be needed to trace over the line to be erased.

3. Immediately press the L key. Each tap of the L key moves the cursor one point along the line to be erased and erases one point on that line. Note that the direction key is pressed only once at the start of the erasing sequence.

Saving Video Displays on Disk or Cassette

The video display may be stored on disk using the subroutine containing statements numbered 300-385. This subroutine is accessed from the main program by first pressing the P pause command key, then pressing the S command key. Both alphanumeric and graphics characters are stored as eight, 255 byte strings. Thus two lines are fielded and stored at a time. Since two complete lines require 256 bytes, the last character of every other line is deleted. This, however, is a small price to pay for the simplicity of the SAVE and PRINT subroutines and the more efficient use of storage.

Storing the video display on cassette can be accomplished using the subroutine containing statements numbered 500-585. This subroutine is accessed from the main program by first pressing the P pause command key, then pressing the Z command key. Be sure that the recorder is in the Record mode *before* pressing the Z key.

As for the disk, both alphanumeric and graphics characters may be stored, although here each character code must be converted into a 4-byte string, which requires each row to be entered as a separate data string. Thus, the cassette subroutine stores 16 strings. Care must be taken to ensure that each character code fills four bytes (which includes the integer's sign); this is accomplished by adding 100 to each code. Again, for the sake of efficiency, the last two characters of each row are deleted from this routine. This is more critical than the case with the disk subroutine, and should be kept in mind when the sketch is drawn.

In order to reload your sketch from disk storage, load the program and then use the command RUN 400. Be sure that line 400 contains the appropriate file name for the particular sketch you wish to retrieve. Also before running the program, you should modify line 300, providing the name under which the new sketch will be filed. The subroutine fills in the video screen with the appropriate sketch and then transfers control to the main program, with the cursor's beginning location being the bottom right-hand corner of the screen.

Reloading the sketch from cassette storage requires the command RUN 600. The cas-

Doodlebug program.

```
1 :REM    LISTING FOR  * DOODLEBUG *
2 :REM
3 :REM    ALL PROGRAM LINES INCREMENT
4 :REM    CONTINUOUSLY BY  5  STARTING
5 :REM    AT LINE 10, ALLOWING USE OF
6 :REM    "AUTO 10,5" MODE.
7 :REM
10 CLS:CLEAR1000
15 PRINT@460,"***  DOODLE  ***"
20 PRINT@832,"BY R.D.BISHOP"
25 PRINT:PRINT"CUSTOM COMP"
30 PRINT"BOX 125, BRANSON, mo 65616"
35 FOR I=1TO999:NEXTI:CLS
36 :REM
37 :REM    INITIALIZE CURSOR POSITION
38 :REM
40 PRINT"ENTER STARTING X POSITION."
45 INPUT"(0 TO 127):";X:IFX>127ORX<0THEN45
50 PRINT"ENTER STARTING Y POSITION."
55 INPUT"(0 TO 47):";Y:IFY>47ORY<0THEN55
60 CLS:SET(X,Y)
61 :REM
62 :REM    TEST FOR KEYBOARD INPUT.
63 :REM    XI & YI DEFINE INCREMENTS FOR X AND Y.
64 :REM
65 A$=INKEY$:IF LEN(A$)=0 THEN 65
70 XI=0:YI=0
```

```
71 :REM
72 :REM    TEST FOR "PAUSE" COMMAND AND
73 :REM    "DIRECTION" COMMANDS.
74 :REM
75 IF A$="P" THEN 125
80 IF A$="H" THEN XI=+1:GOTO145
85 IF A$="F" THEN XI=-1:GOTO145
90 IF A$="T" THEN YI=-1:GOTO145
95 IF A$="B" THEN YI=+1:GOTO145
100 IF A$="R" THEN XI=-1:YI=-1:GOTO145
105 IF A$="U" THEN XI=+1:YI=-1:GOTO145
110 IF A$="N" THEN XI=+1:YI=+1:GOTO145
115 IF A$="C" THEN XI=-1:YI=+1:GOTO145
120 GOTO 65
121 :REM
122 :REM    "PAUSE" SEQUENCE TESTS FOR DISK
123 :REM    OR CASSETTE SAVE COMMANDS.
124 :REM
125 A$=INKEY$:IF LEN(A$)=0 THEN 125
130 IF A$="S" THEN 265
135 IF A$="Z" THEN 410
140 GOTO 70
141 :REM
142 :REM    INCREMENT CURSOR POSITION.
143 :REM    VERIFY THAT POSITION FITS ON SCREEN.
144 :REM
145 X=X+XI:Y=Y+YI
150 IF(X<0 OR X>127)THEN X=X-XI
155 IF(Y<0 OR Y>47) THEN Y=Y-YI
160 P=POINT(X,Y):SET(X,Y)
165 GOSUB595
166 :REM
167 :REM    TEST FOR "G" OR "L" COMMANDS AND
168 :REM    DIRECT PROGRAM TO THE CORRECT MODULE.
169 :REM
170 A$=INKEY$
175 IF LEN(A$)=0 THEN GOTO145
180 IFA$="G"THENRESET(X-XI,Y-YI):GOTO195
185 IFA$="L"THENRESET(X-XI,Y-YI):GOTO235
190 GOTO70
191 :REM
192 :REM    "G" MODULE. CURSOR CONTINUES MOVING, BUT LE
    AVES NO
193 :REM    PERMANENT MARK, UNTIL ANOTHER KEY IS PRESSE
    D.
194 :REM
195 IF P<0 THEN 200  ELSE RESET(X,Y)
200 X=X+XI:Y=Y+YI
205 IF(X<0 OR X>127)THEN X=X-XI
210 IF(Y<0 OR Y>47) THEN Y=Y-YI
215 P=POINT(X,Y)
220 SET(X,Y):GOSUB595
225 A$=INKEY$:IF LEN(A$)=0 THEN 195
230 GOTO 70
231 :REM
232 :REM    "L" MODULE.  PREVIOUS AND CURRENT CURSOR PO
    SITION
233 :REM    ERASED. IF <L> IS TAPPED, CURSOR INCREMENTS
    ONE
234 :REM    STEP AND ERASES NEW POSITION.
235 IF(X<0 OR X>127)THEN X=X-XI
240 IF(Y<0 OR Y>47) THEN Y=Y-YI
245 RESET(X,Y)
250 A$=INKEY$:IF LEN(A$)LOC`ASTOP@r50
255 IF A$="L" THEN X=X+XI:Y=Y+YI:GOTO235
260 GOTO 70
261 :REM    SUBROUTINE THAT SAVES DISPLAY ON DISK, 2 LI
    NES AT A TIME.  J INCREMENTS ONE FOR EACH CHARACTE
    R POSITION.
262 :REM    Z% RECORDS THE CHARACTER CODE WHICH IS CONV
    ERTED TO STRING DATA AND ADDED TO ZP$.
263 :REM    ZP$ ENDS UP WITH 2*(64+63)=254 BYTES. PR IS
     THE PHYSICAL RECORD NUMBER.  ZP$ IS FIELDED AS Z$
    .
264 :REM
265 CLEAR1000:OPEN"R",1,"SKETCH01"
270 FOR I=0TO15 STEP2
275 ZP$=""
280 FOR K=0TO1
285 FOR J=0 TO 63-K
290 Z%=PEEK(15360+J+64*I+64*K)
295 ZZ$=MKI$(Z%)
300 ZP$=ZP$+ZZ$
305 NEXT J
310 NEXT K
315 FIELD 1,254 AS Z$:PR=INT(I/2+.5)+1
320 GET1,PR
325 LSETZ$=ZP$
330 PUT1,PR
335 NEXTI
340 CLS:PRINT"SKETCH IS SAVED ON DISK."
345 CLOSE
350 END
351 :REM    SUBROUTINE THAT LOADS DISPLAY FROM DISK. EA
    CH OF THE 8 PHYSICAL RECORDS IS BROUGHT OUT AND DI
    SPLAYED.
352 :REM    THE LAST 3 CHARACTERS ARE DELETED TO PREVEN
    T ROLL-OVER.
353 :REM    STARTING VALUES FOR X AND Y ARE ASSIGNED. T
    HE PROGRAM IS RETURNED TO THE MAIN PROGRAM FOR KEY
    BOARD INPUT, ALLOWING ADDITIONS TO THE SKETCH.
354 :REM
355 CLEAR1000:CLS:PRINT@515,"** INSERT DISK THAT CONTAI
    NS SKETCH AND PRESS <ENTER>.  **";:INPUTZM$:CLS:OP
    EN"R",1,"SKETCH01"
```


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```
360 FOR I=1TO8
365 FIELD 1, 254 AS Z$
370 GET 1,I
375 IF I=8 THEN Z$=LEFT$(Z$,252)
380 PRINT Z$;" ";
385 NEXT I
390 X=127:Y=47
395 CLOSE
400 SET(X,Y)
405 GOTO 65
406 :REM    SUBROUTINE TO CSAVE DISPLAY ON CASSETTE.  O
     MIT THE CMD"T" AND CMD"R" COMMANDS IF A DISK-DRIVE
      IS NOT ON-LINE.
407 :REM    EACH ROW IS SAVED SEPARATELY AS A STRING OF
      CHR$ CODES. TO INSURE UNIFORM RECORD SIZE OF 4 BY
     TES, 100 IS ADDED IF THE CODE IS LESS THAN 100.
408 :REM  THE CODE IS CONVERTED TO STRING DATA AND ADDE
     D ONTO ZP$.  EACH ROW IS THEN RECORDED ON CASSETTE
     .
409 :REM
410 CLEAR 1000:CMD"T"
420 FOR I=0 TO 15
425 ZP$=""
430 FOR J=0TO62
435 Z%=PEEK(15360+J+64*I)
440 Z%=Z%+100
445 ZZ$=STR$(Z%)
450 ZP$=ZP$+ZZ$
455 NEXT J
460 PRINT#-1,ZP$
465 NEXTI
470 CLS:PRINT"YOUR SKETCH IS SAVED"
475 PRINT"ON CASSETTE AS 16 DATA ITEMS."
480 CMD"R"
485 END
490 CLEAR1000
491 :REM    SUBROUTINE THAT CLOADS VIDEO DISPLAY INFO F
      ROM CASSETTE. OMIT CMD"T" AND CMD"R" INSTRUCTIONS
      IF A DISK SYSTEM IS NOT ON-LINE.
492 :REM    EACH LINE IS READ IN AS ZP$.  ZP$ IS THEN S
      LICED INTO 4 BYTE SECTIONS, EACH BYTE CORRESPONDIN
      G TO A CHR$ CODE, Z%. 100 IS SUBTRACTED FROM EACH
      CODE AND THE RESULT IS POKED INTO THE DISPLAY.
493 :REM    THE LAST TWO COLUMNS OF THE DISPLAY DO NOT
      TRANSFER, SO THESE ARE FILLED WITH BLANKS TO ERASE
       UNWANTED CHARACTERS.  X AND Y ARE ASSIGNED STARTI
      NG VALUES AND PROGRAM RETURNS TO AWAIT INPUT.
494 :REM
495 PRINT@515,"INSERT TAPE TO LOAD DOODLE; PLAY MODE; P
      RESS <ENTER>.":INPUTZM$
500 CMD"T"
505 CLS
510 FOR I=0TO15
515 INPUT#-1,ZP$
520 ZP$="+"+ZP$
525 FOR J=0TO61
530 ZZ$=MID$(ZP$,4*J+1,4)
535 Z%=VAL(ZZ$)
540 Z%=Z%-100
545 POKE 15360+J+64*I,Z%
550 NEXTJ
555 POKE 15423+64*I,032
560 POKE 15422+64*I,032
565 NEXTI
570 POKE 15422,032:POKE 15423,032
575 X=127:Y=47
580 SET(X,Y)
585 CMD"R"
590 GOTO 65
591 :REM
592 :REM    TIME DELAY SUBROUTINE.  LENGTHEN OR SHORTEN
      AS
593 :REM    DESIRED.
594 :REM
595 FOR I=1TO40:NEXTI:RETURN
```

sette recorder must be in Play mode. Again, the subroutine transfers control to the main program, with the cursor located at the bottom right-hand corner of the screen.

It should be noted that these sets of subroutines are entirely general in nature and can be used with any type of program that generates a graphics display that you might wish to preserve for future use. The following comments relating to the program listing need to be emphasized:

1. Only one Clear 1000 instruction needs to be used for the entire program.

2. For a system that does not have a disk drive, it is not necessary to include a CMD"T" or CMD"R" instruction.

3. For applications other than *Doodle*, where it is not necessary to set new data points or change the sketch, lines 435, 445, 660 and 665 are unnecessary.

Program Modifications

You may desire to slow down the program so the lines do not develop so fast. This may be especially true if children are to be using the program. (And, believe me, are kids ever fascinated by the sketches they can generate!) Just change the timing loop in line 999, using a number larger than 40.

On the other hand, you may wish to stop the line generation function altogether, so that only one point is made each time a direction key is depressed. This is most easily accomplished by deleting line 110, changing the GOTO statements in lines 116 and 220 to GOTO 115 and GOTO 220 and changing line 215 to SET(X,Y), deleting the GOSUB999 instruction.

The direction keys chosen are those conveniently reached using the left hand. If you prefer to exercise directional control using your right hand, you may wish to change the U key to Y (line number 65). The P and L keys may be moved to the left side of the keyboard, perhaps using 1 in place of P in line 35 and 3 in place of L in lines 125 and 260.

Finally, in order to insert captions, titles, labels, etc., first complete your sketch and then determine just where each of these labels should be placed on the screen using the PRINT @ XXX, statement. Next, save the sketch on disk or cassette. Now insert your PRINT @ XXX, statements into the program between lines 430 and 450 (disk) or between lines 657 and 680 (cassette), taking care not to erase any other program lines. Now a RUN 400 or RUN 600 will display the sketch complete with titles and labels. This new sketch can be saved right over the disk or cassette recordings of the old sketch, but this time all of the alphanumeric information will be included with the sketch.

With this article, I anticipate a whole new approach to the advertising campaigns of microcomputer manufacturers: "Be the first in your neighborhood with the most elaborate, expensive and versatile doodle-pad ever invented!" ■

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TYP/PRT/80 SMALL BUT MIGHTY Not only permits use of the printer as a typewriter but will allow you to retain any display already on the video, make notes from it, or actually copy it on the printer automatically. This program will run concurrently with another program you may be using and you can go from one to the other at will. Also contains a calculator. So useful it is hard to describe here.	17.95	24.95

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Kaleidoscopic designs can be fascinating, and they make great patterns for painting, needlepoint, fabrics and other crafts projects.

You've probably seen a kaleidoscope program running on a computer, and you've undoubtedly wished that you could create some of those patterns yourself. Why should the computer have all the fun? Well now you can jump right in there and explore your creative potential.

How It Works

Before you begin drawing, you need to understand how the program works. As you can see from Fig. 1, your video screen is split into four quadrants. As you draw in the upper left-hand quadrant, the computer creates mirror images of your design in the other three.

Points in quadrant I are defined as (X,Y) and are printed by using the SET command. Remember that your screen is 128 (0 to 127) by 48 (0 to 47). Therefore, points in quadrant II must be defined as (127-X,Y) in order to produce a mirror image to the right.

Similarly, quadrant III uses (X,47-Y) to produce a mirror image looking down. And in quadrant IV, (127-X,47-Y) creates a mirror image looking down and to the right. The total effect is of a kaleidoscopic pattern centered on the screen.

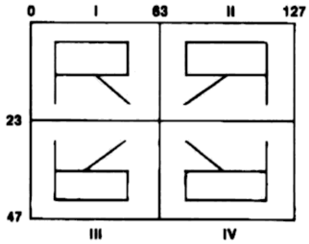

Fig. 1.

Running Kaleidopen you are asked to specify the starting coordinate for your design. Enter the X (0 to 63) and Y (0 to 23) coordinate as a pair separated by a comma. For example, try 20,10. This is the only time you will use the ENTER key while drawing. For the rest of the commands, simply press the key you desire.

Fig. 2 shows the eight directions used in the program. Just press any key (one-eight) and when the line has reached the location you want, press the S key to stop it. Then press the number of the next direction you want. Continue until your design is finished.

Notice that you are only drawing in quadrant I, but that the computer is simultaneously drawing the appropriate mirror images in the other three quadrants. Always remember that your directions refer to quadrant I only!

Suppose You Make a Mistake

Now we all make mistakes once in awhile. If you make an error, just press B to clear the board and begin a new pattern from scratch. If, on the other hand, it is just a case of having drawn a line too long, use the E key to erase.

Suppose I drew a line in direction four, but failed to stop in time. I simply press E to erase, followed by eight. I erase in direction eight because, as you can see from Fig. 2, eight is the direction opposite four. If I drew in direction one, I would have to erase in direction five.

You can also use the E key to skip to a new position on the screen without leaving a trace. For instance, pressing E-three moves the point up without drawing a line. Pressing S stops at a new position.

The only problem is that you may pass over a line you wanted. The result is an erasure at that point. The trick is to move up to the line in the E mode, stop, draw one point and then go back into the E mode again to keep moving without leaving a trace. It takes a little practice, but really isn't that difficult.

If you are feeling ambitious, you can build a move command (M) that moves without leaving a trace and does not erase anything already on the screen. (Hint: Use the POINT (X,Y) command.)

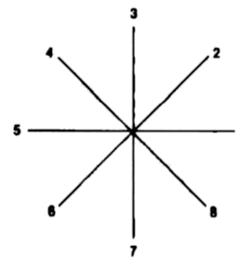

Fig. 2.

```
420 INPUT"ENTER STARTING COORDINATES X (0-127),Y (0-47)";X,Y
440 IF (X<0 OR X>127) OR (Y<0 OR Y>47) THEN 420
1100 IF X+R<0 OR X+R>127 OR Y+U<0 OR Y+U>47 THEN 460
```

Example 1.

So what do you do with your masterpiece once you've completed it? Why save it on tape of course! That way you can recall your best creations for use in projects or for putting on your own one man art show.

Put a blank tape into your recorder, position it, note its location, be sure your cables are all connected and depress both the play and record buttons. Now press the P key to save your design on tape.

The entire process takes about 80 seconds. The screen clears when the process is completed and you will be told that the picture has been saved.

If you wish to recall a picture from tape, respond yes when you are asked. Rewind the tape to the correct position, plug in the cables, depress the play button and hit ENTER. Your picture prints on the screen in 45 seconds.

And that's all there is to it! The program includes a brief summary of the drawing commands to refresh your memory. So limber up your fingers and begin creating with KALEID-

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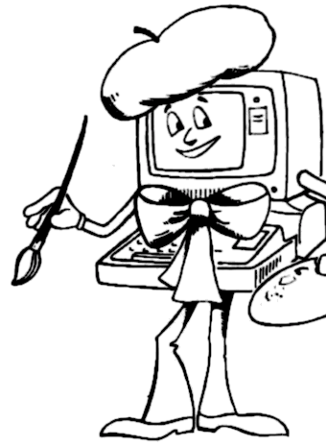

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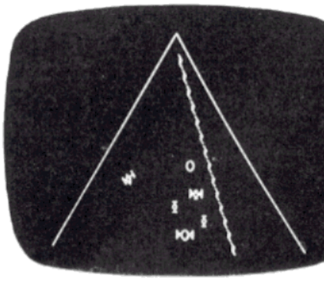
The 80-GRAFIX board allows you to do inverse video to high-light your screen displays.



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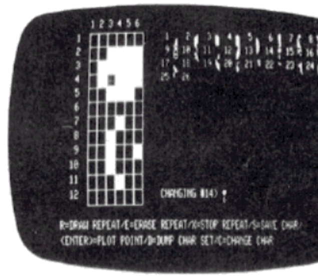

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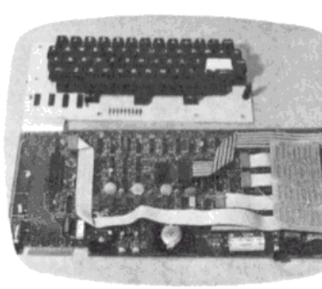

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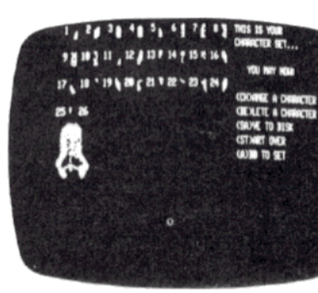
The 80-GRAFIX board is simple to install and fits inside the TRS-80 case.



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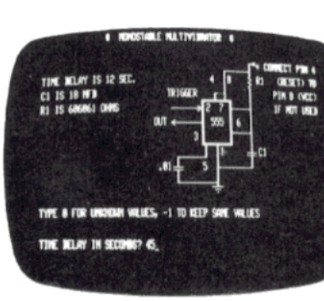

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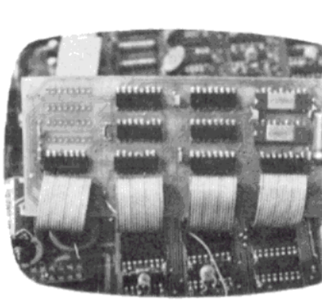

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Modifications

You can modify the program to produce only one mirror image (bilateral symmetry?) by deleting lines 1200, 1210, 1260 and 1270. Also change lines 420, 440 and 1100 as indicated in Example 1.

To create one large drawing board (the entire screen), delete lines 1190, 1200, 1210, 1250, 1260 and 1270 and change lines 420, 440 and 1100 as indicated in Example 2. ■

```
420 INPUT"ENTER STARTING COORDINATES X (0-63),Y (0-47)";X,Y
440 IF (X<0 OR X>63) OR (Y<0 OR Y>47) THEN 420
1100 IF X+R<0 OR X+R>63 OR Y+U<0 OR Y+U>47 THEN 460
```

Example 2.

Program Listing

```
10 '          K A L E I D O P E N
20 '           ROBERT F. NICHOLAS
30 CLS
40 DEFINT A-Z
50 CLEAR 2000
60 PRINT@456,CHR$(23)"K A L E I D O P E N";
70 FOR TI=1 TO 1500
80 NEXT TI
90 CLS
100 DIM P$(5)
110 PRINT"THIS IS A KALEIDOPEN.
120 PRINT"       PRESS A # FROM 1 TO 8 FOR DIRECTION OF
    YOUR MOVE.
130 PRINT"       PRESS 'S' TO STOP A LINE.
140 PRINT"       PRESS 'E' TO ERASE (FOLLOWED BY THE DIR
    ECTION #).
150 PRINT"               ALSO USE 'E' TO SKIP TO A NEW P
    OSITION WITHOUT
160 PRINT"               LEAVING A TRACE.
170 PRINT"       PRESS 'B' TO CLEAR SCREEN AND GET A NEW
     DRAWING BOARD.
180 PRINT
190 PRINT"               THE DIRECTIONS ARE AS FOLLOWS:
1224 PRINT@728,"+";
210 PRINT@736,"1";
220 PRINT@668,"2";
230 PRINT@600,"3";
240 PRINT@660,"4";
250 PRINT@721,"5";
260 PRINT@788,"6";
270 PRINT@856,"7";
280 PRINT@796,"8";
290 PRINT@960,"    ";
300 INPUT"HIT ENTER TO CONTINUE DIRECTIONS";X
310 CLS
320 PRINT"   NOTE THAT YOU DO NOT HIT THE ENTER KEY WHI
    LE YOU ARE
330 PRINT"DRAWING A PICTURE.  JUST PRESS THE KEY YOU DE
    SIRE.
340 PRINT
350 PRINT"   IF YOU WISH TO SAVE ONE OF YOUR PICTURES,
    DEPRESS BOTH
360 PRINT"PLAY AND RECORD KEYS ON RECORDER AND THEN PRE
    SS 'P'.
370 PRINT
380 INPUT"DO YOU WANT TO RECALL A PICTURE PREVIOUSLY SA
    VED (Y/N)";Z$
390 CLS
400 Z$=LEFT$(Z$,1)
410 IF Z$="Y" THEN 1470
420 INPUT"ENTER STARTING COORDINATES X (0-63),Y (0-23)"
    ;X,Y
430 CLS
440 IF (X<0 OR X>63) OR (Y<0 OR Y>23) THEN 420
450 GOSUB 1170
460 E=0
470 A$=""
480 B$=""
490 U=0
500 R=0
510 REM INKEY$ ROUTINE TO ENTER DRAWING COMMANDS
520 B$=INKEY$
530 REM STOP DRAWING
540 IF B$<>"S" THEN 580
550 GOSUB 1170
560 GOTO 460
570 REM GO INTO ERASE MODE
580 IF B$<>"E" THEN 640
590 E=1
600 B$=""
610 GOSUB 1230
620 GOTO 520
630 REM CLEAR THE BOARD AND BEGIN A NEW DESIGN
640 IF B$<>"B" THEN 680
650 CLS
660 GOTO 420
670 REM GO SAVE THE DESIGN ON TAPE
680 IF B$="P" THEN 1300
690 A$=A$+B$
700 REM DRAW WEST
710 IF A$<>"5" THEN 760
720 R=-1
730 U=0
740 GOTO 1100
750 REM DRAW NORTHWEST
760 IF A$<>"4" THEN 810
770 R=-1
780 U=-1
790 GOTO 1100
800 REM DRAW EAST
810 IF A$<>"1" THEN 860
820 R=1
830 U=0
840 GOTO 1100
850 DRAW SOUTHWEST
860 IF A$<>"6" THEN 910
870 R=-1
880 U=1
890 GOTO 1100
900 REM DRAW NORTH
910 IF A$<>"3" THEN 960
920 R=0
930 U=-1
940 GOTO 1100
950 REM DRAW SOUTHEAST
960 IF A$<>"8" THEN 1010
970 R=1
980 U=1
990 GOTO 1100
1000 REM DRAW SOUTH
1010 IF A$<>"7" THEN 1060
1020 R=0
1030 U=1
1040 GOTO 1100
1050 REM DRAW NORTHEAST
1060 IF A$<>"2" THEN 520
1070 R=1
1080 U=-1
1090 REM CHECK NEW POSITION IS WITHIN SCREEN BOUNDARIES
1100 IF X+R<0 OR X+R>63 OR Y+U<0 OR Y+U>23 THEN 460
1110 X=X+R
1120 Y=Y+U
1130 GOSUB 1170
1140 IF E=1 THEN GOSUB 1230
1150 B$=""
1160 GOTO 520
1170 REM SET POINTS IN ALL FOUR QUADRANTS
1180 SET(X,Y)
1190 SET(127-X,Y)
1200 SET(X,47-Y)
1210 SET(127-X,47-Y)
1220 RETURN
1230 REM RESET POINTS IN ALL FOUR QUADRANTS
1240 RESET(X,Y)
1250 RESET(127-X,Y)
1260 RESET(X,47-Y)
1270 RESET(127-X,47-Y)
1280 RETURN
1290 REM SAVE DESIGN ON TAPE
1300 P$=""
1310 N=1
1320 FOR X=15360 TO 16382
1330 P=PEEK(X)
1340 IF P=32 THEN P$=P$+CHR$(128) ELSE P$=P$+CHR$(P)
1350 N=N+1
1360 IF N<250 THEN 1400
1370 N=1
1380 PRINT#-1,P$
1390 P$=""
1400 NEXT X
1410 P=PEEK(16383)
1420 PRINT#-1,P$,P
1430 CLS
1440 PRINT"PICTURE HAS BEEN SAVED.
1450 GOTO 380
1460 REM RECALL DESIGN FROM TAPE
1470 PRINT"   DEPRESS PLAY BUTTON ON RECORDER.  AFTER P
     ICTURE HAS BEEN
1480 PRINT"PRINTED, HIT 'ENTER' TO ERASE SCREEN AND BEG
     IN ANOTHER DESIGN.
1490 PRINT"WHEN TAPE RECORDER IS READY, HIT 'ENTER'.
1500 INPUTX
1510 CLS
1520 FOR J=1 TO 4
1530 INPUT#-1,P$(J)
1540 NEXT J
1550 INPUT#-1,P$(5),P
1560 PRINT@0,"";
1570 FOR J=1 TO 5
1580 PRINT P$(J);
1590 NEXT J
1600 POKE 1v383,P
1610 IF INKEY$="" THEN 1610 ELSE CLS
1620 GOTO 380
```

the electric pencil II™

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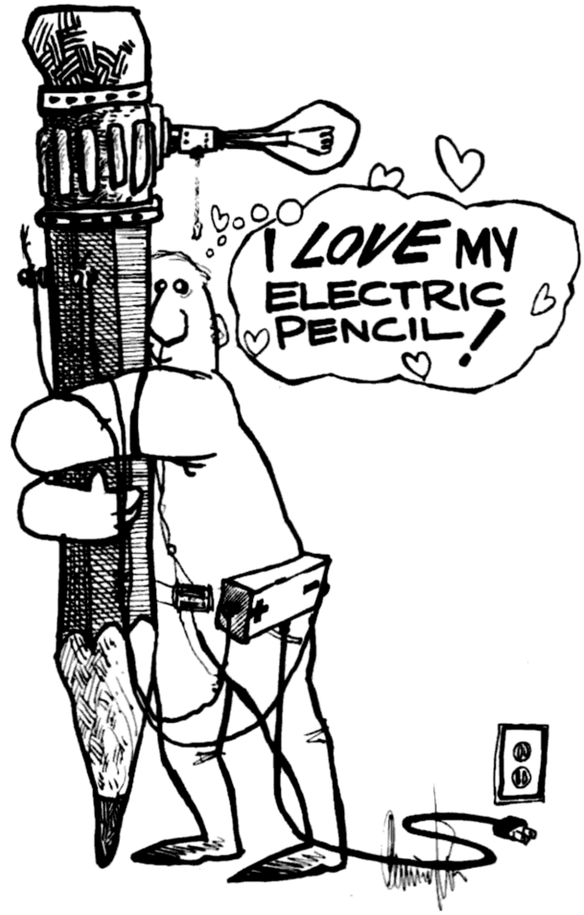
for the TRS-80 Model II* Computer



The Electric Pencil is a Character Oriented Word Processing System. This means that text is entered as a continuous string of characters and is manipulated as such. This allows the user enormous freedom and ease in the movement and handling of text. Since lines are not delineated, any number of characters, words, lines or paragraphs may be inserted or deleted anywhere in the text. The entirety of the text shifts and opens up or closes as needed in full view of the user. Carriage returns as well as word hyphenation are not required since each line of text is formatted automatically.

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The Electric Pencil I is still available for TRS-80 Model I users. Although not as sophisticated as Electric Pencil II, it is still an extremely easy to use and powerful word processing system. The software has been designed to be used with both Level I (16K system) and Level II models of the TRS-80. Two versions, one for use with cassette, and one for use with disk, are available on cassette. The TRS-80 disk version is easily transferred to disk and is fully interactive with the READ, WRITE, DIR, and KILL routines of TRSDOS.

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Richard A. Zidonis
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If your friends were like mine, the first thing they asked about your computer was, "What can it do?" Most likely, you responded by loading a game program. As time went on, you became less impressed with the standard Wumpus or lander game and struck out on your own to develop the ultimate game program. And that's where we begin!

PEEKing

I have a Radio Shack TRS-80, 16K, Level II system.

The TRS-80 has an available command called INKEY$. The INKEY$ function returns a one-character string equal to a strobed keyboard depression. This allows you to interact with the system during real time. Visions of real-time video games came to my mind at once. But as often happens, problems came into play. For instance, if you had a dot on the screen that you wished to move to the left, a single keystroke could start it moving, but another keystroke would be needed to stop it. This problem was quite troublesome for awhile, but the solution finally materialized.

We will develop a method of moving and stopping a game paddle with a single keystroke, and at computer real time. Not only that, but we're also going to move it at a speed rivaling a true analog-input video game.

To do this we first need to develop a method of determining the presence of a single depressed key. The TRS-80 system is memory mapped. Upon looking at the memory map, we find that the keyboard is located between memory locations decimal 14336 and decimal 15359. Knowing that, let's PEEK some keyboard locations.

The PEEK command in Level II requires that a variable be assigned to what is found at the PEEK location. As in the statement X = PEEK (14337), the decimal value of memory location 14337 is assigned to the variable X. Still with me? Since we can only assign variables to alpha (A) or alphanumeric (A1) characters, we are only interested in PEEKing the letters of the alphabet. Refer to Table 1. Note the first 16 keyboard memory locations (for the alphabet) and the PEEK value for each letter of the alphabet. If you are saying to yourself that it looks repetitive and long, don't despair; it's not.

If we tell the system X = PEEK

	14336	14337	14338	14339	14340	14341	14342	14343	14344	14345	14346	14347	14348	14349	14350	14351
A	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2
B		4		4		4		4		4		4		4		4
C		8		8		8		8		8		8		8		8
D		16		16		16		16		16		16		16		16
E		32		32		32		32		32		32		32		32
F		64		64		64		64		64		64		64		64
G		128		128		128		128		128		128		128		128
H	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
I			2	2			2	2			2	2			2	2
J			4	4			4	4			4	4			4	4
K			8	8			8	8			8	8			8	8
L			16	16			16	16			16	16			16	16
M			32	32			32	32			32	32			32	32
N			64	64			64	64			64	64			64	64
O			128	128			128	128			128	128			128	128
P	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
Q					2	2	2	2					2	2	2	2
R					4	4	4	4					4	4	4	4
S					8	8	8	8					8	8	8	8
T					16	16	16	16					16	16	16	16
U					32	32	32	32					32	32	32	32
V					64	64	64	64					64	64	64	64
W					128	128	128	128					128	128	128	128
X	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Y									2	2	2	2	2	2	2	2
Z									4	4	4	4	4	4	4	4

Table 1. PEEK chart.

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15360	PLUS 63 =	15423
15424		15487
15488		15551
15552		15615
15616		15679
15680		15743
15744		15807
15808		15871
15872		15935
15936		15999
16000		16063
16064		16127
16128		16191
16192		16255
16256		16319
16320		16383

Position 15360 is the same as print location zero.

Position 15551 is the last print position in the third row, etc.

Table 2. POKE chart.

(14337) and then depress an "A" key, the variable X will have a value of 2. If the above PEEK statement is locked in a loop, the variable X will take on the PEEK value *only during the key depression.* With the A key depressed, X returns a decimal value of 2; with the key *not* depressed, X returns a decimal value of zero. Now if that doesn't forward-bias the LED above your head, keep reading. Keep reading anyway; we're not done.

POKE

First let's change the subject for a moment. The TRS-80 graphics character consists of a block two bits wide by three bits deep. Each of these bits can be accessed and turned on by the set (X,Y) command and turned off by the reset (X,Y) command. This method is effective but terribly slow. Fortunately, we have an alternative. We can POKE the graphics positions. Refer to Table 2, which shows you the POKE locations of all the print locations. POKE location 15360 is the same as print location zero.

As you can see, the chart is self-explanatory. If you know the print position you can find the POKE position. OK? So now we have established places to POKE, but what do we POKE? Time to move on again.

Available Graphics

Via the TRS-80, we have available a number of ASCII codes (129-191). If you examine these codes, you will see that they are different configurations of the 2 x 3 graphics block. To do the examining, the command is PRINT CHR$ (X). If X equals one of the available graphics codes, you will see a graphics configuration displayed.

To see what is available, refer to Table 3, which shows the ASCII number and the corresponding display. An X refers to a bit turned on, and an O refers to a bit *not* on. For instance, a PRINT CHR$ (191) results in all six bits turning on. A PRINT CHR$ (149) results in the bits on the left side of the block being turned on. As you can see, we have lots of different configurations available for our use.

Doing It

Now that all the preliminaries are out of the way, let's get it working. Refer to the short program in Listing 1. While referring to this program, let's decipher each line and see what we have.

Line 10 is easy; it's a standard clear screen command. Line 20 sets the initial value of X to be used when we start POKEing. Table 2 shows that the location of the POKE is on the left side of the display about halfway down.

In line 30 we ae assigning the value of PEEK (14337) to the variable named Y. In line 40 we set the stage for moving our paddle. The line starts with IF Y=2 THEN POKE X,128. The only time Y can equal 2 is during the depression of the A key on the keyboard.

Scanned by Ira Goldklang - www.trs-80.com

If Y does equal two then we POKE X, 128. The format for POKE (in my system) is POKE LOCATION, INFORMATION. The ASCII character code for a space is 128. After POKEing the space we increment the value of X by 64 (puts us one line down). The last portion of line 40 keeps the value of X within our video POKE positions; otherwise, we POKE into places we do not need to be, such as the program, the stack, etc. This causes all kinds of nasty crashes. Line 50 decreases the value of X during a key depression, which produces a Y value of 4, which happens to be the B key. Line 60 POKEs at our new X value the ASCII graphics code 149. Looking at Table 3, we find 149 to be all the bits on the left side of the graphics block. Line 70 loops us back to our PEEK statement at line 30.

In a nutshell, what we are doing is quickly lighting a graphics position, erasing it and relighting it at the new location as is appropriate. If you have the program in your system, you will notice that when you depress the A or B key the paddle moves, and when you release the key the paddle stops. What we have is real-time interaction with our program with a single key depression. Use the keyboard table to pick where you want to PEEK. In the case of the UP, DOWN, LEFT and RIGHT commands, you may use several PEEK locations assigned different variables—for instance, U = PEEK (14340). When the U

129	130	131	132	133	134
xo	ox	xx	oo	xo	ox
oo	oo	oo	xo	xo	xo
oo	oo	oo	oo	oo	oo
135	136	137	138	139	140
xx	oo	xo	ox	xx	oo
xo	ox	ox	ox	ox	xx
oo	oo	oo	oo	oo	oo
141	142	143	144	145	146
xo	ox	xx	oo	xo	ox
xx	xx	xx	oo	oo	oo
oo	oo	oo	xo	xo	xo
147	148	149	150	151	152
xx	oo	xo	ox	xx	oo
oo	xo	xo	xo	xo	ox
xo	xo	xo	xo	xo	xo
153	154	155	156	157	158
xo	ox	xx	oo	xo	ox
ox	ox	ox	xx	xx	xx
xo	xo	xo	xo	xo	xo
159	160	161	162	163	164
xx	oo	xo	ox	xx	oo
xx	oo	oo	oo	oo	xo
xo	ox	ox	ox	ox	ox
165	166	167	168	169	170
xo	ox	xx	oo	xo	ox
xo	xo	xo	ox	ox	ox
ox	ox	ox	ox	ox	ox
171	172	173	174	175	176
xx	oo	xo	ox	xx	oo
ox	xx	xx	xx	xx	oo
ox	ox	ox	ox	ox	xx
177	178	179	180	181	182
xo	ox	xx	oo	xo	ox
oo	oo	oo	xo	xo	xo
xx	xx	xx	xx	xx	xx
183	184	185	186	187	188
xx	oo	xo	ox	xx	oo
xo	ox	ox	ox	ox	xx
xx	xx	xx	xx	xx	xx
189	190	191			
xo	ox	xx			
xx	xx	xx			
xx	xx	xx			

Table 3. Graphics chart.

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key is depressed on the keyboard, your variable U returns a decimal 32. When the U is not depressed, you have a zero returned to your variable.

In the case of an actual video display, use Table 2 to find the screen location and Table 3 to find your particular graphics character. Also—hadn't mentioned it before—you can POKE any character, number, symbol or control code that you may desire by referring to the appropriate chart in your user's manual.

```
10    CLS
20    X=15808
30    Y=PEEK(14337)
40    IF Y=2 THEN POKE X,128 : X=X+64 :
      IF X > 16320 THEN X=16320
50    IF Y=4 THEN POKE X,128 : X=X-64 :
      IF X < 15360 THEN X=15360
60    POKE X,149
70    GOTO 30
80    REM  "A" FOR UP AND "B" FOR DOWN
```

Listing 1.

New Thoughts

Now that we have all that accomplished, you can start writing your ultimate game program, either a video game as above or the ever-popular lander-type program. Use the above idea to enter fuel and direction during real time. The trouble with a lot of present lander games is that the program stops and allows you to think. With real-time entries you become a busy pilot. It will also be almost impossible to come up with a set routine to land your lander. How about running a dot through a maze? You could have an incrementing counter in your control loop that gives a relative time readout upon negotiating the maze.

I put this article together to demonstrate a function that I find convenient. If you find it interesting, then I have accomplished my goal. If you have also picked up some general PEEK, POKE and graphics information, then I have doubly succeeded.

Conclusions

Just remember to put your PEEK statement in a loop where it will be strobed. You can branch out when your statement is qualified and then return. When POKEing the video section, always put in an upper and lower POKE limit to keep from crashing through. ■

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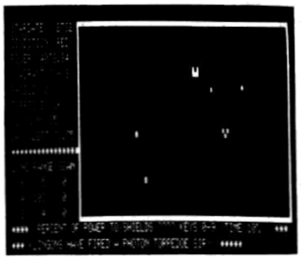

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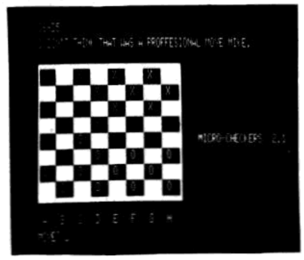

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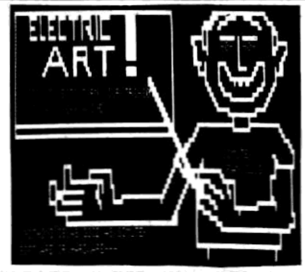

PACKAGE THREE INCLUDES: POETRY — This program lets you choose the subject as well as the mood of the poem you want. You give TRS-80 certain nouns or names, then the mood, and it does the rest! It has a 1000-word + vocabulary of nouns, verbs, adjectives and adverbs! ★ **ELECTRIC ARTIST** — Manual: draw, erase, move as well as, Auto: draw, erase and move. Uses graphics bits not bytes. Saves drawing on tape or disk! ★ **GALACTIC BATTLE** — The Swineus enemy have long range phasers but cannot travel at warp speed! You can, but only have short range phasers! Can you blitzkrieg the enemy without getting destroyed! Full graphics — real time! ★ **WORD MANIA** — Can you guess the computer's words using your human intuitive and logical abilities? You'll need to, to beat the computer! ★ **AIR COMMAND** — Battle the Kamikaze pilots. Requires split second timing. This is a FAST action arcade game.

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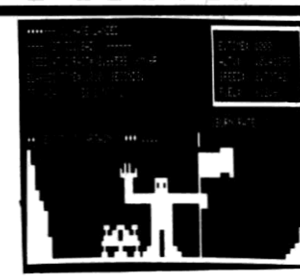

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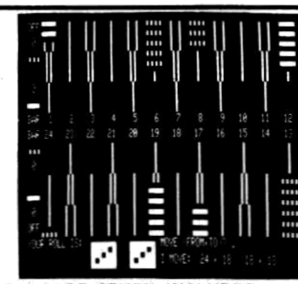

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Hex Display

```
100 GOSUB370
110 A=0:B=0:C=1:D=10:H=48
120 FORI=1TO10:IFB>0ANDB<10ORB>15ANDB<26ORB>95ANDB<129PRINTA;B, :IFB>31ANDB<42PRINTA;B,
130 IFB>27ANDB<95ORB>128ANDB<192PRINTA;B;"  ";CHR$(B),
140 A=A+1:B=B+1:NEXT
150 FORI=1TO6:H1$=CHR$(H):H2$=CHR$(64+C):IFB>9ANDB<16ORB>25ANDB<32ORB>95ANDB<129PRINT" ";
H1$;H2$;" ";D, :IFB>41ANDB<48PRINT" "; H1$;H2 $;D;
160 IFB>27ANDB<95ORB>128ANDB<192PRINT" ";H1$;H2$;" ";D;"  ";CHR$(D),
170 C=C+1:D=D+1:NEXT
180 B=B+6:C=1:H=H+1:D=D+10
190 IFH1$="2"ANDH2$="F"GOSUB360
200 IFH1$="5"ANDH2$="F"GOSUB360
210 IFH1$="8"ANDH2$="F"GOSUB360
220 ••H1$="9"ANDH2$="F"GOTO240
230 GOTO120
240 D=160:E=1:H=48:K=170:J=65
250 IFD>191GOSUB360:GOTO290
260 FORI=1TO10:H1$=CHR$(J):H2$=CHR$(H):PRINT" ";H1$;H2$;" ";D;" ";CHR$(D),
:D=D+1:H=H+1:NEXT
270 FORI=1TO6:H1$=CHR$(J):H2$=CHR$(64+E):PRINT" ";H1$;H2$;" ";K;"  ";CHR$(K),
:E=E+1:K=K+1:NEXT
280 J=J+1:H=H-10:D=D+6:E=1:K=K+10
285 GOTO250
290 FORI=1TO10:H1$=CHR$(J):H2$=CHR$(H):PRINT" ";H1$;H2$;" ";D, :D=D+1:H=H+1:NEXT
300 FORI=1TO6:H1$=CHR$(J):H2$=CHR$(64+E):PRINT" ";H1$;H2$;" ";K, :E=E+1:K=K+1:NEXT
310 J=J+1:H=H-10:D=D+6:E=1:K=K+10
320 IFH1$="B"ANDH2$="F"GOSUB360
330 IFH1$="E"ANDH2$="F"GOSUB360
340 IFH1$="F"ANDH2$="F"GOTO380
350 GOTO290
360 PRINT:PRINTTAB(20)"WAIT FOR  MORE":FORI=1TO1000:NEXT
370 CLS:PRINT" ";"H";"   ";"D";"   ";"ASCII";TAB(17)"H";"   ";"D";"   ";"ASCII";
TAB(33)"H";"   ";"D";"   ";"ASCII";TAB(49)"H";"   ";
"D";"   ";"ASCII":RETURN
380 PRINTTAB(20)"END OF DISPLAY":END
```

```
 H   D   ASCII   H   D   ASCII   H   D   ASCII   H   D   ASCII
 1  1            2  2            3  3            4  4
 5  5            6  6            7  7            8  8
 9  9            0A  10          0B  11          0C  12
 0D  13          0E  14          0F  15          10  16
 11  17          12  18          13  19          14  20
 15  21          16  22          17  23          18  24
 19  25          1A  26          1B  27          1C  28
 1D  29          1E  30          1F  31          20  32
 21  33   !      22  34   "      23  35   #      24  36   $
 25  37   %      26  38   &      27  39   '      28  40   (
 29  41   )      2A  42   *      2B  43   +      2C  44   ,
 2D  45   -      2E  46   .      2F  47   /
                     WAIT FOR  MORE

 H   D   ASCII   H   D   ASCII   H   D   ASCII   H   D   ASCII
 30  48   0      31  49   1      32  50   2      33  51   3
 34  52   4      35  53   5      36  54   6      37  55   7
 38  56   8      39  57   9      3A  58   :      3B  59   ;
 3C  60   <      3D  61   =      3E  62   >      3F  63   ?
 40  64   @      41  65   A      42  66   B      43  67   C
 44  68   D      45  69   E      46  70   F      47  71   G
 48  72   H      49  73   I      4A  74   J      4B  75   K
 4C  76   L      4D  77   M      4E  78   N      4F  79   O
 50  80   P      51  81   Q      52  82   R      53  83   S
 54  84   T      55  85   U      56  86   V      57  87   W
 58  88   X      59  89   Y      5A  90   Z      5B  91   [
 5C  92   \      5D  93   ]      5E  94   ^      5F  95   _
```

Dr. H. J. Campbell
Institute of Psychiatry
De Crespigny Park
London SE5 8AF

The speed of many micro applications could be improved by rapid and accurate hexadecimal conversions of decimals 0–255.

Assembly language programming is tedious without this facility and modifying byte data in main memory or disk sectors can be highly dangerous.

Although converting numbers in this range with a pencil and paper is not difficult when done as an exercise, it is a source of distraction and prone to error when carried out while programming or doing surgery on data registers. Yet there appears to be no software available specifically designed for this purpose.

Display ASCII as Well

The program Hexadecimal Display, written here in Level II BASIC, displays not only hex conversions but also the ASCII characters and the TRS-80 graphics characters. The latter, of course, appear only as periods in the printed RUN.

Hexadecimals composed only of numbers can be displayed by using the simple variables A and B. Since variables consisting of a combination of letters and numbers cannot be assigned or called directly, it is necessary to introduce two modifications to the simple A-B scheme.

Firstly, the calls for all number hexadecimals must be made to leapfrog over the alphanumeric ones. This is done with the Boolean logic of line 120, having initialized the variables in line 110.

Secondly, to call the alphanumeric hexadecimals the variables are first assigned to strings and these are then equated with appropriate CHR$ functions. This can be seen in lines 50, 260, 270, 290 and 300.

The logic in line 150 ensures correct spacing in the display. Here, as in all the PRINT lines, meticulous care must be taken with punctuation. Throughout, CHR$(H) provides the hexadecimal number byte and CHR$(64 + C) or CHR$(64 + E) establishes the appropriate letter byte.

Calling the ASCII and graphics characters cannot be done as a continuous series because many of them are control codes, which execute following a PRINT statement. For example, a simple request such as

```
FOR I = 0 TO 255:PRINT CHR$(I):NEXT
```

will founder in several places. The worst, perhaps, is when CHR$(23) is reached. This immediately converts all subsequent display to 32-character format.

Higher codes will do other unacceptable things such as clearing the screen and compressing in tabular fashion. Still, this problem is easily overcome by

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M **SEND FOR CATALOG** ☐

incorporating leapfrogging logic into the lines that display the CHR$ equivalent of the decimal variable, viz. lines 130, 160, 250, 260 and 270.

Hexadecimal Categories

This set of hexadecimals comprises several groups that fall into two categories. One category is the groups in which the first byte runs from A to F; the other category has the numbers 0-9 as the first byte. Each of these categories requires a distinct FORNEXT loop, 1 to 6 and 1 to 10 respectively (see lines 150, 270, 300 for the first category; 120, 260, 290 for the second category).

The values of the variables *within* each loop are changed by the accumulator assignments in lines 140, 170, 260, 270, 290 and 300.

Since each FORNEXT loop assigns its own set of values to the variables, these must be reset correctly for the looping that follows the GOTO statements in lines 230 and 250. Resetting is done in lines 180, 280 and 310.

When the first hexadecimal byte is a letter (decimal 160) and when both bytes are letters (decimal 170) variable values must be reassigned. Line 240 accomplishes this. The pointer is sent here when 9FH is reached (line 220).

As listed, the program scrolls page-size displays with pauses between each page. Interim pages carry the message WAIT FOR MORE and the last page contains the information END OF DISPLAY. These break points cannot, of course, occur within FORNEXT loops, so lines 190-210 and 320-330 call the delay subroutine in line 360 (which may be user-modified to alter the length of the delay period).

When FFH is reached, line 340 sends the pointer to the final message and END of the program in line 380.

Headings for the columns are provided by the subroutine in line 370, which is called at the beginning (line 100) and which follows the various GOSUB, to line 360.

The program responds to BREAK at any time and the RUN may be printed in whole or in part by using the JKL screen printer of NEWDOS+. In the absence of this facility or if hard copy is desired, obviously the PRINT statements should be changed to LPRINTS.

Deliberate compression of the program by avoiding spaces and REMs produces a memory requirement of only 1.1K. Thus the program can usually be SAVEd on most disks where surgery is to be carried out, providing an *in situ* source of hexadecimals which, unlike printouts, cannot become buried under other papers.■

```
                     WAIT FOR  MORE

H   D   ASCII   H   D   ASCII   H   D   ASCII   H   D   ASCII
60  96          61  97          62  98          63  99
64  100         65  101         66  102         67  103
68  104         69  105         6A  106         6B  107
6C  108         6D  109         6E  110         6F  111
70  112         71  113         72  114         73  115
74  116         75  117         76  118         77  119
78  120         79  121         7A  122         7B  123
7C  124         7D  125         7E  126         7F  127
80  128         81  129    .    82  130    .    83  131    .
84  132    .    85  133    .    86  134    .    87  135    .
88  136    .    89  137    .    8A  138    .    8B  139    .
8C  140    .    8D  141    .    8E  142    .    8F  143    .

                     WAIT FOR  MORE

H   D   ASCII   H   D   ASCII   H   D   ASCII   H   D   ASCII
90  144    .    91  145    .    92  146    .    93  147    .
94  148    .    95  149    .    96  150    .    97  151    .
98  152    .    99  153    .    9A  154    .    9B  155    .
9C  156    .    9D  157    .    9E  158    .    9F  159    .
A0  160    .    A1  161    .    A2  162    .    A3  163    .
A4  164    .    A5  165    .    A6  166    .    A7  167    .
A8  168    .    A9  169    .    AA  170    .    AB  171    .
AC  172    .    AD  173    .    AE  174    .    AF  175    .
B0  176    .    B1  177    .    B2  178    .    B3  179    .
B4  180    .    B5  181    .    B6  182    .    B7  183    .
B8  184    .    B9  185    .    BA  186    .    BB  187    .
BC  188    .    BD  189    .    BE  190    .    BF  191    .

                     WAIT FOR  MORE

H   D   ASCII   H   D   ASCII   H   D   ASCII   H   D   ASCII
C0  192         C1  193         C2  194         C3  195
C4  196         C5  197         C6  198         C7  199
C8  200         C9  201         CA  202         CB  203
CC  204         CD  205         CE  206         CF  207
D0  208         D1  209         D2  210         D3  211
D4  212         D5  213         D6  214         D7  215
D8  216         D9  217         DA  218         DB  219
DC  220         DD  221         DE  222         DF  223
E0  224         E1  225         E2  226         E3  227
E4  228         E5  229         E6  230         E7  231
E8  232         E9  233         EA  234         EB  235
EC  236         ED  237         EE  238         EF  239

                     WAIT FOR  MORE

H   D   ASCII   H   D   ASCII   H   D   ASCII   H   D   ASCII
F0  240         F1  241         F2  242         F3  243
F4  244         F5  245         F6  246         F7  247
F8  248         F9  249         FA  250         FB  251
FC  252         FD  253         FE  254         FF  255
                    END OF DISPLAY
READY
>_
```

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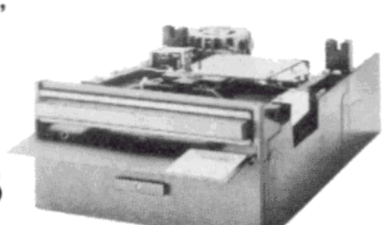

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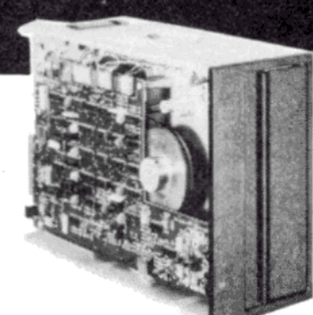

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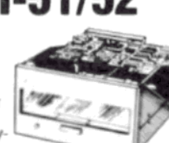

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Vendor: Micro Architect, 96 Dothan Street, Arlington MA 02174
Name: WORD-1
Purpose: General-purpose word-processing system
Documentation: Four pages—well-written
Loading: OK—Level 7
Implementation: Requires a printer to be of any practical value. Also, the TRS-80 should be modified for lowercase. User should have some BASIC programming background since text is entered into the system as data statements. This is more difficult than the method used in most word processing systems, but they cost at least four times as much as WORD-1. Also, since this is written in BASIC rather than machine language, it is quite slow.
Suitability: This is not for the author or others with high-volume requirements. It is, however, quite suitable for the letter writer or for someone who needs many copies of the same letter with a different name and address on each one. I like word processors because they allow me to correct all of my mistakes without being committed to paper.

Vendor: Micro Architect
Name: BANK-1
Purpose: Personal checkbook accounting system
Documentation: One page—sufficient, mostly self-documenting
Loading: OK—Level 7
Implementation: No hardware requirements except the standard cassette recorder. This program will process and store 100 checks in a 4K machine and 1600 checks if you have 16K. Data is input from the keyboard and includes check number, amount and transaction code. Each check is put into one of a number of categories depending upon the transaction code. All checks can be recalled, changed or deleted, and a summary report can be displayed at any time. The summary breaks expenses down into categories with totals for each one. All check data is stored on cassette for future use.
Suitability: A simple but effective personal accounting system. Should be all that most households will need. Since it is written in BASIC, the names of categories can easily be changed to suit your situation. I have already entered all of last year's checks into its data base.

Vendor: Micro Architect
Name: STOCK-1
Purpose: To keep track of the value of your stock portfolio
Documentation: One page—sufficent, self-documenting
Loading: OK—Level 7
Implementation: Program comes loaded with sample stocks so that the user can get an idea of what to expect. For your own stocks, you enter the date, original price, number of shares and current dividend. The program then computes your current worth by asking for the latest price for each of your stocks. It also figures in the present value of your house. As in WORD-1, all data is input as data statements rather than as a response to an input statement. It is also awkward to use if you have blocks of the same stock that were purchased at different times or for different prices. Each block must be input as a separate stock entry. Data is stored on cassette as part of the program which is resaved anytime that changes are made.
Suitability: The speculator will want something more sophisticated than this. For the user who buys and holds his stocks for a reasonable period of time, this program will compute his net worth and gain or loss position. It will not analyze future stock possibilities.

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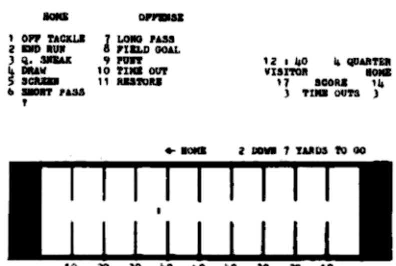

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✓Reader Service—see page 162

ysis of variation and analysis of covariance from user input.

Documentation: Five pages—excellent

Loading: OK—Level 6

Implementation: If I lost you reading the purpose of these (five) programs, then we're still together. Quite frankly, I'm not a math major (or math minor either!) and this is way over my head.

Suitability: Math students, scientists and anyone else who understands the terms used above can probably put this package to good use.

Other programs available from M and S Computer Software: A Dissassembler.

Vendor: Contract Services Associates, 1846 W. Broadway, Anaheim CA 92804

Name: Form 1040A Tax Program

Purpose: To help the user fill out the IRS 1040A income tax form

Documentation: Two pages—complete

Loading: OK—Level 7

Implementation: You are asked to enter from the keyboard the information that will be used to fill out the 1040A. If you qualify for earned income credit (income under $8000), this is computed. You are directed to the tax tables and asked to enter your tax. The information required on the form is then displayed on the screen.

Suitability: Since the form 1040A is so simple to fill out, it would be hard to justify the purchase of this program for a one-time use. There is no guarantee that the form will be the same next year or that you will qualify for it.

Other software from Contract Services Associates: All income tax forms and schedules (home and professional), Monitor, Calculator, Loan Payment Computation, Hex-Dec-Oct Conversions, Cash Flow Prediction and many more.

Vendor: Circle Enterprises, Inc., PO Box 546, Groton CT 06340

Name: File Handling

Purpose: To keep a file of names, addresses, telephone numbers and birthdays

Documentation: Self-documenting

Loading: OK—Level 7

Implementation: Program is self-documented and easy to use. Names (last name first) can be entered in any sequence and will be arranged in alphabetical order. Any listing can be recalled, changed or deleted, and the entire block—name, address, telephone number and birthday—will be displayed while it is being modified. You can step your way through the file or cause a list of all of the names and telephone numbers in the file to be displayed. No direct provision for hard copy is made, but this could easily be added.

Suitability: This is another one that I've put into family service. It will handle up to 100 names and should be usable by most households. It ought to make our Christmas card list much simpler to generate this year.

Other software available from Circle Enterprises, Inc.: Moving Signboard, Loan Payment, Prime Numbers, Amway Distributer System and more.

Conclusion

Note that most programs were loaded with the CTR-41 volume control set between 6 and 7. In order to get a good CLOAD for the first time, I used the following procedure:

```
10 Set the volume control to 4.
20 CLOAD.
30 If CLOAD fails THEN advance volume
   slightly:GOTO 20
40 RUN
```

Radio Shack has a modification out for the TRS-80 that uses the data on the tape instead of the computer clock for clocking the CLOAD. This should allow a much greater volume control setting range. I have another computer that uses that method, and I can set the volume anywhere from 1 to 10 and still get a good load.

When I CSAVE my own programs, they CLOAD best with the volume set at 4½. I don't like to have tapes that play back at different levels because I usually forget to reset the volume control correctly. Therefore, once I get a good CLOAD. I CSAVE the program back to a second tape. This means that from now on it will CLOAD from this tape with my standard volume setting. Also note that most programs only take up a portion of the tape that they are sold on, so I put many programs on this second tape, which reduces the number of active tapes in my library.

Most of the tapes that I received came without boxes. Since dust and error free digital tape recording are not compatible, I do not like to see cassette tapes lying around loose gathering dust. A box for each tape would be a small part of the vendor's program production expense and would certainly be a beneficial service to the customer.

I have barely scratched the surface of this field. While I was disappointed in some of the above software for the reasons given, I think that we have made a start in the right direction. However, I still think that there is a need for more sophisticated applications-type programming. Personal computing is growing up very rapidly. More and more people who are not interested in computers as a hobby are getting involved. They are going to demand and be willing to pay for good applications software. ■

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Unfortunately,

converting your TRS-80 requires installing the video memory chip plus wiring changes. There is only one modification on the market which eliminates most of the wiring. To get the dualcase mod installed you have three choices: 1) Send your computer to a company or individual who will do the wiring, 2) do it yourself, or 3) "THE PATCH" (trade mark).

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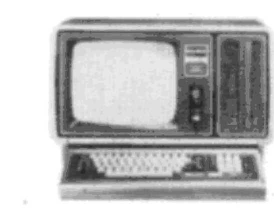

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If you bought your 80 to learn about computers, why upgrade to Level II?

Inside Level I

Robert V. Meushaw
4188 Brittany Dr.
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Once I had worked my way through the *TRS-80 Level I BASIC User's Manual* and had run most of the examples, I grew itchy to move on to Level II BASIC. My friends who already had Level II machines constantly reminded me of how primitive my system was. The pressure to move up kept growing.

I would have succumbed to the pressure, if I had not already gone through a similar experience in my younger days when I had been bitten by the stereo bug. I had spent thousands of dollars on speakers, amplifiers, tuners, turntables, etc., in an attempt to own the ultimate system. Clearly, it was an impossible task.

Looking back, I realized that my pretention overcame my better judgement. After all, the purpose of owning a stereo was to listen to music, not to claim the lowest distortion figures of any of your friends' systems.

My ears could have been satisfied with a much less expensive system.

I had to reevaluate my true motives for owning a computer. After several days of mulling it over, I realized I wanted to understand the underlying concepts of the machine. My true desire was to know the details of the Z-80 microprocessor, how the various software routines worked and how the Level I BASIC interpreter worked. There was so much more to learn on the system I already had. I had only scratched the surface of understanding the TRS-80.

```
10    I = 1
20    I = I + 1
30    IF I = 15000 THEN 50
40    GOTO 20
50    PRINT "DONE"
60    END
```

Listing 1: Timing loop using incremented variable (302 seconds).

```
10    FOR I = 1 TO 15000
20    NEXT I
30    PRINT "DONE"
40    END
```

Listing 2: Timing loop using FOR-NEXT statement (33 seconds).

```
10    FOR I = 1 TO 15000: NEXT I
20    PRINT "DONE"
30    END
```

Listing 3: Single line version of timing loop in Listing 2 (28 seconds).

```
10    FOR I = 1 TO 5000
20    **** BASIC STATEMENT ****
30    NEXT I
40    PRINT "DONE"
50    END
```

Listing 4: Program used to investigate timing behavior of various Level I BASIC statements.

Level I BASIC

What I needed was a more well-defined objective than just to "learn more about Level I." I decided to begin my investigation with Level I BASIC and attempt to learn any technique that allowed me to use the language more efficiently.

A simple timing experiment (Listing 1) opened my eyes. This is a very simple timing loop which increments the variable I from 1 to 15,000 and then prints "DONE".

There is nothing amazing about this program, but I was dumbfounded to find that it took 302 seconds to execute. In fact, I was so amazed that on the first several runs of the program, I terminated the execution prematurely because I thought the computer was broken.

Why on earth, considering the speed of modern day computers, should it take 302 seconds to count to 15,000? This was extemely puzzling, so for my second investigation I ran an equivalent program, shown in Listing 2. It took only 33 seconds.

Here was a problem worth investigating: Why should two equivalent programs differ in execution time by a factor of almost ten? More importantly: What can be done to obtain the fastest program execution time?

Out of curiosity, I tried to improve on the results of the program in Listing 2. Listing 3 shows a third program that executed in 28 seconds. This improvement was not as dramatic, but it still amounted to about a 15% increase in speed.

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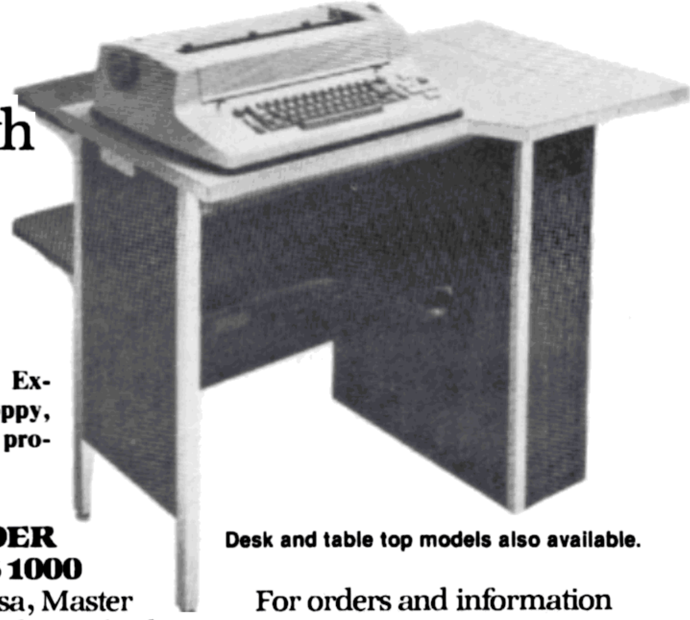

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Clearly, for a given program, there could exist a large number of equivalent programs whose execution times might differ substantially. Unless each equivalent program was coded and tested, it might not be possible to determine *a priori* which would be fastest.

I had defined my project: Determine a set of guidelines which could be applied to an arbitrary program to improve its execution time.

The Approach

Since I had already obtained execution times for the FOR-NEXT loop shown in Listing 2, it was a simple matter to add statements in the loop as shown in Listing 4 and measure the total time of execution. The extra time for execution beyond that required by the FOR-NEXT loop would be directly attributable to the extra statement in the loop.

For example, if the timing loop of Listing 2 required 48 seconds to execute its 15,000 iterations after a statement was added, then the additional time required because of that statement would be 48 minus 33 = 15 seconds. If the time per execution of that statement was computed, it would be 15/15,000 = .001 seconds.

In practice, the delay loop which I used performed 5000 iterations because it did not result in excessive execution times.

Firstly, I attempted to categorize the kinds of Level I BASIC statements including:

Assignment Statements;

Arithmetical Statements;

Logical Assignment Statements;

Single Parameter Statements;

Two Parameter Statements;

Transfer of Control Statements;

Conditional Statements;

I/O Statements.

Within each statement category, I included various forms of each statement in order to test the effect of the variations. While the list is not exhaustive, it's sufficient to gain an understanding of the overall operation of Level I BASIC.

The Assignment Statement

Table 1 shows the execution times of the assignment statement variations. The various forms included the assignment of constants, variables, array elements and strings to real variables, string variables and array element variables.

For example, the first two results show that it requires more time to assign a constant to the variable K than to assign the value of X to K.

The next two lines show that it requires less time to assign K the value of a variable array element, i.e. A(X), than to assign it the value of a particular array element, i.e. A(7).

Comparing these results with the previous results shows that it requires more time to assign W the value of an array element than a non-array element. For instance, in going from K = A(8) to K = X, we can cut the execution time by 41%.

The next three lines show the considerable savings that result from using the optional assignment statement LET. Going from K = A(8) to LET K = X we can cut execution time by over 65%.

The next series of statements shows the results of assigning values to array elements. As you see, the fastest executing statement uses only variables and the LET statement (i.e., LET A(I) = X), and the slowest uses constant parameters without the LET statement (i.e., A(8) = 7).

Finally, the limited string assignment capabilities of Level I are evaluated in the last two statements. As expected, the use of the LET statement results in a considerable savings in time.

Aside from comparing relative speeds it is interesting to examine the absolute times required to execute assignment statements.

It takes approximately 10 ms. to execute these assignment statements. If you approximate the machine instruction execution time of the microprocessor as 6 microseconds, it would appear that as many as 1500 machine instructions are executed in carrying out one BASIC assignment statement.

These crude approximations can give some insight into the relative inefficiency of an interpreted language as compared to a machine code implementation of the same operation.

Arithmetical Statements

Since so many programs involve arithmetic functions, the results of Table 2 are particularly interesting. The left column of the table shows the expressions evaluated in the timing loop described previously.

Each expression is written in a general form using ? to stand for one of the functions +, −, /, or *, shown at the top of the table. All the functions have relatively close execution times. Addition and subtraction, for example, have nearly identical execution times. The next fastest function is multiplication, and division is the slowest function.

Comparing execution times in each column, we get similar results to those previously obtained. For a given expression, approximately 24 percent more time is required if parentheses are used, and approximately 26 percent less time is required if the LET statement is used. Additionally, substitution of variables for constants improves execution speed. For instance, A = I + J is 24 percent faster than using A = 5 + 5.

Logical Assignment Statements

Often programs require the use of Boolean variables, or variables which take only two values, usually 0 and 1.

Table 3 shows some examples of statements which compute the value of a Boolean variable. The first statement assigns A the value of 1 if (B = C) and 0 otherwise. The second

Logical Assignment Statements

	A = (B = C)	.011
	A = B = C	.0086
LET	A = B = C	.0062
	A = B>C	.0085
	A = B<=C	.0085

Table 3: Logical Assignment Statement Execution Times.

Assignment Statements

BASIC Statement		Execution Time (Sec.)
	K = 5	.007
	K = X	.0058
	K = A(5)	.0098
	K = A(X)	.0086
LET	K = 5	.0046
LET	K = X	.0034
LET	K = A(X)	.0062
	A(5) = 5	.0108
	A(I) = 5	.0096
	A(5) = X	.0096
	A(I) = X	.0084
LET	A(I) = X	.006
	A$ = "ABCD"	.0042
LET	A$ = "ABCD"	.0018

Table 1: Execution times for Level I BASIC Assignment Statements.

Arithmetical Statements

		+	−	*	/
	A = 5?5	.01	.01	.011	.0118
	A = I?5	.009	.009	.01	.0104
	A = I?J	.0076	.008	.0088	.0092
	A = (5?5)	.0124	.0124	.0134	.0142
	A = (I?5)	.0114	.0114	.0124	.0128
	A = (I?J)	.01	.0104	.0112	.0116
LET	A = 5?5	.0074	.0074	.0084	.0092
LET	A = I?5	.0066	.0066	.0074	.0078
LET	A = I?J	.005	.0054	.0062	.0068

Table 2: Arithmetical Statement Execution Times for Level I BASIC.

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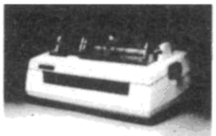

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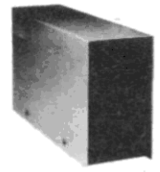

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Single Parameter Statements

K = RND(66)	.0134	
K = RND(X)	.012	
LET K = RND(X)	.0096	
K = RND(30000)	.014	
K = RND(0)	.0098	
K = RND(J)	.0088	where J = 0
LET K = RND(0)	.0072	
K = INT(5)	.0096	
K = INT(X)	.0084	
LET K = INT(X)	.006	
K = ABS(5)	.0086	
K = ABS(X)	.0074	
LET K = ABS(X)	.005	

Table 4: Single parameter statement execution times.

statement may look somewhat strange, but it is equivalent to the first and it executes 22 percent faster.

This is another example of the execution time penalty incurred when unnecessary parentheses are used. As expected, the use of the LET statement provides a significant decrease in execution time over the first statement. In this case the decrease amounts to 44 percent.

The last two statements show that there is no substantial difference in execution time when using logical tests such as "greater than," "less than or equal," etc.

On the average, the logical assignment statements are noticeably slower than the addition/subtraction statements, which surprised me. This may indicate that arithmetical statements can be used in place of logical statements in cases where execution time is critical.

Two Parameter Statements

SET(30,47)	.0112
SET(X,Y)	.008
REST(30,47)	.0098
RESET(X,Y)	.0066
K = POINT(30,47)	.0146
K = POINT(X,Y)	.0114
LET K = POINT(X,Y)	.009

Table 5. Two-parameter statement execution times.

Single Parameter Statements

Level I BASIC includes the single parameter functions RND, INT, and ABS, which are shown in various forms in Table 4. The examples given for all of these functions show a modest increase in speed when using a variable rather than a constant parameter.

The speed increase ranges from 10.5 percent for the RND function to 14 percent for the ABS function. A LET statement increases the speed more dramatically. This increase ranges from 28 percent for the RND function to 42 percent for the ABS function.

In Level I BASIC when RND(0) is used, a random number between 0 and 1 is generated. This particular function executes considerably faster than when the RND function is used with a non-zero constant parameter or even a non-zero variable parameter.

The fastest execution of RND results when a variable whose value is 0 is used as a parameter. It is interesting to note that the execution times of the ABS and INT functions are on a par with the addition/subtraction assignment statements shown in Table 2. However, the RND function appears considerably slower than even the division statements shown in that table.

Two Parameter Statements

There are three statements in Level I BASIC which require two parameters. These statements, summarized in Table 5, are all associated with the TRS-80 graphics.

The SET statement is used to turn on a particular point in the 128 by 48 point display, while RESET is used to turn off a particular point. POINT is a Boolean function used to determine whether or not a particular point is turned on.

As expected, each of these statements executes faster when using variable parameters rather than constants or other expressions. Oddly enough, it requires considerably more time to turn on a point than to turn it off, despite the fact that the instruction set of the Z-80 microprocessor allows a particular bit in memory to be set to 1 as quickly as it can be set to 0.

The POINT statement is the slowest of the graphics instructions, even when it employs a LET statement. Unfortunately, the LET statement cannot be used to increase the speed of the SET or RESET statements.

It is possible to determine the approximate time required to turn on or off every point in the display, using the figures in Table 5 and the fact that there are 128 x 48 = 6144 individual points in the display. The time required to turn on 6144 points is approximately 49 seconds, while the time required to turn them off is 41 seconds. But this does not include the time required by the necessary FOR-

```
10    FOR I = 1 TO 5000
20    GOTO 30
30    NEXT I
```

Listing 5a: Program used to test GOTO statement.

```
10    FOR I = 1 TO 5000
20    GOSUB 100
30    NEXT I
100   RETURN
```

Listing 5b: Program used to test GOSUB/RETURN statements.

```
10    FOR I = 1 TO 5000
20    GOTO 100
30    NEXT I
100   GOTO 30
```

Listing 5c: Program used to compare GOTO statement with GOSUB/RETURN statements.

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NEXT loops. Using the results of Table 1 to approximate the loop time necessary for 6144 iterations adds about 14 seconds to the total, giving us 63 seconds to turn on all the points and 55 seconds to turn them all off.

Transfer of Control Statements

Measuring the execution speed of a transfer of control statement required a slightly different approach.

The GOTO statement required a number to which control could be passed. The GOSUB statement required not only a control number, but a RETURN of control to the statement after the GOSUB.

The particular routines which I used to test these statements are shown in Listings 5a, 5b and 5c. Listing 5a allows the GOTO statement to transfer control to the NEXT statement of the timing loop. Listing 5b was used to test the GOSUB/RETURN statements. Listing 5c was used to compare the transfer of control to a routine using only GOTO statements with that required by the GOSUB/RETURN statements.

The results are given in Table 6. Interpreting them is not as clear cut as in the previous cases. To execute a given routine using only GOTO statements is faster, but this routine is not as flexible as one that uses GOSUB/RETURN statements, especially in the return of control to the calling routine.

There may be occasions when you can use the increased speed of the GOTO to your advantage. In comparison, the transfer of control using only GOTO statements is approximately 14 percent faster than using GOSUB/RETURN.

A similar savings should be gained by using the ON N GOTO rather than the ON N GOSUB statement. Of course, the entire overhead associated with the transfer of control can be avoided, at the expense of a longer program, by including the subroutine as in-line code.

Unfortunately, in Level I BASIC you cannot use a variable name in place of a line number in the transfer of control statements (e.g. GOTO K), so this trick does not reduce execution time.

Conditional Statements

Level I BASIC includes only the IF-THEN conditional statement. At first glance, it does not appear that there is much you can do to improve its operating characteristics.

I found, however, that in some cases the THEN portion of the statement is unnecessary. In an expression such as IF X=1 THEN 100, where control is passed to line number 100, THEN is required, but for conditional assignment statements, etc., it's simply not.

The execution times in Table 7 indicate that there is no penalty in speed for omitting the THEN statement, so this is a four byte savings which is always worth taking.

The execution speed of the conditional statement depends heavily upon whether or not the condition tested is true or false. By comparing the third and

Transfer of Control Statements

GOSUB –	GOSUB 100 100 RETURN	.0072
GOTO –	GOTO 30 30 NEXT I	.0026
	GOTO 100 30 NEXT I 100 GOTO 30	.0062
ON N GOSUB	ON N GOSUB 100 100 RETURN	.0092
ON N GOTO	ON N GOTO 30 30 NEXT I	.0052

Table 6. Execution times for the transfer of control statements.

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Conditional Statements	
(The following execution times are measured with J = 1)	
IF J = 1 THEN X = 1	.0142
IF J = 1 X = 1	.0142
IF J = 1 LET X = 1	.0114
IF J = 2 THEN X = 1	.007
IF J = 2 X = 1	.007

Table 7: Execution times for conditional statements.

fourth statements in Table 7, you can see that when the test fails, its execution speed is increased by a minimum of about 40 percent.

This means that, where feasible, conditional statements should be constructed to allow for failure of the condition tested. It is probably safest to time your program with conditionals that usually test true, and again with conditionals that usually test false, in order to determine which approach is fastest.

I/O Statements

Because of the limitless number of ways in which strings, variables, TABs, ATs, constants, etc., can be combined in an I/O statement, it is a large field to test. I limited my survey to a few combinations which provide insight into possible areas of saving. These are shown in Table 8.

The first eleven statements are examples of PRINT statements. The results seem inconclusive, except to say that using a variable parameter in an AT statement is faster than using a constant. It also appears that suppressing the carriage return in a PRINT statement, ending it with a ";", saves time.

After further consideration, it seems to me that the execution speed of the PRINT statement is not really significant because it makes no sense to print huge amounts of data—the display screen only holds 1024 characters. Execution speed is important only in the internal computation that occurs before a print statement.

The data entry statements available in Level I BASIC are the INPUT and READ statements. The INPUT statement, of course, requires manual intervention to supply the data. But the READ statement, since it can execute continuously in a timing loop, is measurable.

It was necessary for me to include a RESTORE statement with the READ statement in the timing loop, since I didn't want to type a DATA statement with 5000 entries, even if I did have sufficient memory to hold it. I determined the execution time for a single READ operation by independently finding the execution time of the RESTORE statement and subtracting this from the combined READ/RESTORE execution time. These results are also displayed in Table 8.

Some interesting tradeoffs are available when using READ/RESTORE statements. For example, if a sequence of numbers is referenced frequently in a program loop, the numbers can be referenced either as array elements or by READ/RESTORE statements.

The DATA statement is not normally considered executable, but it does require time to determine that it isn't an executable statement. When placed in the FOR-NEXT timing loop, I measured an "execution" time of .003 seconds. This time did not vary appreciably with the number of items in the statement.

I arbitrarily included the CLS, or clear screen, statement in Table 8. This is the slowest executing statement in all of Level I BASIC. I didn't know why, so I explored it in more detail.

By consulting a Z-80 microprocessor reference card, I developed an assembly language routine which cleared the screen (Listing 6). It first loads the HL register with the start address of the display memory (i.e., 3C00 hex) and then stores a blank at that location (i.e., 20 hex).

Next, the DE register is loaded with the address of the second display location address (i.e., 3C01 hex). Then the BC register is loaded with the number of bytes to be moved in the following "block move" instruction. The effect of the "block move" is to clear the screen.

Compound Statements	
K = INT(A(X))	.0074
K = ABS(X + Y)	.0094
K = ABS(A(X))	.0114
K = INT(X)	.0084
K = INT(X + Y)	.0104
K = INT(A(X))	.0114

Table 9: Execution times for various compound statements.

Each instruction in Listing 6 is accompanied by the number of "T cycles" it requires, where a "T cycle" corresponds to the machine clock period. The total time required by this routine is shown beneath the listing.

The number 1023 in the calculations is the number of bytes moved in the block move, and the number 1.8 x 10**6 is the approximate clock speed of the TRS-80. The total time required by the assembly language program is approximately .012 seconds, just under one-half of the time required by the CLS statement.

Compound Statements

After determining the execution times of various Level I statements, I decided to examine their behavior when they were combined. Table 9 shows the execution times of the ABS and INT statements used with different parameters. In both cases, the fastest execution time results when a simple variable is used as a parameter, which is not surprising.

It occurred to me that by decomposing them into several simpler statements, I might

Input/Output Statements		
PRINT	PRINT	.0172
	PRINT " "	.0184
	PRINT " ";	.0042
	PRINT " (64 spaces) "	.0278
	PRINT " (64 spaces) ";	.027
	PRINT AT 0, " "	.0098
	PRINT AT 0, " ";	.0086
	PRINT AT N, " ";	.0072
	PRINT AT 0, " (64 spaces)"	.0178
	PRINT AT 0, "(64 spaces)";	.0178
	PRINT TAB(10); " ";	.0088
INPUT	Not measured	
READ/RESTORE	READ X RESTORE	.012
	RESTORE	.0022
(from above we can compute)	READ X	.0098
DATA	DATA (.. 20 ITEMS ..)	.003
CLS	CLS	.0262

Table 8: Execution times for various I/O statements.

```
Instruction              Number of T cycles
LD     HL,3C00H          10
LD     (HL),20H          10
LD     DE,3C01H          10
LD     BC,3FFH           10
LDIR                     21
Total T cycles  = 10 + 10 + 10 + 10 + 1023*21
                = 40 + 21483
                = 21523

One T cycle  =  1/(1.8 * 10**6) sec.
Total time  =  21523/(1.8 * 10**6)
            = .0119
            = .012 sec.
```

Listing 6: Assembly language program to perform CLS (clear screen).

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K = ABS(X + Y)	.0094	K = X + Y L = ABS(K)	.0076 .0074 .015 total
K = ABS((A(X))	.0114	K = A(X) L = ABS(K)	.0086 .0074 .016 total
LET K = ABS(X + Y)	.007	LET K = X + Y LET L = ABS(K)	.005 .005 .01 total

Table 10: Execution time comparison of compound and decomposed statements.

reduce their execution time. Table 10 gives three examples. In each of the cases, a single compound statement is replaced by two simpler statements that produce the same result. As the execution times clearly show, using a single compound statement is considerably faster than using two simpler statements.

While it is not fair to say that this will always be the case, it is certainly something that you should investigate when developing your programs.

BASIC Variations

As a final project in my investigation of Level I BASIC, I decided to examine the behavior of the language when used in ways not documented in the *Level I User's Manual*. It often turns out that there are quirks in a language, which you can use to your advantage if you can find them.

The first statement I looked at was the FOR statement. A typical form of this statement is:

```
FOR I = 1 TO 100 STEP 2
```

In this example, the start index, end index and step size are all numbers. I wanted to know what would happen if I used something other than a number, and I was pleased to discover that I could replace any or all of these numbers with either variables or expressions.

For example, the following statements will execute properly:

```
FOR I = A TO B STEP C

FOR I = A + 3 TO ABS(K/4) STEP RND(5)
```

This is very useful in programming situations. One example is a general purpose subroutine that can be called and supplied with the particular parameters to be used in its loop calculation. The use of variables or logical expressions can be extended considerably beyond what is described in the manual. It is possible to use logical expressions to define Boolean variables such as:

```
X = (A> = 5) * (B< = 7)
```

It is also possible to use "mixed mode" expressions, or expressions in which logical tests are used with other variables. For instance:

```
SET( (X>Y)*32 + 2, 42)
```

is a valid expression.

In the expressions ON K GOTO and ON K GOSUB, I found that if K is a negative integer the expression will not work. However, if K is zero, or if K is a positive integer greater than the number of parameters in the expression, the first parameter will be selected. For example, in the expression:

```
ON K GOTO 100,200,300
```

if K is zero or if K is greater than three, the statement will transfer control to line number 100. I tried a sample program which includes multiple statements on the same line as a conditional test. The program line I selected was:

```
IF X = * THIN A = 0: B = 1: C = 2
```

In running the program with several values for X, I found that if the test evaluations were true, all the remaining statements on the line were executed; while if the test evaluations were false, all the remaining statements on the line were skipped.

This might be very bothersome, but it can be useful in programs that require multiple actions after some decision. Many interesting variations of program statements are possible as a result of this feature. For example:

```
IF X = 1 THEN A = 1: B = 2: IF Y = 1 THEN A = A + 1: B = B - 1
```

will set A = 2 and B = 1, if X = 1 and Y = 1 or A = 1 and B = 2, if X = 1 and Y<>1. A,B are unchanged if X<>1.

One final interesting result that I found was that in a program line which includes a PRINT statement, if the final character on the line is a quote the mark can be eliminated, thereby saving one byte of storage.

This means that the following program lines will produce the same result:

```
PRINT "NO FINAL QUOTE NEEDED"
PRINT "NO FINAL QUOTE NEEDED
```

Level I Guidelines

Some of the above results have shown you how to conserve memory space, while others have shown you how to increase speed, usually at the expense of program size. You should make the tradeoffs you feel are necessary in your own applications. It should be possible to obtain the benefits of both reduced program size and increased speed if the "80/20" rule of programs applies in your case (i.e., 80 percent of the execution time is spent in 20 percent of the code).

Following is a summary of some general guidelines you can use to increase the performance of your programs.

1) Avoid unnecessary use of parentheses.
2) Use the LET statement in assignment statements.
3) Use FOR-NEXT loops as much as possible without tests for exiting the loop.
4) Use FOR-NEXT loops on a single line.
5) Avoid unnecessary statements within loops.
6) Use variables in frequently evaluated expressions rather than constants or array elements.
7) Use compound statements rather than sequences of simpler statements.
8) Use the random function with a zero parameter where feasible.
9) Where possible, use conditional statements which evaluate false most of the time.
10) In arithmetical expressions use multiplication operations rather than division operations.

As I have noted, these items are strictly guidelines: Consider them along with the various timing results I have presented.

I have applied some of these guidelines in Listing 7a which was recoded in Listing 7b. The execution time for the first program was 47 seconds. Using the recoded version, the execution time was reduced to 17 seconds, a reduction of almost 64 percent!

While results such as this may not be possible in every case, I believe that the savings you can attain are well worth the effort. ■

```
10    A(0) = 1
20    FOR I = 1 TO 500
30    X = (1/6.28) * A(0) * I
40    IF (((X - A(0)/100) > .0001) THEN X = 6.28*X
50    A(I) = X
60    NEXT I
```

Listing 7a: Sample program for use in applying Level I BASIC programming guidelines.

```
10    P = 6.28
20    K = A(0)/P
30    L = A(0) + 5
40    M = 1/100
50    N = .0001
60    FOR I = 1 TO 500
70    LET X = K*I
80    IF (X - L)*M >N LET X = P*X
90    LET A(I) = X
100   NEXT I
```

Listing 7b: Recoded version of program shown in Listing 7a.

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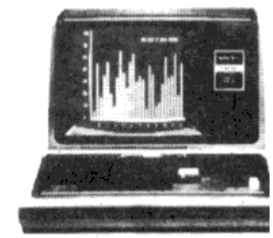

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It's funny how one thing leads to another in computing. I start adapting a hangman program and end by PEEKing, POKEing and performing some fancy logic that has nothing to do with spelling.

While transcribing a hangman program into my TRS-80 Level II machine, I decided that the meager graphics in the original needed some embellishment, like sketching the figure and gallows, followed by a rope dropping down and the head moving to one side with the word "snap" appearing next to it.

Simple Garbage

That's simple enough, but I am using the double-sized character width for greater legibility on my 9-inch monitor with the command:

```
PRINT CHR$(23)
```

That's where the trouble begins. I have written the graphics part using SET(X,Y) and a PRINT@ for the word to appear near the head, but in normal 64 character mode. When I insert the CHR$(23) at the beginning and run it, all I get is garbage, and the PRINT@ line fails to appear.

Extensive debugging fails to show anything of importance, except when I eliminate the CHR$(23), everything works fine. It is also apparent that once you are in the double-width mode, the only way to get out of it is to clear the screen with the CLS command, erasing anything on the screen. Radio Shack gives no information on how to restore single width graphics and letters without erasing the screen.

The article,"Hidden Codes and Missing Chips", by Patrick and Leah O'Connor (*80-Microcomputing*, January, 1980) starts me on the way to a solution when they describe how double mode works in hardware. I try OUT255,0 and OUT255,8 to go back and forth between the two modes, but it is too quick. The OUT command does not latch, so when it is finished the double mode reverts back to what it was before.

Putting the OUT command in a delay loop helps, but this is impractical. Somewhere there has to be a bit that is flipped and used as a reference to change the bit No. 3 on the output port when it is finished.

To find it, I have to get my feet wet in the swamp of PEEK and POKE to examine the several hundred addresses of reserved RAM that Radio Shack does not explain.

Since some byte has to change when going from CLS to CHR$(23), I try writing a short program to test RAM within range of addresses, compare the contents before and after the conversion and store any positive results for display at the end of the run.

Listing 1 does just that, storing the contents of memory in B and C, then comparing them and storing those that changed. I dimension the arrays to 12 places which, as it turns out, are more than enough. Try the program and specify memory locations starting at 16384 and ending at 17128, which is the zero at the beginning of Program Text (see the T-BUG manual for more detailed information).

The results show that there has been a change in the cursor location, and six other locations in reserved RAM. The one that stands out and says, "BINGO!" is location 16445, which shows a zero in normal mode and an eight (or binary 00001000) for data pin No. 3 in the CHR$(23) mode.

Now all I have to do is POKE 16445,0 to convert back to normal graphics and character size. As far as I can tell, POKE 16445,8 is equivalent to PRINT-CHR$(23).

Switching back and forth between normal and double mode, it is soon apparent how the thing works.

Even Numbering

First, the PRINT@, in double mode, only works for a word starting at an *even*-numbered position. If you are in double-width mode and type:

```
10    REM  ADDRESS COMPARE FOR TRS-80
20    REM  B THIEL   1/05/80
30    DIM D1(12),D2(12), D3(12)
40    INPUT "STARTING ADDRESS";A1
50    INPUT "ENDING ADDRESS";A2
60    LET A=A1
70    CLS
80    B=PEEK(A)
90    PRINT CHR$(23)
100   C=PEEK(A)
110   IFB<>C THEN GOSUB 200
120   LET A=A+1
130   IF A<A2 THEN 70
140   CLS
150   PRINT "ADDRESS","NORMAL","DOUBLE"
160   FOR D=1 TO 12
170   PRINT D1(D),D2(D),D3(D)
180   NEXT
190   STOP
200   J=J+1
210   D1(J)=A:D2(J)=B:D3(J)=C
220   RETURN
```

Program Listing 1.

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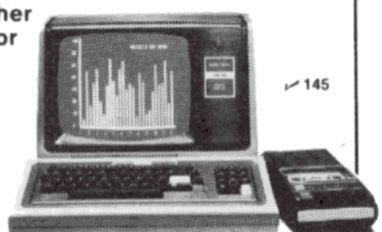

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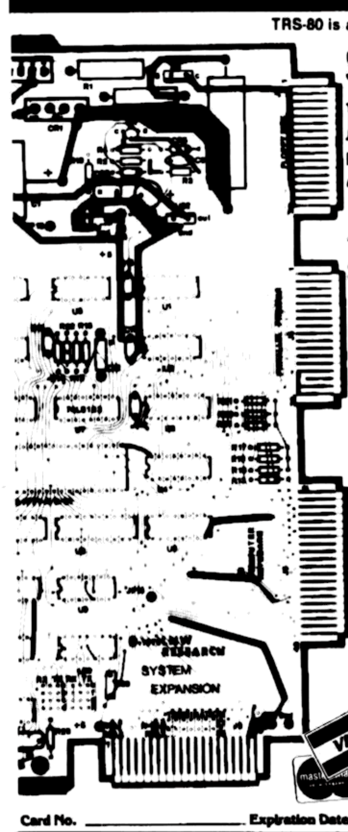

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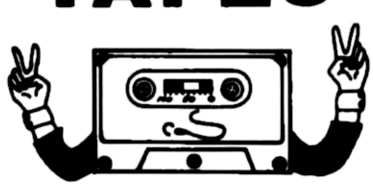

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Character	Division	Remainder	Division	Remainder	Action
0	x/2	no	x/2/2	no	x = x
1	(x + 1)/2	no	(x + 1)/2/2	yes	x = x − 1
2	x/2	no	x/2/2	yes	x = x − 1
3	(x + 1)/2	no	(x + 1)/2/2	no	x = x − 2

Table 1. Logic chart.

```
PRINT@100,"HELLO 1":PRINT@165,
    "HELLO 2"
```

you see only the first line printed. Now enter:

```
POKE16445,0
```

and the other line will appear. Note they are both double spaced. Double-width mode inputs characters every other position in memory, and if they don't start in an even position, you'll never see them. This can be surprising when loading the screen memory with a message or graphic in double-width, and you have it suddenly appear by reverting back to the normal mode.

If you have printing on the screen in normal mode and you POKE 16445,8 or PRINT CHR$(23), you see only one half of what was there before. Also, the whole screen is shifted right one double-character width, which is the clue to understanding how double mode characters and graphics work.

Remember that you can SET any X position between 0 and 127, but in double mode all you have available is every other *pair* of X memories. If we look at the first four numbers, 0,1,2 and 3, you'll see what I mean.

Type in SET(0,30) and you get a block in positions zero and one (in double width mode), SET(1,31) occupies screen positions two and three on line 31. SET(2,32) and SET(3,33) though they do reside in video memory, are not displayed on the screen. POKE 16445,0 and you see them; POKE 16445,8 and they disappear again. To draw in double mode graphics, you have to take this into account.

The only thing left to explain is how to do it easily, especially if you are graphing. Studying the characteristics of the numbers, it becomes apparent that each had a couple of characteristics unique to its own group (multiples of four). Each time you divide by two you have a result that either does or does not have a remainder, with a one added to compensate for odd numbers.

Table 1 shows how a position can be evaluated and, when true, what action will be taken to set the proper memory bit to give a continuous line.

Subroutine

The subroutine starting at line 1000 in Listing 2 uses these characteristics from the table with the integer function and the logical AND to determine if there is a remainder after division.

Note that a fourth decision line does not exist since, if the first three are not satisfied, then the X must be of character three type which requires a displacement two positions to the left. Special consideration is given to zero in line 1020 and an overvalue check in line 1010.

If you enter the program as shown and run it, you get a normal graphics line from 0,0 to 47,47. Insert:

```
15 PRINTCHR$(23)
```

and note the discontinuous line on a new run. To activate the subroutine, put in the line:

```
35 GOSUB 1000
```

and you correct this problem. Study how the subroutine is used and insert it whenever you decide to use double mode in graphics.

With the knowledge of the PRINT@ idiosyncracies and the unusual use of graphics memory storage, many unusual and useful effects can be accomplished. ■

```
1     REM       DEMONSTRATION PROGRAM WITH GRAPHICS
2     REM       SUBROUTINE TO CORRECT FOR CHR$(23)
3     REM       B THIEL   1/05/80
10    CLS
20    FOR Y=0 TO 47
30    X=Y
40    SET(X,Y)
50    NEXT Y
60    GOTO 60
999   END
1000  REM SUBROUTINE TO EVALUATE X POSITION IN SET COMMAND
1010  IF X>127 PRINT "X IS OVERVALUED": STOP
1020  IF X=0 RETURN
1030  A=X/2
1040  B=A/2
1050  C=(X+1)/2
1060  D=C/2
1070  IF((A-INT(A))=0) AND ((B-INT(B))=0) THEN RETURN
1080  IF((C-INT(C))=0) AND ((D-INT(D))>0) THEN X=X-1:RETURN
1090  IF((A-INT(A))=0) AND ((B-INT(B))>0) THEN X=X-1:RETURN
1100  X=X-2: RETURN
1110  STOP
```

Program Listing 2.

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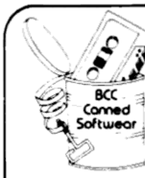

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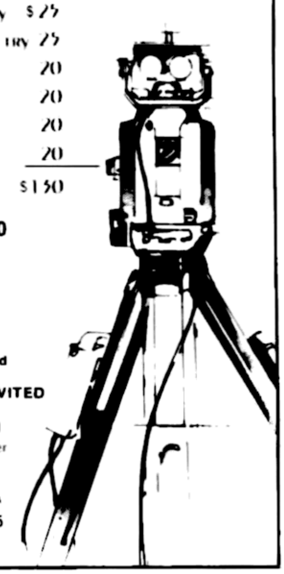

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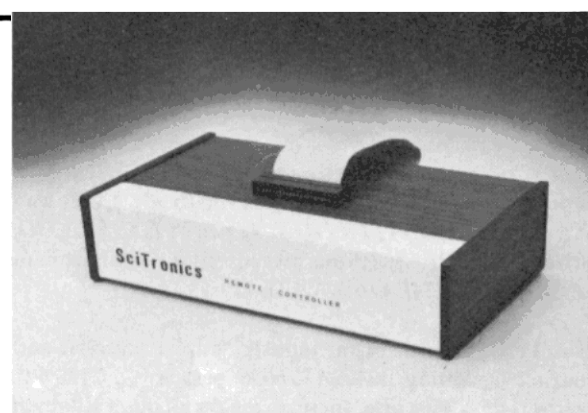

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What is better for a microcomputer's output blues than a line printer, but costs about the same? A printing terminal!

After considering various line printers I decided the best thing that I could buy for my TRS-80 was the DECwriter LA-34. Here was a table top printer, for about the same price as a Centronics line printer, yet was a professional terminal as well. The only thing missing was the software driver enabling the LA-34 to be used as a terminal.

Though the RS-232 port from Radio Shack has a DECwriter Driver listed in the instruction manual, it is only an output driver to be used with the LPRINT command. I wanted a real I/O driver for my DECWRITER.

The Control Codes

So I sat down, chained myself to the computer and wrote the Term program that Radio Shack had announced but not yet released. The DECwriter I/O driver is broken down into several sections which I have separated with comment lines. The first section of the listing is the control codes.

Control A is used as a BREAK. The key labeled BREAK on the LA-34 transmits a .233 ms pulse which is ignored by the TRS-80. The computer decodes its own break as 01H. This is the control character SOH in ASCII and is transmitted by the CTRL A on the LA-34.

The second control character, S, was added because the TRS-80 has a habit of speeding off during the DOS PRINT command. Every time I tried to list a program from disk, the TRS-80 would outrun the LA-34 and I would lose valuable data.

Since the DECwriter can automatically transmit an X-OFF character whenever its character buffer contains over 100 characters and an X-ON when it contains less than 10, I decided to take advantage of this feature.

During the print cycle, whenever an X-OFF is received, the print routine enters a tight loop (at label X-OFF). When any character other than X-OFF is in the RS-232 data register, the loop is terminated.

During normal operation, when the register does not contain the X-OFF character, the loop is ignored. The loop can also be entered by pressing the Control S during printing and exited by pressing the carriage return.

Another control character I added, to prevent printing on the perforations of my fanfold paper, is CTR L or form feed. I added a line counter (actually Radio Shack added it in the line printer device control block, it just seems that they did not make very good use of it) and a routine (FORMFD) to generate enough line feeds to send the printer to the top of the page whenever the FF character is transmitted.

I also inserted a check for the CTR L in the keyboard routine to allow the form feed routine to be invoked manually.

The Controls 8 and I were recognized by the TRS-80 and required no special programming. So that I could have the option of using typing paper I added a loop (PLOOP for pause loop) in the form feed routine. This caused the computer to pause at the end of each page. This loop responds to a flag (PFLAG) that is set with Control P (for PAUSE) and reset with Control R (for RESET PAUSE).

Input and Output

The next sections of the program are the Equate Table and the DCB initialization. Here I set the values in all of the DCBs except the keyboard. The keyboard is initialized by going to BASIC and using the SYSTEM command to jump to KBINIT-6 (here I have used 65001—see ORG in line 600).

This is the technique used by KBFIX and is the only way I could get the keyboard to initialize. If anyone else can get the keyboard to initialize from DOS, I would be grateful to hear how you do it.

The next section performs the actual input from the DECwriter keyboard. It first checks the UART to see if it has been initialized and, if so, inputs the character. If FORM FEED and PAUSE commands are present they are acted upon; otherwise, the character is returned. The UART is then initialized—a standard routine suggested by Radio Shack in their RS-232 manual.

FFTEST begins the output routine by checking the line counter to see if the printer is within five lines of the perforation. If it is, the current character is stored and a form feed is output.

The computer next checks the status register to see if the LA-34 is ready to receive another character, then checks the data register to see if a control character has been received from the LA-34. The possible characters are X-OFF, X-ON, CTRL P and CTRL R. If one of these is detected, it is acted upon immediately, otherwise the next character is output.

After the character is output the computer checks for a line feed and a carriage return. If a line feed has been sent, the line counter is decremented and if a carriage return has been sent, a line feed is also output.

The next section contains the subroutines for decrementing the line counter, generating a form feed, setting and resetting the PLOOP flag and a loop for PLOOP to wait in.

Program Listing

```
A /NO
             ;************************************************************
             ;*                  DECWRITER I/O DRIVER                    *
             ;*    AUGUST 26,1979                   JAMES BEAUCHAMP      *
             ;*                                     2318 KENT ST         *
             ;*                                     BRYAN, TEXAS         *
             ;************************************************************
             ;      THIS IO DRIVER ALLOWS MY DEC LA-34 TO ACT AS A FULL
             ;TERMINAL TO MY TRS-80. IT ALSO TAKES CARE OF THE END OF PAGE
             ;FORM FEED AND THE LINE COUNTER.
             ;
             ; THESE CONTROL CODES HAVE THE FOLLOWING FUNCTIONS:
             ;CTRL A === BREAK
             ;CTRL S === PAUSE - THIS IS A TIGHT LOOP
             ;CTRL L === FORM FEED
             ;CTRL B === CANCEL THE LINE
             ;CRTL I === TAB
             ;CTRL P === PAUSE AT END OF PAGE ON
             ;CTRL R === PAUSE AT END OF PAGE OFF
             ;
             ;
             ;**********************************************************
             ;** EQUATE TABLE                                          *
             ;**********************************************************
             ;
4029         LINECT  EQU     4029H           ;ADDRESS OF THE LINE COUNTER
4028         PGLNTH  EQU     4028H           ;ADDRESS OF THE PAGE LENGTH
                                             ;THIS IS FROM TRSDOS
00E8         RESURT  EQU     0E8H            ;AN OUT TO THIS LOCATION RESETS
                                             ;THE UART, AN IN READS THE RS-232
                                             ;CONTROL BITS
00E9         SWITCH  EQU     0E9H            ;AN OUT TO THIS LOCATION LOADS
                                             ;THE BAUD RATE GENERATOR, AN IN
                                             ;READS THE SENSE SWITCHES
00EA         CNTREG  EQU     0EAH            ;AN OUT TO THIS LOCATION LOADS
                                             ;THE CONTROL REGISTER, AN IN
                                             ;READS THE UART STATUS REGISTER
00EB         DTAREG  EQU     0EBH            ;AN OUT TO THIS LOCATION LOADS THE
                                             ;UART XMIT HOLDING REGISTER,
                                             ;AN IN READS IN THE RECIEVED
                                             ;DATA
0010         CTRLP   EQU     020O            ;CONTROL P
0012         CTRLR   EQU     022O            ;CONTROL R
000C         CTRLL   EQU     0CH             ;CONTROL L
             ;************************************************************
             ;* DEVICE CONTROL BLOCK INITIALIZATION                      *
             ;************************************************************
401E                 ORG     16414
401E D4FE            DEFW    VIDEO
4026                 ORG     4026H           ;INITIALIZE KB DCB
4026 22FE            DEFW    DECINT
FDE9                 ORG     65001
FDE9 3A2840          LD      A,(PGLNTH)
FDEC 322940          LD      (LINECT),A
FDEF AF      KBINIT  XOR     A               ;INITIALIZE
FDF0 110A00          LD      DE,000AH        ;PUT 10 IN DE REGISTER
FDF3 CD0B00          CALL    000BH
FDF6 19              ADD     HL,DE           ;HL CONTAINS $,ADD 10 TO IT
FDF7 221640          LD      (4016H),HL      ;STORE $+10 IN KB BLOCK
FDFA CD611B          CALL    1B61H
FDFD C3191A          JP      1A19H           ;RETURN TO BASIC
             ;************************************************************
             ;* THIS SECTION INPUTS THE CHARACTER FROM THE DECWRITER.    *
             ;* IT THEN CHECKS THE CHARACTER FOR CONTROL CODES AND IF PRESENT *
             ;* IT GOES TO THE CORRECT ROUTINE. FOR INSTANCE, IF A FORM FEED *
             ;* IS RECIEVED, WE CALL FORMFD. IF CTRL P IS RECIEVED WE CALL   *
             ;* THE SETP ROUTINE. WE THEN RETURN TO THE CALLING CODE.    *
             ;************************************************************
FE00 3AD2FE  KBFIX   LD      A,(FLAG)        ;HAS UART BEEN INITIALIZED?
FE03 FE01            CP      01H
FE05 C222FE          JP      NZ,DECINT       ;INITIALIZE IT IF NOT
FE08 DBEA            IN      A,(CNTREG)      ;HAS A NEW CHARACTER BEEN SENT?
FE0A CB7F            BIT     7,A
FE0C 2812            JR      Z,RSX           ;CLEAR A AND RETURN IF NOT
FE0E DBEB            IN      A,(DTAREG)      ;ELSE GET NEW CHARACTER
FE10 FE10            CP      CTRLP           ;IS IT CTRL P
FE12 CCB0FE          CALL    Z,SETP          ;SET PAUSE FLAG IF SO
FE15 FE12            CP      CTRLR           ;IS IT CTRL R
FE17 CCB8FE          CALL    Z,RSETP         ;RESET PAUSE FLAG IF SO
FE1A FE0C            CP      CTRLL           ;IS IT CTRL L
FE1C C0              RET     NZ              ;IF NOT THEN RETURN CHARACTER
FE1D CD91FE          CALL    FORMFD          ;IF CTRL L THEN FORM FEED
FE20 AF      RSX     XOR     A               ;CLEAR A REGISTER
FE21 C9              RET                     ;AND RETURN
             ;************************************************************
             ;* THIS ROUTINE IS USED TO INITIALIZE THE RS-232 PORT. IT IS USED*
             ;* ONLY WHEN THE FLAG IS NOT SET.                           *
             ;************************************************************
FE22 E5      DECINT  PUSH    HL              ;SAVE REGISTERS
FE23 C5              PUSH    BC
FE24 F5              PUSH    AF
FE25 3AD2FE          LD      A,(FLAG)        ;CHECK FLAG TO SEE IF UART AND
                                             ;BRG HAVE BEEN INIT
FE28 FE01            CP      01H
FE2A 2820            JR      Z,RESTOR        ;RESTORE REG AND OUT CHR IF SO
FE2C 3E01            LD      A,01H
FE2E 32D2FE          LD      (FLAG),A        ;SET FLAG TO INDICATE UNIT
FE31 D3E8            OUT     (RESURT),A      ;READ 370CH TO RESET UART
FE33 DBE9            IN      A,(SWITCH)      ;READ SENSE SWITCHES
FE35 E6F8            AND     0F8H            ;LOP OFF LOWER 3 BITS
FE37 F604            OR      04H             ;RSTS RTS, RSTS DTR, SETS BRK
                                             ;IN HANDSHAKE LATCH
FE39 32D1FE          LD      (SWTING),A      ;LOAD SWTNG W/IMAGE OF LATCH
                                             ;BITS
FE3C D3EA            OUT     (CNTREG),A      ;LOAD UART W/SWITCH IMAGE
FE3E DBE9    BAUDST  IN      A,(SWITCH)      ;SET BAUD RATE ACCORDING TO
                                             ;SWITCH SELECTION
FE40 E607            AND     07H             ;LOP OFF UPPER 5 BITS
FE42 21C9FE          LD      HL,BDTABL       ;POINT TO FIRST IN BAUD TBL
FE45 0600            LD      B,00H           ;ZERO B REG
FE47 4F              LD      C,A             ;PUT OFFSET IN C
FE48 09              ADD     HL,BC           ;ADD OFFSET TO HL
FE49 7E              LD      A,(HL)          ;LOAD POINTED VALUE
FE4A D3E9            OUT     (SWITCH),A      ;LOAD BRG W/TABLE VALUE
FE4C F1      RESTOR  POP     AF
FE4D C1              POP     BC
FE4E E1              POP     HL              ;RESTORE REGISTERS
             ;************************************************************
             ;* CHECK IF AT LAST OF PAGE. IF SO THEN SAVE CHARACTER AND OUTPUT*
             ;* A FORM FEED. ELSE OUTPUT THE CHARACTER.                  *
             ;* THIS ROUTINE IS USED BY BOTH THE LPRINT COMMAND AND THE VIDEO *
             ;*DRIVER ROUTINE. IT WILL BE CALLED BY <LPRINT> AND <VIDEO>  *
             ;************************************************************
FE4F 3A2940  FFTEST  LD      A,(LINECT)      ;TEST IF END OF PAGE
FE52 FE05            CP      5               ;WITHIN 5 OF END?
FE54 C25EFE          JP      NZ,STATIN       ;OUTPUT CHARACTER IF NOT
FE57 F5              PUSH    AF
FE58 C5              PUSH    BC              ;SAVE REGISTERS
FE59 CD91FE          CALL    FORMFD          ;DO A FORM FEED IF AT END
FE5C C1              POP     BC
FE5D F1              POP     AF              ;RESTORE REGISTERS
FE5E DBEA    STATIN  IN      A,(CNTREG)      ;LOAD UART STATUS
FE60 CB77            BIT     6,A             ;TEST THREE FOR HIGH
FE62 28FA            JR      Z,STATIN        ;LOOP IF NOT
             ;************************************************************
             ;* TEST FOR CONTROL CHARACTERS ENTERED WHILE IN PRINT LOOP  *
             ;* OF YOU DON'T TEST HERE, YOU MAY BE STUCK IN A PRINTING LOOP *
             ;* FOR A LONG TIME.                                         *
             ;************************************************************
FE64 DBEB    XOFF    IN      A,(DTAREG)      ;INPUT ANY CHARACTER THE DEC SENT
FE66 FE13            CP      13H             ;CHECK IF XOFF
FE68 28FA            JR      Z,XOFF          ;LOOP IF XOFF IS BEING SENT
FE6A FE1B            CP      330             ;TEST FOR ESCAPE
FE6C CA2D40          JP      Z,402DH         ;IF SO RETURN TO DOS
FE6F FE10            CP      CTRLP           ;TEST FOR CONTROL P
FE71 CCB0FE          CALL    Z,SETP          ;IF SO ,SET PFLAG
FE74 FE12            CP      CTRLR           ;TEST FOR CONTROL R
FE76 CCB8FE          CALL    Z,RSETP         ;IF SO, RESET PFLAG
             ;************************************************************
             ;* OTHERWISE OUTPUT THE CHARACTER                           *
             ;************************************************************
FE79 79              LD      A,C             ;LOAD A W/CHAR TO BE OUTPUT
FE7A D3EB            OUT     (DTAREG),A      ;LOAD HOLDING REG W/ CHAR
FE7C FE0A            CP      0AH             ;IS IT A LINE FEED
FE7E CC8AFE          CALL    Z,LFCTR         ;IF SO DECREMENT LINE COUNT
FE81 FE0D            CP      0DH             ;IS IT A <CR> ?
FE83 2004            JR      NZ,RETRN        ;RETURN IF NOT
FE85 0E0A            LD      C,0AH           ;IF SO OUTPUT A <LF> ALSO
FE87 18D5            JR      STATIN          ;OUTPUT TO UART
FE89 C9      RETRN   RET                     ;RETURN TO CALLING CODE
             ;************************************************************
             ;*::::::::::::::::::::::::SUBROUTINES:::::::::::::::::::::::*
             ;* FORMFD === GENERATES ENOUGH LINE FEEDS TO CREATE A FORM FEED *
             ;* SETP   === SETS THE PAUSE FLAG                           *
             ;* RSETP  === RESETS THE PAUSE FLAG                         *
             ;* LFCTR  === DECREMENTS THE LINE COUNTER EVERY LINE FEED   *
             ;************************************************************
FE8A E5      LFCTR   PUSH    HL              ;SUBROUTINE TO DECREMENT THE LINE CTR
FE8B 212940          LD      HL,LINECT       ;GET LINE COUNT ADDRESS
FE8E 35              DEC     (HL)            ;DECREMENT IT
FE8F E1              POP     HL              ;RESTORE HL
FE90 C9              RET
FE91 0E0A    FORMFD  LD      C,0AH           ;GENERATE A FORM FEED
                                             ;PUT LINE FEED IN C REG
FE93 3A2940          LD      A,(LINECT)      ;GET LINES TO END OF PAGE
FE96 FE01            CP      1               ;AT BOTTOM YET?
FE98 2806            JR      Z,FFQUIT        ;QUIT IF AT BOTTOM
FE9A CD5EFE          CALL    STATIN          ;ELSE OUTPUT LINE FEED
FE9D C391FE          JP      FORMFD          ;AND DO IT AGAIN TILL DONE
FEA0 3A2840  FFQUIT  LD      A,(PGLNTH)      ;IF DONE GET PAGE LENGTH
FEA3 322940          LD      (LINECT),A      ;MOVE IT TO LINE COUNT
FEA6 3AD3FE          LD      A,(PFLAG)       ;CHECK PAUSE FLAG
FEA9 FEFF            CP      0FFH            ;IS IT FFH?
FEAB 2813            JR      Z,PLOOP         ;LOOP IF SET
FEAD C389FE          JP      RETRN           ;ELSE RETURN
FEB0 F5      SETP    PUSH    AF              ;SUBROUTINE TO SET PAUSE FLAG
```

Program continued

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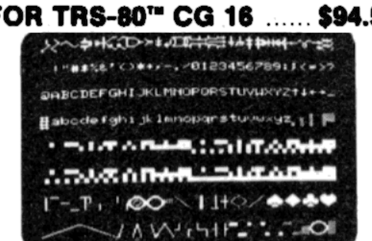

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The baud rate and variable table are explained in the Radio Shack RS-232 users manual. The last section is the housekeeping routine to return to the video driver.

If you have added lowercase to your TRS-80, remove lines 2400 thru 2420 and all of the proper conversions will be made.

Conclusion

The only problem I have encountered is that the editor assembler uses upper memory to store its symbol reference table and a large table will wipe out the driver. It will also wipe out any other routines that you have in upper memory—so beware!

I invoke this routine with SYSTEM /65001 on my computer, but if you have smaller memory, change the ORG in line 600. This is the address you will use to enable the keyboard.

One last word about this program and assembly language programming on the TRS-80. If you have a disk, but have not bought the Apparat Editor/Assembler patches, you are not realizing the full potential of your TRS-80. The only problem is the lack of a memory size command at assembly to protect the drivers. ■

Continued Program

```
FEB1 3EFF      01950          LD      A,0FFH          ;PUT FF IN A
FEB3 32D3FE    01960          LD      (PFLAG),A       ;PUT IT IN PAUSE FLAG
FEB6 F1        01970          POP     AF
FEB7 C9        01980          RET                     ;RETURN TO CALLING CODE
FEB8 F5        01990 RSETP    PUSH    AF              ;ROUTINE TO RESET PAUSE FLAG
FEB9 3E00      02000          LD      A,0             ;GET 0 IN A REG
FEBB 32D3FE    02010          LD      (PFLAG),A       ;STORE 0 IN PAUSE FLAG
FEBE F1        02020          POP     AF
FEBF C9        02030          RET                     ;RETURN TO CALLING CODE
FEC0 DBEB      02040 PLOOP    IN      A,(DTAREG)      ;PAUSE LOOP, GET LAST KEY HIT
FEC2 FE0D      02050          CP      0DH             ;WAS IT A <CR>
FEC4 20FA      02060          JR      NZ,PLOOP        ;IF NOT LOOP
FEC6 C389FE    02070          JP      RETRN           ;WHEN <CR> HIT, THEN RETURN
               02080 ;*****************************************************************
               02090 ;* BAUD RATE AND VARIABLE TABLE                                  *
               02100 ;*****************************************************************
FEC9 22        02110 BDTABL   DEFB    22H             ;110 BAUD
FECA 44        02120          DEFB    44H             ;150 BAUD
FECB 55        02130          DEFB    55H             ;300 BAUD
FECC 66        02140          DEFB    66H             ;600 BAUD
FECD 77        02150          DEFB    77H             ;1200 BAUD
FECE AA        02160          DEFB    0AAH            ;2400 BAUD
FECF CC        02170          DEFB    0CCH            ;4800 BAUD
FED0 EE        02180          DEFB    0EEH            ;9600 BAUD
FED1 00        02190 SWTING   DEFB    00H             ;IMAGE OF HANDSHAKE LATCH
FED2 00        02200 FLAG     DEFB    00H             ;FLAG TO INDICATE INITIALIZATION
FED3 00        02210 PFLAG    DEFB    00              ;PAUSE FLAG
```

```
               02220 ;*****************************************************************
               02230 ;* THIS IS THE VIDEO DRIVER. DON'T FORGET TO DO THE DEC OUT.     *
               02240 ;*****************************************************************
FED4 F5        02250 VIDEO    PUSH    AF
FED5 C5        02260          PUSH    BC
FED6 E5        02270          PUSH    HL              ;SAVE REGISTERS
FED7 CD22FE    02280          CALL    DECINT          ;OUTPUT CHARACTER TO DECWRITER
FEDA E1        02290          POP     HL
FEDB C1        02300          POP     BC
FEDC F1        02310          POP     AF              ;RESTORE REGISTERS
FEDD DD6E03    02320          LD      L,(IX+3)
FEE0 DD6604    02330          LD      H,(IX+4)
FEE3 DA9A04    02340          JP      C,049AH
FEE6 DD7E05    02350          LD      A,(IX+5)
FEE9 B7        02360          OR      A
FEEA 2801      02370          JR      Z,VID1
FEEC 77        02380          LD      (HL),A
FEED 79        02390 VID1     LD      A,C
FEEE FE60      02400          CP      60H             ;CONVERT LOWER TO UPPER CASE
FEF0 FAF5FE    02410          JP      M,VID2          ;REMOVE THESE THREE LINES
FEF3 E65F      02420          AND     5FH             ;IF YOU HAVE THE LOWER CASE MOD
FEF5 FE20      02430 VID2     CP      20H
FEF7 DA0605    02440          JP      C,0506H
FEFA FE80      02450          CP      80H
FEFC D2A604    02460          JP      NC,04A6H
FEFF C37D04    02470          JP      047DH
402D           02480          END     402DH
00000 TOTAL ERRORS
BAUDST FE3E 01140
BDTABL FEC9 02110   01170
CNTREG 00EA 00430   00800 01130 01400
CTRLL  000C 00520   00880
CTRLP  0010 00500   00840 01530
CTRLR  0012 00510   00860 01550
DECINT FE22 00970   00590 00790 02280
DTAREG 00EB 00460   00830 01480 01610 02040
FFQUIT FEA0 01880   01850
FFTEST FE4F 01320
FLAG   FED2 02200   00770 01000 01050
FORMFD FE91 01810   00900 01370 01870
KBFIX  FE00 00770
KBINIT FDEF 00630
LFCTR  FE8A 01760   01630
LINECT 4029 00340   00620 01320 01770 01830 01890
PFLAG  FED3 02210   01900 01960 02010
PGLNTH 4028 00350   00610 01880
PLOOP  FEC0 02040   01920 02060
RESTOR FE4C 01230   01030
RESURT 00E8 00370   01060
RETRN  FE89 01680   01650 01930 02070
RSETP  FEB8 01990   00870 01580
RSX    FE20 00810   00820
SETP   FEB0 01940   00850 01540
STATIN FE5E 01400   01340 01420 01670 01860
SWITCH 00E9 00400   01070 01140 01220
SWTING FED1 02190   01110
VID1   FEED 02390   02370
VID2   FEF5 02430   02410
VIDEO  FED4 02250   00570
XOFF   FE64 01480   01500
```


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A guessing game, where the computers recognize patterns!

True or False?

John Krutch
P.O. Box 9284
Fort Worth, TX 76107

The subject of artificial intelligence seems to fascinate everyone, computer scientists and the general public alike. Public interest in AI is amply demonstrated by the popularity of such movies as *The Forbin Project* and *The Demon Seed*. (Both of them are shallow and unimaginative; for a much more thoughtful presentation, see the computer-psychiatrist in science fiction writer Frederik Pohl's fine novel, Gateway.)

Computer scientists, like Terry Winograd and Peter Woods, are hard at work developing programs that someday, perhaps, will make these fictional portraits a reality.

Most of the programs are written for big computers with 32-bit processors and elephant-like main memories. Smaller, but interesting AI programs can be written for 8-bit processors with modest amounts of memory. The TF program I describe in this article is one of them.

How the Game Works

TF is a sort of prediction game. The program tries to predict what the player is going to do next, based on its observation of his past behavior.

The player types in the letter T or the letter F at random. The program must figure out which letter the player plans to type next. The program assumes that a person's behavior is never *truly* random. No matter how many times the player tries to arbitrarily respond, certain patterns, of which he himself may be unaware, surface in his actions. The program carefully stores each response, whether T or F, and searches for patterns in the player's behavior. If it finds a particular pattern that occurs again later, the program finds itself in a position to make a prediction.

TF is written in Radio Shack Level II BASIC. It requires 16K RAM in its present version, but it can be converted to a 4K machine without too much effort. The program stores the first four characters the player types in order to make its prediction. The character that the player types is known as the "current event." (This terminology is adopted from AI researcher John H. Andreae of New Zealand, although the program itself is not derived from Andreae's work.)

Starting with the fifth current event, TF makes its first prediction by displaying the character it has established the player will choose. The player must wait a second or two for the command READY to appear before typing another character.

The keys you strike do not appear on the display. The letter that shows on the screen after you press a key is the computer's prediction. The program keeps a running score of

Program Listing 1.

```
10 '            INITIALIZATION
20 RANDOM
30 DEFINT C,E,F,I,Q,R,T
40 DEFSTR A
50 DIM Q(1111,2)
60 CNTXTLNGTH = 4
70 CLS

100 '            MAIN PROGRAM
110   FOR I = 1 TO CNTXTLNGTH
120   GOSUB 500      ' INPUT SUBROUTINE
130   CRNTCNTEXT(I) = EVENTCODE
140   NEXT I
150 GOSUB 500      ' INPUT SUBROUTINE
160 GOSUB 800      ' PRINTING AND SCOREKEEPING SUBROUTINE
170 GOSUB 600      ' LOCATION-CALCULATING SUBROUTINE
180 IF EVENTCODE = 1 THEN Q(LO,1) = Q(LO,1) + 1 ELSE
    Q(LO,2) = Q(LO,2) + 1
190 GOSUB 700      ' CURRENT CONTEXT UPDATING SUBROUTINE
200 GOSUB 600      ' LOCATION-CALCULATING SUBROUTINE
210 GOTO 150

500 '            INPUT SUBROUTINE
510 PRINT@ 412, "READY"
520 CURRENTEVENT$ = INKEY$: IF CURRENTEVENT$ = "T" OR
    CURRENTEVENT$ = "F" THEN 530 ELSE 520
530 IF CURRENTEVENT$ = "T" THEN EVENTCODE = 1: GOTO 550
540 IF CURRENTEVENT$ = "F" THEN EVENTCODE = 0: GOTO 550
550 CLS
560 RETURN

600 '            LOCATION-CALCULATING SUBROUTINE
610 A = ""
620   FOR I = 1 TO CNTXTLNGTH
630   A = A + MID$(STR$(CRNTCNTEXT(I)),2)
640   NEXT I
650 LO = VAL(A)
660 RETURN

700 '            CURRENT CONTEXT UPDATING SUBROUTINE
710   FOR I = 1 TO 3
720   CRNTCNTEXT(I) = CRNTCNTEXT(I + 1)
730   NEXT I
740 CRNTCNTEXT(4) = EVENTCODE
750 RETURN

800 '            PRINTING AND SCOREKEEPING SUBROUTINE
810 IF Q(LO,1) > Q(LO,2) THEN TF$ = "T": T = T + 1:
    PRINT@ 350, TF$: GOTO 860
820 IF Q(LO,2) > Q(LO,1) THEN TF$ = "F": F = F + 1:
    PRINT@ 350, TF$: GOTO 860
830 RAN = RND(2)
840 IF RAN = 1 THEN TF$ = "T": T = T + 1: PRINT@ 350, TF$
850 IF RAN = 2 THEN TF$ = "F": F = F + 1: PRINT@ 350, TF$
860 IF TF$ = CURRENTEVENT$ THEN RIGHT = RIGHT + 1
870 PRINT@ 512, "TOTAL NUMBER OF ENTRIES:     "; T + F
880 PRINT@ 576, "NUMBER OF CORRECT PRE-"
890 PRINT@ 641, "DICTIONS BY THE COMPUTER:    "; RIGHT
900 PRINT@ 704, "PERCENT OF CORRECT PRE-"
910 PRINT@ 769, "DICTIONS BY THE COMPUTER:    ";
    INT(((RIGHT / (T + F)) * 100) * 10 + .5) / 10; "%"
920 RETURN
```

how well it's doing.

How does TF make its predictions? Each time the player types in a letter, TF examines the "current context"—the last four letters you've typed, including the one you just entered. The length of this context is four. That is the value assigned in line 60, but you can experiment with other values.

Suppose you type the letter T. Assume that the three previous characters were T, F and F. The program consults array Q to see what you did in the past when the combination TFFT came up.

For example, if you typed T six times and F twice after the pattern TFFT first appeared, the program predicts that the next character you will type is T. If you have typed T and F an equal number of times after a particular pattern, the program generates a random T or F as its new prediction.

Each time you type in a new letter, TF eagerly codes it (T = 1, F = 0) and stores it as data. The storage structure set up in line 50 is a 1111 X 2 array. The vast majority of the elements in this array go unused. It's done this way only for convenience.

The program consists of six modules, shown in Listing 1. An initialization routine takes care of some housekeeping, followed by the main program and four subroutines.

The REMark statements are intended to help you understand TF, but they can be omitted when typing the program. The long variable names can be abbreviated to the first two letters of the name without damage to the program. However, if the variable name contains the $ character, this must be included in the abbreviation. For instance, CURRENTEVENT$ must be typed in either as CU$ or in its entirety.

Incidentally, variable A in line 610 is set to the empty string, not to a blank. The confusion sometimes produced when double quotation marks are printed is one of the few defects of Radio Shack's Line Printer III. ■

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Learn about assembly language by "looking" into the Z-80.

Assembly Language Trainer

William L. Colsher
4328 Nutmeg Lane, Apt. 111
Lisle, IL 60532

Sooner or later, most hobbyists get the urge to learn assembly language. Unfortunately, many never get any further. They've heard that assembler is hard to learn, that only advanced programmers use it, and that it is only good for bit twiddling.

Actually, assembly language is no more difficult than any other programming language—it just takes a slightly different mind set. One must think not only about solving the problem at hand, but also about what is physically going on inside the computer.

Because nothing stands between your program and your computer's CPU, assembler programs can be very fast. Real-time games with animated graphics come to mind as a case where fast execution is critical. If you have any devices like coffee pots or furnaces you plan to use as peripherals, chances are you'll want to use assembler programs to control them.

I can't teach you assembler in a single article. I can give you a tool—the TRS-80 Trainer—to make learning assembler a little easier. It is an assembler program that will run with changes to the I/O on any Z-80 computer, not just the TRS-80. The program instantly shows the result of nearly all the machine instructions which you're likely to find troublesome.

Getting the Program to Run

Obviously, you'll need an assembler. This is a not-so-subtle technique to get you into using assembly language quickly. This particular program is written for the Radio Shack Editor/Assembler, so you'll need to run out and buy one.

If you already have another assembler, you may have to make some changes in the code. They shouldn't be major, though. You'll also need a Level II TRS-80 with at least 16K.

All the information on getting the Editor/Assembler running is included in the Radio Shack manual. Since it is a system format tape you may have some trouble loading it. Be patient and keep turning the volume *down*. Some of the information about using the assembler won't make too much sense at first, but things should seem more clear after you've started to type in the program.

While you're typing the program, you'll be glad to know that the spaces in the code listing are actually tabs—the right-arrow on the keyboard. Naturally, spaces that are inside quotes are actually spaces. Just as in BASIC, comments can be deleted, but really shouldn't be.

Because this program uses many symbols, assemble it with the "/NS" option. This suppresses the symbol table, and you can see how many typos you make. When the symbol table is displayed on the screen, it scrolls the error count off.

Once the program is error free, follow the instructions in the Editor/Assembler manual for creating a tape. Make sure you save the *source* with the "W" command as well.

Using the TRS-80 Trainer

You're now ready to run the TRS-80 Trainer. Your system format tape should have the TRS-80 Trainer on it. Fig. 1 shows how to load the tape and start up the program.

Displayed on Monitor	Comments
MEMORY SIZE? (cr)	
RADIO SHACK LEVEL II BASIC	
READY	
>SYSTEM (cr)	Puts the computer into system mode and allows it to read machine language tapes put out by the Assembler.
*? TRAIN (cr)	"TRAIN" is the name I used for the program when I assembled it.
*? /17152 (cr)	17152 is the decimal address of the first instruction in the Trainer. When you press ENTER the Trainer display comes on. (See Fig. 2.)

Fig. 1. How to load the TRS-80 Trainer.

```
A – 00000000 00   F – 00000000 00   A1 – 00000000 00   F1 – 00000000 00
B – 00000000 00   C – 00000000 00   B1 – 00000000 00   C1 – 00000000 00
D – 00000000 00   E – 00000000 00   D1 – 00000000 00   E1 – 00000000 00
H – 00000000 00   L – 00000000 00   H1 – 00000000 00   L1 – 00000000 00

            I – 00000000 00   R – 00000000 00
              IX – 0000000000000000 0000
              IY – 0000000000000000 0000
                    INSTRUCTION:

Display format: Register name
                Binary representation of register contents
                Hexadecimal representation of register contents.
```

Fig. 2. TRS-80 Trainer Display.

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Your display (Fig. 2) shows all the Z-80's registers, except the stack pointer and program counter. They are all initialized to zero to make it easy to see the effects of the instructions you type.

At this point, I caution you: It is quite simple to blow up the Trainer. Entering jump instructions will do it, as will messing with the stack pointer. Storing things in RAM, where the program is (4300_{16} through 4760_{16}) can foul things up, too.

To use the Trainer, you have to know what kinds of input it accepts. There are exactly three. The hexadecimal digits zero through nine and letters A through F form allowable machine instructions. Secondly, the ENTER key tells the computer you want something EXECUTED. The third is the exclamation mark. If you make a typing error, press the "!", and your input will be erased. If you enter less than five bytes of machine instruction, you have to press ENTER to make the program execute them. Table 1 reviews these commands.

You've already seen that the Trainer sets all the registers to zero when you start out. With this in mind, type 3E01. Now press ENTER. You'll notice that the A register in the upper left hand corner of the display now contains a one. In this example, 3E is the machine code for "load the next byte into the A register". Of course, the byte this time is 01.

Now type in 0601 and press ENTER. A one appears in the B register. Type 80 and press ENTER. 80 is the machine instruction for "ADD the contents of register B to register A." If all is well, there should be two in register A.

With the TRS-80 Trainer you can enter up to five bytes of machine code at once. This example loads register A with five, register B with six and then adds the two. Note that as soon as you type the final zero, the computer displays the results. Try this by typing: 3E05060680.■

Input	Function/Use
!	Erases current instruction. Use it when you make a typing mistake.
ENTER	Signals the computer to execute the current instruction. If the instruction you have typed uses five bytes, the enter is not needed.
0-9, A-F	The hexadecimal digits used to input instructions to the TRS-80 Trainer.

Table 1. TRS-80 Trainer Input.

Program Listing

```
4300                  ORG     4300H
4300 210050           LD      HL,SCRBUF
4303 110150           LD      DE,SCRBUF+1
4306 010004           LD      BC,400H
4309 3620             LD      (HL),20H
430B EDB0             LDIR
430D 215546           LD      HL,TEXT
4310 111950           LD      DE,SCRBUF+25
4313 010E00           LD      BC,0EH
4316 EDB0             LDIR
4318 115353           LD      DE,SCRBUF+851
431B 010C00           LD      BC,0CH
431E EDB0             LDIR
4320 216F46           LD      HL,L1
4323 118050           LD      DE,SCRBUF+128
4326 013400           LD      BC,52
4329 EDB0             LDIR
432B 11C050           LD      DE,SCRBUF+192
432E 013400           LD      BC,52
4331 EDB0             LDIR
4333 110051           LD      DE,SCRBUF+256
4336 013400           LD      BC,52
4339 EDB0             LDIR
433B 114051           LD      DE,SCRBUF+320
433E 013400           LD      BC,52
4341 EDB0             LDIR
4343 11D351           LD      DE,SCRBUF+467
4346 011100           LD      BC,17
4349 EDB0             LDIR
434B 115452           LD      DE,SCRBUF+596
434E 010300           LD      BC,03H
4351 EDB0             LDIR
4353 119452           LD      DE,SCRBUF+660
4356 010300           LD      BC,03H
4359 EDB0             LDIR
                ;THIS CODE PUTS USER REG VALUES IN THE DISPLAY
435B CD4145     SHOW  CALL    HEXR    ;DISPLAY HEX VALUES
                ;REST OF CODE DOES BINARY VALUES
435E 218350           LD      HL,SCRBUF+131
4361 3A3E46           LD      A,(SA)
4364 CD2346           CALL    DISPR
4367 219350           LD      HL,SCRBUF+147
436A 3A3D46           LD      A,(SF)
436D CD2346           CALL    DISPR
4370 21C350           LD      HL,SCRBUF+195
4373 3A4046           LD      A,(SB)
4376 CD2346           CALL    DISPR
4379 21D350           LD      HL,SCRBUF+211
437C 3A3F46           LD      A,(SC)
437F CD2346           CALL    DISPR
4382 210351           LD      HL,SCRBUF+259
4385 3A4246           LD      A,(SD)
4388 CD2346           CALL    DISPR
438B 211351           LD      HL,SCRBUF+275
438E 3A4146           LD      A,(SE)
4391 CD2346           CALL    DISPR
4394 214351           LD      HL,SCRBUF+323
4397 3A4446           LD      A,(SH)
439A CD2346           CALL    DISPR
439D 215351           LD      HL,SCRBUF+339
43A0 3A4346           LD      A,(SL)
43A3 CD2346           CALL    DISPR
43A6 21A450           LD      HL,SCRBUF+164
43A9 3A4646           LD      A,(SA1)
43AC CD2346           CALL    DISPR
43AF 21B450           LD      HL,SCRBUF+180
43B2 3A4546           LD      A,(SF1)
43B5 CD2346           CALL    DISPR
43B8 21E450           LD      HL,SCRBUF+228
43BB 3A4846           LD      A,(SB1)
43BE CD2346           CALL    DISPR
43C1 21F450           LD      HL,SCRBUF+244
43C4 3A4746           LD      A,(SC1)
43C7 CD2346           CALL    DISPR
43CA 212451           LD      HL,SCRBUF+292
43CD 3A4A46           LD      A,(SD1)
43D0 CD2346           CALL    DISPR
43D3 213451           LD      HL,SCRBUF+308
43D6 3A4946           LD      A,(SE1)
43D9 CD2346           CALL    DISPR
43DC 216451           LD      HL,SCRBUF+356
43DF 3A4C46           LD      A,(SH1)
43E2 CD2346           CALL    DISPR
43E5 217451           LD      HL,SCRBUF+372
43E8 3A4B46           LD      A,(SL1)
43EB CD2346           CALL    DISPR
43EE 21D551           LD      HL,SCRBUF+469
43F1 3A5346           LD      A,(SI)
43F4 CD2346           CALL    DISPR
43F7 21E451           LD      HL,SCRBUF+484
43FA 3A5446           LD      A,(SR)
43FD CD2346           CALL    DISPR
4400 215752           LD      HL,SCRBUF+599
4403 3A4E46           LD      A,(SIX+1)
4406 CD2346           CALL    DISPR
4409 215F52           LD      HL,SCRBUF+607
440C 3A4D46           LD      A,(SIX)
440F CD2346           CALL    DISPR
4412 219752           LD      HL,SCRBUF+663
4415 3A5046           LD      A,(SIY+1)
4418 CD2346           CALL    DISPR
441B 219F52           LD      HL,SCRBUF+671
441E 3A4F46           LD      A,(SIY)
4421 CD2346           CALL    DISPR
4424 CD0846           CALL    MOVE    ;MOVE DISPLAY TO SCREEN
                ;THIS SETS UP FOR ACCEPTING AN INSTRUCTION
                ;HL -> DISPLAY AREA, DE -> EXECUTE B IS MAX BYTES
4427 21603F           LD      HL,SCRTOP+864
442A 115947           LD      DE,INSTR
442D 0605             LD      B,5
442F C5         READ  PUSH    BC
4430 CD9A44           CALL    HXIN    ;READ ONE HEX BYTE
4433 C1               POP     BC
4434 DA3B44           JP      C,FINIS
4437 12               LD      (DE),A
4438 13               INC     DE
4439 10F4             DJNZ    READ
                ;NEXT CODE GETS USER REGS SET UP
443B ED735146   FINIS LD      (SSP),SP
443F 313D46           LD      SP,SF
4442 3A5346           LD      A,(SI)
4445 ED47             LD      I,A
4447 3A5446           LD      A,(SR)
444A ED4F             LD      R,A
444C F1               POP     AF
444D C1               POP     BC
444E D1               POP     DE
444F E1               POP     HL
4450 08               EX      AF,AF'
4451 D9               EXX
4452 F1               POP     AF
4453 C1               POP     BC
4454 D1               POP     DE
4455 E1               POP     HL
4456 08               EX      AF,AF'
4457 D9               EXX
4458 DDE1             POP     IX
445A FDE1             POP     IY
445C ED7B5146         LD      SP,(SSP)
4460 CD5947           CALL    INSTR   ;EXECUTE USER INSTRUCTION
                ;NEXT CODE SAVES USER REGS
4463 ED735146         LD      (SSP),SP
4467 315146           LD      SP,SIY+2
446A FDE5             PUSH    IY
446C DDE5             PUSH    IX
446E 08               EX      AF,AF'
446F D9               EXX
4470 E5               PUSH    HL
4471 D5               PUSH    DE
4472 C5               PUSH    BC
4473 F5               PUSH    AF
4474 08               EX      AF,AF'
4475 D9               EXX
4476 E5               PUSH    HL
4477 D5               PUSH    DE
4478 C5               PUSH    BC
```

Program continues

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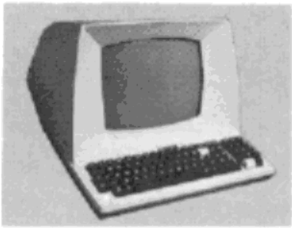

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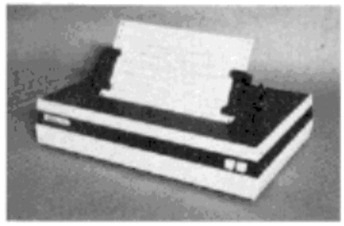

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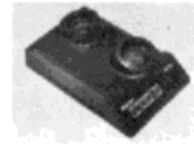

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Program continued

```
4479 F5       01700        PUSH    AF
447A ED57     01710        LD      A,I
447C 325346   01720        LD      (SI),A
447F ED5F     01730        LD      A,R
4481 325446   01740        LD      (SR),A
4484 ED7B5146 01750        LD      SP,(SSP)
4488 3E00     01760 CLEAR  LD      A,0      ;CLEAR USER INSTRUCTION AREA
448A 215947   01770        LD      HL,INSTR
448D 115A47   01780        LD      DE,INSTR+1
4490 010400   01790        LD      BC,4
4493 3600     01800        LD      (HL),0
4495 EDB0     01810        LDIR
4497 C35B43   01820        JP      SHOW     ;CONTINUE
              01830 ;THIS CODE ACCEPTS ONE HEXADECIMAL BYTE
              01840 ;A CARRIAGE RETURN ENDS CURRENT INSTRUCTION
449A CDD544   01850 HXIN   CALL    CHAR
449D FE0D     01860        CP      0DH
449F CACE44   01870        JP      Z,SETLST
44A2 32D344   01880        LD      (C1),A
44A5 CDD544   01890        CALL    CHAR
44A8 FE0D     01900        CP      0DH
44AA CACE44   01910        JP      Z,SETLST
44AD 32D444   01920        LD      (C2),A
44B0 3AD344   01930        LD      A,(C1)
44B3 CD0545   01940        CALL    HEXIT
44B6 CB27     01950        SLA     A
44B8 CB27     01960        SLA     A
44BA CB27     01970        SLA     A
44BC CB27     01980        SLA     A
44BE F5       01990        PUSH    AF
44BF 3AD444   02000        LD      A,(C2)
44C2 CD0545   02010        CALL    HEXIT
44C5 C1       02020        POP     BC
44C6 80       02030        ADD     A,B
44C7 47       02040        LD      B,A
44C8 3E00     02050        LD      A,0
44CA CB27     02060        SLA     A
44CC 78       02070        LD      A,B
44CD C9       02080        RET
44CE 3EFF     02090 SETLST LD      A,0FFH
44D0 CB27     02100        SLA     A
44D2 C9       02110        RET
44D3 00       02120 C1     DEFB    0
44D4 00       02130 C2     DEFB    0
              02140 ;THIS CODE CALLS R.S. KEYBOARD ROUTINE
44D5 D5       02150 CHAR   PUSH    DE
44D6 FDE5     02160        PUSH    IY
44D8 CD2B00   02170 AGN    CALL    2BH
44DB B7       02180        OR      A
44DC 28FA     02190        JR      Z,AGN
              02200 ;IF NONZERO MAKE SURE IT'S HEX OR CR
44DE FDE1     02210        POP     IY
44E0 D1       02220        POP     DE
44E1 FE0D     02230        CP      0DH
44E3 CA0445   02240        JP      Z,RET2
44E6 FE21     02250        CP      21H
44E8 CA0F45   02260        JP      Z,KILLIT
44EB FE30     02270        CP      30H
44ED FAD544   02280        JP      M,CHAR
44F0 FE3A     02290        CP      3AH
44F2 F2F844   02300        JP      P,TRY41
44F5 FA0245   02310        JP      M,RET1
44F8 FE41     02320 TRY41  CP      41H
44FA FAD544   02330        JP      M,CHAR
44FD FE47     02340        CP      47H
44FF F2D544   02350        JP      P,CHAR
4502 77       02360 RET1   LD      (HL),A
4503 23       02370        INC     HL
4504 C9       02380 RET2   RET
4505 FE40     02390 HEXIT  CP      40H
4507 FA0C45   02400        JP      M,ZAPHI
450A C609     02410        ADD     A,9
450C E60F     02420 ZAPHI  AND     0FH
450E C9       02430        RET
450F F1       02440 KILLIT POP     AF
4510 F1       02450        POP     AF
4511 C38844   02460        JP      CLEAR
4514 7E       02470 HEXOUT LD      A,(HL)
4515 F5       02480        PUSH    AF
4516 CB3F     02490        SRL     A
4518 CB3F     02500        SRL     A
451A CB3F     02510        SRL     A
451C CB3F     02520        SRL     A
451E FE0A     02530        CP      0AH
4520 F22845   02540        JP      P,A1
4523 EE30     02550        XOR     30H
4525 C32C45   02560        JP      ST1
4528 D609     02570 A1     SUB     9
452A EE40     02580        XOR     40H
452C 12       02590 ST1    LD      (DE),A
452D 13       02600        INC     DE
452E F1       02610        POP     AF
452F E60F     02620        AND     0FH
4531 FE0A     02630        CP      10
4533 F23B45   02640        JP      P,A2
4536 EE30     02650        XOR     30H
4538 C33F45   02660        JP      ST2
453B D609     02670 A2     SUB     9
453D EE40     02680        XOR     40H
453F 12       02690 ST2    LD      (DE),A
4540 C9       02700        RET
              02710 ;NEXT CODE DOES HEX REGISTER DISPLAY
4541 213E46   02720 HEXR   LD      HL,SA
4544 118C50   02730        LD      DE,SCRBUF+140
4547 CD1445   02740        CALL    HEXOUT
454A 213D46   02750        LD      HL,SF
454D 119C50   02760        LD      DE,SCRBUF+156
4550 CD1445   02770        CALL    HEXOUT
4553 214646   02780        LD      HL,SA1
4556 11AD50   02790        LD      DE,SCRBUF+173
4559 CD1445   02800        CALL    HEXOUT
455C 214546   02810        LD      HL,SF1
455F 11BD50   02820        LD      DE,SCRBUF+189
4562 CD1445   02830        CALL    HEXOUT
4565 214046   02840        LD      HL,SB
4568 11CC50   02850        LD      DE,SCRBUF+204
456B CD1445   02860        CALL    HEXOUT
456E 213F46   02870        LD      HL,SC
4571 11DC50   02880        LD      DE,SCRBUF+220
4574 CD1445   02890        CALL    HEXOUT
4577 214846   02900        LD      HL,SB1
457A 11ED50   02910        LD      DE,SCRBUF+237
457D CD1445   02920        CALL    HEXOUT
4580 214746   02930        LD      HL,SC1
4583 11FD50   02940        LD      DE,SCRBUF+253
4586 CD1445   02950        CALL    HEXOUT
4589 214246   02960        LD      HL,SD
458C 110C51   02970        LD      DE,SCRBUF+268
458F CD1445   02980        CALL    HEXOUT
4592 214146   02990        LD      HL,SE
4595 111C51   03000        LD      DE,SCRBUF+284
4598 CD1445   03010        CALL    HEXOUT
459B 214A46   03020        LD      HL,SD1
459E 112D51   03030        LD      DE,SCRBUF+301
45A1 CD1445   03040        CALL    HEXOUT
45A4 214946   03050        LD      HL,SE1
45A7 113D51   03060        LD      DE,SCRBUF+317
45AA CD1445   03070        CALL    HEXOUT
45AD 214446   03080        LD      HL,SH
45B0 114C51   03090        LD      DE,SCRBUF+332
45B3 CD1445   03100        CALL    HEXOUT
45B6 214346   03110        LD      HL,SL
45B9 115C51   03120        LD      DE,SCRBUF+348
45BC CD1445   03130        CALL    HEXOUT
45BF 214C46   03140        LD      HL,SH1
45C2 116D51   03150        LD      DE,SCRBUF+365
45C5 CD1445   03160        CALL    HEXOUT
45C8 214B46   03170        LD      HL,SL1
45CB 117D51   03180        LD      DE,SCRBUF+381
45CE CD1445   03190        CALL    HEXOUT
45D1 215346   03200        LD      HL,SI
45D4 11DE51   03210        LD      DE,SCRBUF+478
45D7 CD1445   03220        CALL    HEXOUT
45DA 215446   03230        LD      HL,SR
45DD 11ED51   03240        LD      DE,SCRBUF+493
45E0 CD1445   03250        CALL    HEXOUT
45E3 214E46   03260        LD      HL,SIX+1
45E6 116852   03270        LD      DE,SCRBUF+616
45E9 CD1445   03280        CALL    HEXOUT
45EC 214D46   03290        LD      HL,SIX
45EF 116A52   03300        LD      DE,SCRBUF+618
45F2 CD1445   03310        CALL    HEXOUT
45F5 215046   03320        LD      HL,SIY+1
45F8 11A852   03330        LD      DE,SCRBUF+680
45FB CD1445   03340        CALL    HEXOUT
45FE 214F46   03350        LD      HL,SIY
4601 11AA52   03360        LD      DE,SCRBUF+682
4604 CD1445   03370        CALL    HEXOUT
4607 C9       03380        RET
              03390 ;THIS CODE MOVES SCREEN BUFFER TO R.S. SCREEN AREA
4608 210050   03400 MOVE   LD      HL,SCRBUF
460B 11003C   03410        LD      DE,3C00H
460E 010004   03420        LD      BC,400H
4611 EDB0     03430        LDIR
4613 C9       03440        RET
4614 215947   03450        LD      HL,INSTR
4617 115A47   03460        LD      DE,INSTR+1
461A 010400   03470        LD      BC,4
461D 3E00     03480        LD      A,0
461F 77       03490        LD      (HL),A
4620 EDB0     03500        LDIR
4622 C9       03510        RET
              03520 ;THIS CODE DOES BINARY REGISTER DISPLAY
4623 0608     03530 DISPR  LD      B,08H
4625 CB27     03540 SHIFT  SLA     A
4627 D43146   03550        CALL    NC,ZERO
462A DC3746   03560        CALL    C,ONE
462D 23       03570        INC     HL
462E 10F5     03580        DJNZ    SHIFT
4630 C9       03590        RET
4631 F5       03600 ZERO   PUSH    AF
4632 3E30     03610        LD      A,30H
4634 77       03620        LD      (HL),A
4635 F1       03630        POP     AF
4636 C9       03640        RET
4637 F5       03650 ONE    PUSH    AF
4638 3E31     03660        LD      A,31H
463A 77       03670        LD      (HL),A
463B F1       03680        POP     AF
463C C9       03690        RET
              03700 ;NEXT ARE USER REG STORAGE AREAS
463D 00       03710 SF     DEFB    0
463E 00       03720 SA     DEFB    0
463F 00       03730 SC     DEFB    0
4640 00       03740 SB     DEFB    0
4641 00       03750 SE     DEFB    0
4642 00       03760 SD     DEFB    0
4643 00       03770 SL     DEFB    0
4644 00       03780 SH     DEFB    0
4645 00       03790 SF1    DEFB    0
4646 00       03800 SA1    DEFB    0
4647 00       03810 SC1    DEFB    0
4648 00       03820 SB1    DEFB    0
4649 00       03830 SE1    DEFB    0
464A 00       03840 SD1    DEFB    0
464B 00       03850 SL1    DEFB    0
464C 00       03860 SH1    DEFB    0
464D 0000     03870 SIX    DEFW    0
464F 0000     03880 SIY    DEFW    0
4651 0000     03890 SSP    DEFW    0
4653 00       03900 SI     DEFB    0
4654 00       03910 SR     DEFB    0
              03920 ;FOLLOWING DEFINES SCREEN DISPLAY
4655 54       03930 TEXT   DEFM    'TRS-80 TRAINERINSTRUCTION:'
5000          03940 SCRBUF EQU     5000H
466F 41       03950 L1     DEFM    'A -        F -        A1-        F1-'
46A3 42       03960        DEFM    'B -        C -        B1-        C1-'
46D7 44       03970        DEFM    'D -        E -        D1-        E1-'
470B 48       03980        DEFM    'H -        L -        H1-        L1-'
473F 49       03990        DEFM    'I-                R-'
4750 49       04000        DEFM    'IX-IY-SP-'
4759 0000     04010 INSTR  DEFW    0
475B 0000     04020        DEFW    0
475D 00       04030        DEFB    0
475E C9       04040        DEFB    0C9H
3C00          04050 SCRTOP EQU     3C00H
0000          04060        END
00000 TOTAL ERRORS


A1      4528 02570   02540
A2      453B 02670   02640
AGN     44D8 02170   02190
C1      44D3 02120   01880 01930
C2      44D4 02130   01920 02000
CHAR    44D5 02150   01850 01890 02280 02330 02350
CLEAR   4488 01760   02460
DISPR   4623 03530   00540 00570 00600 00630 00660 00690 00720
                     00750 00780 00810 00840 00870 00900 00930
                     00960 00990 01020 01050 01080 01110 01140
                     01170
```

Program continues

Program continued

```
FINIS   443B 01320   01270
HEXIT   4505 02390   01940 02010
HEXOUT  4514 02470   02740 02770 02800 02830 02860 02890 02920
                     02950 02980 03010 03040 03070 03100 03130
                     03160 03190 03220 03250 03280 03310 03340
                     03370
HEXR    4541 02720   00500
HXIN    449A 01850   01250
INSTR   4759 04010   01220 01530 01770 01780 03450 03460
KILLIT  450F 02440   02260
L1      466F 03950   00270
MOVE    4608 03400   01180
ONE     4637 03650   03560
READ    442F 01240   01300
RET1    4502 02360   02310
RET2    4504 02380   02240
SA      463E 03720   00530 02720
SA1     4646 03800   00770 02780
SB      4640 03740   00590 02840
SB1     4648 03820   00830 02900
SC      463F 03730   00620 02870
SC1     4647 03810   00860 02930
SCRBUF  5000 03940   00150 00160 00210 00240 00280 00310 00340
                     00370 00400 00430 00460 00520 00550 00580
                     00610 00640 00670 00700 00730 00760 00790
                     00820 00850 00880 00910 00940 00970 01000
                     01030 01060 01090 01120 01150 02730 02760
                     02790 02820 02850 02880 02910 02940 02970
                     03000 03030 03060 03090 03120 03150 03180
                     03210 03240 03270 03300 03330 03360 03400
SCRTOP  3C00 04050   01210
SD      4642 03760   00650 02960
SD1     464A 03840   00890 03020
SE      4641 03750   00680 02990
SE1     4649 03830   00920 03050
SETLST  44CE 02090   01870 01910
SF      463D 03710   00560 01330 02750
SF1     4645 03790   00800 02810
SH      4644 03780   00710 03080
SH1     464C 03860   00950 03140
SHIFT   4625 03540   03580
SHOW    435B 00500   01820
SI      4653 03900   01010 01340 01720 03200
SIX     464D 03870   01070 01100 03260 03290
SIY     464F 03880   01130 01160 01560 03320 03350
SL      4643 03770   00740 03110
SL1     464B 03850   00980 03170
SR      4654 03910   01040 01360 01740 03230
SSP     4651 03890   01320 01520 01550 01750
ST1     452C 02590   02560
ST2     453F 02690   02660
TEXT    4655 03930   00200
TRY41   44F8 02320   02300
ZAPHI   450C 02420   02400
ZERO    4631 03600   03550
```


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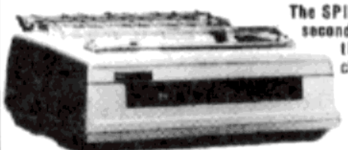

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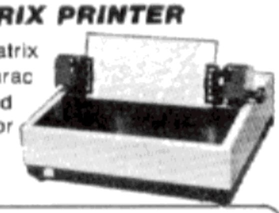

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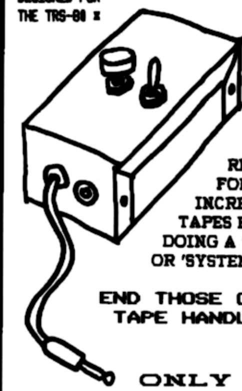

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An additional index for Radio Shack's Editor/Assembler manual—cross-referenced for easy use.

EDTASM Index

Terry Kepner
P.O. Box 481
Peterborough, NH 03458

Learning to program in assembly code is like trying to learn a foreign language; how long it takes will depend upon how good a reference book you have.

If the book is well written with a good cross-reference listing the new words, their English equivalents and the pages where you can find their descriptions, you will learn the language more easily. If the book doesn't have these features, you have a hard trip ahead.

Unfortunately, the Radio Shack Editor/Assembler Manual falls into the latter category. While it does provide an alphabetic and a numeric opcode-mnemonic cross-reference list at the back, these two lists do not tell the user where their descriptions can be found.

It took only a few frustrating hours before I decided to rectify the situation and produce a good cross-referenced index. However, this proved more difficult than I had thought.

The numeric cross-reference in the Radio Shack Editor/Assembler is actually organized into three separate numeric lists. This meant, in addition to an alphabetic index, I also had to make a new numeric index, properly sorted.

Creating the index, I discovered some errors in the Radio Shack manual, which are detailed as follows:

1. The LD A,R (pg. 22) and LD R,A (pg. 23) mnemonics are not in the Radio Shack numeric and alphabetic indices.
2. OUT (D),R (pg. 103) should be OUT (C),R.
3. LD B,H,NN (pg. 121) should be LD B,H.

I hope these indices are as useful to you as they have been for me. Since I am a beginner at assembly language programming, the time it took to prepare them has been more than repaid by the time saved finding information. ■

OBJECT CODE	MNEMONICS		PAGE #
8E	ADC	A,(HL)	46
DD8E05	ADC	A,(IX+IND)	46
FD8E05	ADC	A,(IY+IND)	46
8F	ADC	A,A	46
88	ADC	A,B	46
89	ADC	A,C	46
8A	ADC	A,D	46
8B	ADC	A,E	46
8C	ADC	A,H	46
8D	ADC	A,L	46
CE20	ADC	A,N	46
ED4A	ADC	HL,BC	63
ED5A	ADC	HL,DE	63
ED6A	ADC	HL,HL	63
ED7A	ADC	HL,SP	63
86	ADD	A,(HL)	44
DD8605	ADD	A,(IX+IND)	44
FD8605	ADD	A,(IY+IND)	45
87	ADD	A,A	43
80	ADD	A,B	43
81	ADD	A,C	43
82	ADD	A,D	43
83	ADD	A,E	43
84	ADD	A,H	43
85	ADD	A,L	43
C620	ADD	A,N	43
09	ADD	HL,BC	63
19	ADD	HL,DE	63
29	ADD	HL,HL	63
39	ADD	HL,SP	63
DD09	ADD	IX,BC	64
DD19	ADD	IX,DE	64
DD29	ADD	IX,IX	64
DD39	ADD	IX,SP	64
FD09	ADD	IY,BC	65
FD19	ADD	IY,DE	65
FD29	ADD	IY,IY	65
FD39	ADD	IY,SP	65
A6	AND	(HL)	49
DDA605	AND	(IX+IND)	49
FDA605	AND	(IY+IND)	49
A7	AND	A	49
A0	AND	B	49
A1	AND	C	49
A2	AND	D	49
A3	AND	E	49
A4	AND	H	49
A5	AND	L	49
E620	AND	N	49
CB46	BIT	0,(HL)	81
DDCB0546	BIT	0,(IX+IND)	82
FDCB0546	BIT	0,(IY+IND)	82
CB47	BIT	0,A	81
CB40	BIT	0,B	81
CB41	BIT	0,C	81
CB42	BIT	0,D	81
CB43	BIT	0,E	81
CB44	BIT	0,H	81
CB45	BIT	0,L	81
CB4E	BIT	1,(HL)	81
DDCB054E	BIT	1,(IX+IND)	82
FDCB054E	BIT	1,(IY+IND)	82
CB4F	BIT	1,A	81
CB48	BIT	1,B	81
CB49	BIT	1,C	81
CB4A	BIT	1,D	81
CB4B	BIT	1,E	81
CB4C	BIT	1,H	81
CB4D	BIT	1,L	81
CB56	BIT	2,(HL)	81
DDCB0556	BIT	2,(IX+IND)	82
FDCB0556	BIT	2,(IY+IND)	82
CB57	BIT	2,A	81
CB50	BIT	2,B	81
CB51	BIT	2,C	81
CB52	BIT	2,D	81
CB53	BIT	2,E	81
CB54	BIT	2,H	81
CB55	BIT	2,L	81
CB5E	BIT	3,(HL)	81
DDCB055E	BIT	3,(IX+IND)	82
FDCB055E	BIT	3,(IY+IND)	82
CB5F	BIT	3,A	81
CB58	BIT	3,B	81
CB59	BIT	3,C	81
CB5A	BIT	3,D	81
CB5B	BIT	3,E	81
CB5C	BIT	3,H	81
CB5D	BIT	3,L	81
CB66	BIT	4,(HL)	81
DDCB0566	BIT	4,(IX+IND)	82
FDCB0566	BIT	4,(IY+IND)	82
CB67	BIT	4,A	81
CB60	BIT	4,B	81
CB61	BIT	4,C	81
CB62	BIT	4,D	81
CB63	BIT	4,E	81
CB64	BIT	4,H	81
CB65	BIT	4,L	81
CB6E	BIT	5,(HL)	81
DDCB056E	BIT	5,(IX+IND)	82
FDCB056E	BIT	5,(IY+IND)	82
CB6F	BIT	5,A	81
CB68	BIT	5,B	81
CB69	BIT	5,C	81
CB6A	BIT	5,D	81
CB6B	BIT	5,E	81
CB6C	BIT	5,H	81
CB6D	BIT	5,L	81
CB76	BIT	6,(HL)	81
DDCB0576	BIT	6,(IX+IND)	82
FDCB0576	BIT	6,(IY+IND)	82
CB77	BIT	6,A	81
CB70	BIT	6,B	81
CB71	BIT	6,C	81
CB72	BIT	6,D	81
CB73	BIT	6,E	81
CB74	BIT	6,H	81
CB75	BIT	6,L	81
CB7E	BIT	7,(HL)	81
DDCB057E	BIT	7,(IX+IND)	82
FDCB057E	BIT	7,(IY+IND)	82
CB7F	BIT	7,A	81
CB78	BIT	7,B	81
CB79	BIT	7,C	81
CB7A	BIT	7,D	81
CB7B	BIT	7,E	81
CB7C	BIT	7,H	81
CB7D	BIT	7,L	81
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FC8405	CALL	M,NN	93
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CD8405	CALL	NN	92
C48405	CALL	NZ,NN	93
F48405	CALL	P,NN	93
EC8405	CALL	PE,NN	93
E48405	CALL	PO,NN	93
CC8405	CALL	Z,NN	93
3F	CCF		58
BE	CP	(HL)	52
DDBE05	CP	(IX+IND)	52
FDBE05	CP	(IY+IND)	52
BF	CP	A	52
B8	CP	B	52
B9	CP	C	52
BA	CP	D	52
BB	CP	E	52
BC	CP	H	52
BD	CP	L	52
FE20	CP	N	52
EDA9	CPD		42
EDB9	CPDR		42
EDA1	CPI		41
EDB1	CPIR		41
2F	CPL		57
27	DAA		56
35	DEC	(HL)	55
DD3505	DEC	(IX+IND)	55
FD3505	DEC	(IY+IND)	55
3D	DEC	A	55
05	DEC	B	55
0B	DEC	BC	67
0D	DEC	C	55
15	DEC	D	55
1B	DEC	DE	67
1D	DEC	E	55
25	DEC	H	55
2B	DEC	HL	67
DD2B	DEC	IX	67
FD2B	DEC	IY	68
2D	DEC	L	55
3B	DEC	SP	67
F3	DI		60
102E	DJNZ	DIS	91
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E3	EX	(SP),HL	35
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FDE3	EX	(SP),IY	36
08	EX	AF,AF'	34
EB	EX	DE,HL	34
D9	EXX		35
76	HALT		59
ED46	IM	0	61
ED56	IM	1	61
ED5E	IM	2	62
ED78	IN	A,(C)	98
DB20	IN	A,(N)	98
ED40	IN	B,(C)	98
ED48	IN	C,(C)	98
ED50	IN	D,(C)	98
ED58	IN	E,(C)	98

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ED68	IN L,(C)	98
34	INC (HL)	53
DD3405	INC (IX+IND)	54
FD3405	INC (IY+IND)	54
3C	INC A	53
04	INC B	53
03	INC BC	65
0C	INC C	53
14	INC D	53
13	INC DE	65
1C	INC E	53
24	INC H	53
23	INC HL	65
DD23	INC IX	66
FD23	INC IY	66
2C	INC L	53
33	INC SP	65
EDAA	IND	101
EDBA	INDR	102
EDA2	INI	99
EDB2	INIR	100
E9	JP (HL)	89
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FDE9	JP (IY)	90
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FA8405	JP M,NN	86
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C38405	JP NN	86
C28405	JP NZ,NN	86
F28405	JP P,NN	86
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E28405	JP PO,NN	86
CA8405	JP Z,NN	86
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282E	JR Z,DIS	88
02	LD (BC),A	20
12	LD (DE),A	20
77	LD (HL),A	15
70	LD (HL),B	15
71	LD (HL),C	15
72	LD (HL),D	15
73	LD (HL),E	15
74	LD (HL),H	15
75	LD (HL),L	15
3620	LD (HL),N	17
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DD7005	LD (IX+IND),B	16
DD7105	LD (IX+IND),C	16
DD7205	LD (IX+IND),D	16
DD7305	LD (IX+IND),E	16
DD7405	LD (IX+IND),H	16
DD7505	LD (IX+IND),L	16
DD360520	LD (IX+IND),N	17
FD7705	LD (IY+IND),A	16
FD7005	LD (IY+IND),B	16
FD7105	LD (IY+IND),C	16
FD7205	LD (IY+IND),D	16
FD7305	LD (IY+IND),E	16
FD7405	LD (IY+IND),H	16
FD7505	LD (IY+IND),L	16
FD360520	LD (IY+IND),N	18
328405	LD (NN),A	21
ED438405	LD (NN),BC	28
ED538405	LD (NN),DE	28
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DD228405	LD (NN),IX	28
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0A	LD A,(BC)	18
1A	LD A,(DE)	19
7E	LD A,HL	14
DD7E05	LD A,(IX+IND)	14
FD7E05	LD A,(IY+IND)	15
3A8405	LD A,(NN)	19
7F	LD A,A	13
78	LD A,B	13
79	LD A,C	13
7A	LD A,D	13
7B	LD A,E	13
7C	LD A,H	13
ED57	LD A,I	21
7D	LD A,L	13
3E20	LD A,N	13
ED5F	LD A,R	22
46	LD B,(HL)	14
DD4605	LD B,(IX+IND)	14
FD4605	LD B,(IY+IND)	15
47	LD B,A	13
40	LD B,B	13
41	LD B,C	13
42	LD B,D	13
43	LD B,E	13
44	LD B,H	13
45	LD B,L	13
0620	LD B,N	13
ED4B8405	LD BC,(NN)	26
018405	LD BC,NN	24
4E	LD C,(HL)	14
DD4E05	LD C,(IX+IND)	14
FD4E05	LD C,(IY+IND)	15
4F	LD C,A	13
48	LD C,B	13
49	LD C,C	13
4A	LD C,D	13
4B	LD C,E	13
4C	LD C,H	13
4D	LD C,L	13
0E20	LD C,N	13
56	LD D,(HL)	14
DD5605	LD D,(IX+IND)	14
FD5605	LD D,(IY+IND)	15
57	LD D,A	13
50	LD D,B	13
51	LD D,C	13
52	LD D,D	13
53	LD D,E	13
54	LD D,H	13
55	LD D,L	13
1620	LD D,N	13
ED5B8405	LD DE,(NN)	26
118405	LD DE,NN	24
5E	LD E,(HL)	14
DD5E05	LD E,(IX+IND)	14
FD5E05	LD E,(IY+IND)	15
5F	LD E,A	13
58	LD E,B	13
59	LD E,C	13
5A	LD E,D	13
5B	LD E,E	13
5C	LD E,H	13
5D	LD E,L	13
1E20	LD E,N	13
66	LD H,(HL)	14
DD6605	LD H,(IX+IND)	14
FD6605	LD H,(IY+IND)	15
67	LD H,A	13
60	LD H,B	13
61	LD H,C	13
62	LD H,D	13
63	LD H,E	13
64	LD H,H	13
65	LD H,L	13
2620	LD H,N	13
2A8405	LD HL,(NN)	25,26
218405	LD HL,NN	24
ED47	LD I,A	22
DD2A8405	LD IX,(NN)	26
DD218405	LD IX,NN	24
FD2A8405	LD IY,(NN)	27
FD218405	LD IY,NN	25
6E	LD L,(HL)	14
DD6E05	LD L,(IX+IND)	14
FD6E05	LD L,(IY+IND)	15
6F	LD L,A	13
68	LD L,B	13
69	LD L,C	13
6A	LD L,D	13
6B	LD L,E	13
6C	LD L,H	13
6D	LD L,L	13
2E20	LD L,N	13
ED4F	LD R,A	23
ED7B8405	LD SP,(NN)	26
F9	LD SP,HL	29
DDF9	LD SP,IX	30
FDF9	LD SP,IY	30
318405	LD SP,NN	24
EDA8	LDD	39
EDB8	LDDR	40
EDA0	LDI	37
EDB0	LDIR	38
ED44	NEG	57
00	NOP	59
B6	OR (HL)	50
DDB605	OR (IX+IND)	50
FDB605	OR (IY+IND)	50
B7	OR A	50
B0	OR B	50
B1	OR C	50
B2	OR D	50
B3	OR E	50
B4	OR H	50
B5	OR L	50
F620	OR N	50
EDBB	OTDR	107
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ED79	OUT (C),A	103
ED41	OUT (C),B	103
ED49	OUT (C),C	103
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F1	POP AF	32
C1	POP BC	32
D1	POP DE	32
E1	POP HL	32
DDE1	POP IX	33
FDE1	POP IY	33
F5	PUSH AF	31
C5	PUSH BC	31
D5	PUSH DE	31
E5	PUSH HL	31
DDE5	PUSH IX	31
FDE5	PUSH IY	32
CB86	RES 0,(HL)	85
DDCB0586	RES 0,(IX+IND)	85
FDCB0586	RES 0,(IY+IND)	85
CB87	RES 0,A	85
CB80	RES 0,B	85
CB81	RES 0,C	85
CB82	RES 0,D	85
CB83	RES 0,E	85
CB84	RES 0,H	85
CB85	RES 0,L	85
CB8E	RES 1,(HL)	85
DDCB058E	RES 1,(IX+IND)	85
FDCB058E	RES 1,(IY+IND)	85
CB8F	RES 1,A	85
CB88	RES 1,B	85
CB89	RES 1,C	85
CB8A	RES 1,D	85
CB8B	RES 1,E	85
CB8C	RES 1,H	85
CB8D	RES 1,L	85
CB96	RES 2,(HL)	85
DDCB0596	RES 2,(IX+IND)	85
FDCB0596	RES 2,(IY+IND)	85
CB97	RES 2,A	85
CB90	RES 2,B	85
CB91	RES 2,C	85
CB92	RES 2,D	85
CB93	RES 2,E	85
CB94	RES 2,H	85
CB95	RES 2,L	85
CB9E	RES 3,(HL)	85
DDCB059E	RES 3,(IX+IND)	85
FDCB059E	RES 3,(IY+IND)	85
CB9F	RES 3,A	85
CB98	RES 3,B	85
CB99	RES 3,C	85
CB9A	RES 3,D	85
CB9B	RES 3,E	85
CB9C	RES 3,H	85
CB9D	RES 3,L	85
CBA6	RES 4,(HL)	85
DDCB05A6	RES 4,(IX+IND)	85
FDCB05A6	RES 4,(IY+IND)	85
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CBA0	RES 4,B	85
CBA1	RES 4,C	85
CBA2	RES 4,D	85
CBA3	RES 4,E	85
CBA4	RES 4,H	85
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CBAE	RES 5,(HL)	85
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FDCB05AE	RES 5,(IY+IND)	85
CBAF	RES 5,A	85
CBA8	RES 5,B	85
CBA9	RES 5,C	85
CBAA	RES 5,D	85
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CBAD	RES 5,L	85
CBB6	RES 6,(HL)	85
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CBB0	RES 6,B	85
CBB1	RES 6,C	85
CBB2	RES 6,D	85
CBB3	RES 6,E	85
CBB4	RES 6,H	85
CBB5	RES 6,L	85
CBBE	RES 7,(HL)	85
DDCB05BE	RES 7,(IX+IND)	85
FDCB05BE	RES 7,(IY+IND)	85
CBBF	RES 7,A	85
CBB8	RES 7,B	85
CBB9	RES 7,C	85
CBBA	RES 7,D	85
CBBB	RES 7,E	85
CBBC	RES 7,H	85
CBBD	RES 7,L	85
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D8	RET C	95
F8	RET M	95
D0	RET NC	95
C0	RET NZ	95
F0	RET P	95
E8	RET PE	95
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CB12	RL D	73
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CB19	RR C	75
CB1A	RR D	75
CB1B	RR E	75
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CB08	RRC B	74
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E7	RST 20H	97
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FD9E05	SBC A,(IY+IND)	48
9F	SBC A,A	48
98	SBC A,B	48
99	SBC A,C	48
9A	SBC A,D	48
9B	SBC A,E	48
9C	SBC A,H	48
9D	SBC A,L	48
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CBC6	SET 0,(HL)	83
DDCB05C6	SET 0,(IX+IND)	84
FDCB05C6	SET 0,(IY+IND)	84
CBC7	SET 0,A	83
CBC0	SET 0,B	83
CBC1	SET 0,C	83
CBC2	SET 0,D	83
CBC3	SET 0,E	83
CBC4	SET 0,H	83
CBC5	SET 0,L	83
CBCE	SET 1,(HL)	83
DDCB05CE	SET 1,(IX+IND)	84
FDCB05CE	SET 1,(IY+IND)	84
CBCF	SET 1,A	83
CBC8	SET 1,B	83
CBC9	SET 1,C	83
CBCA	SET 1,D	83
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CBCC	SET 1,H	83
CBCD	SET 1,L	83
CBD6	SET 2,(HL)	83
DDCB05D6	SET 2,(IX+IND)	84
FDCB05D6	SET 2,(IY+IND)	84
CBD7	SET 2,A	83
CBD0	SET 2,B	83
CBD1	SET 2,C	83
CBD2	SET 2,D	83
CBD3	SET 2,E	83
CBD4	SET 2,H	83
CBD5	SET 2,L	83
CBD8	SET 3,B	83
CBDE	SET 3,(HL)	83
DDCB05DE	SET 3,(IX+IND)	84
FDCB05DE	SET 3,(IY+IND)	84
CBDF	SET 3,A	83
CBD9	SET 3,C	83
CBDA	SET 3,D	83
CBDB	SET 3,E	83
CBDC	SET 3,H	83
CBDD	SET 3,L	83
CBE6	SET 4,(HL)	83
DDCB05E6	SET 4,(IX+IND)	84
FDCB05E6	SET 4,(IY+IND)	84
CBE7	SET 4,A	83
CBE0	SET 4,B	83
CBE1	SET 4,C	83
CBE2	SET 4,D	83
CBE3	SET 4,E	83
CBE4	SET 4,H	83
CBE5	SET 4,L	83
CBEE	SET 5,(HL)	83
DDCB05EE	SET 5,(IX+IND)	84
FDCB05EE	SET 5,(IY+IND)	84
CBEF	SET 5,A	83
CBE8	SET 5,B	83
CBE9	SET 5,C	83
CBEA	SET 5,D	83
CBEB	SET 5,E	83
CBEC	SET 5,H	83
CBED	SET 5,L	83
CBF6	SET 6,(HL)	83
DDCB05F6	SET 6,(IX+IND)	84
FDCB05F6	SET 6,(IY+IND)	84
CBF7	SET 6,A	83
CBF0	SET 6,B	83
CBF1	SET 6,C	83
CBF2	SET 6,D	83
CBF3	SET 6,E	83
CBF4	SET 6,H	83
CBF5	SET 6,L	83
CBFE	SET 7,(HL)	83
DDCB05FE	SET 7,(IX+IND)	84
FDCB05FE	SET 7,(IY+IND)	84
CBFF	SET 7,A	83
CBF8	SET 7,B	83
CBF9	SET 7,C	83
CBFA	SET 7,D	83
CBFB	SET 7,E	83
CBFC	SET 7,H	83
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CB25	SLA L	76
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CB2B	SRA E	77
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CB2D	SRA L	77
CB3E	SRL (HL)	78
DDCB053E	SRL (IX+IND)	78
FDCB053E	SRL (IY+IND)	78
CB3F	SRL A	78
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CB3A	SRL D	78
CB3B	SRL E	78
CB3C	SRL H	78
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96	SUB (HL)	47
DD9605	SUB (IX+IND)	47
FD9605	SUB (IY+IND)	47
97	SUB A	47
90	SUB B	47

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OBJECT CODE	MNEMONICS	PAGE #
91	SUB C	47
92	SUB D	47
93	SUB E	47
94	SUB H	47
95	SUB L	47
D620	SUB N	47
AE	XOR (HL)	51
DDAE05	XOR (IX+IND)	51
FDAE05	XOR (IY+IND)	51
AF	XOR A	51
A8	XOR B	51
A9	XOR C	51
AA	XOR D	51
AB	XOR E	51
AC	XOR H	51
AD	XOR L	51
EE20	XOR N	51
00	NOP	59
018405	LD BC,NN	24
02	LD (BC),A	20
03	INC BC	65
04	INC B	53
05	DEC B	55
0620	LD B,N	13
07	RLCA	69
08	EX AF,AF'	34
09	ADD HL,BC	63
0A	LD A,(BC)	18
0B	DEC BC	67
0C	INC C	53
0D	DEC C	55
0E20	LD C,N	13
0F	RRCA	70
102E	DJNZDIS	91
118405	LD DE,NN	24
12	LD (DE),A	20
13	INC DE	65
14	INC D	53
15	DEC D	55
1620	LD D,N	13
17	RLA	69
182E	JR DIS	87
19	ADD HL,DE	63
1A	LD A,(DE)	19
1B	DEC DE	67
1C	INC E	53
1D	DEC E	55
1E20	LD E,N	13
1F	RRA	70
202E	JR NZ,DIS	89
218405	LD HL,NN	24
228405	LD (NN),HL	27,28
23	INC HL	65
24	INC H	53
25	DEC H	55
2620	LD H,N	13
27	DAA	56
282E	JR Z,DIS	88
29	ADD HL,HL	63
2A8405	LD HL,(NN)	25,26
2B	DEC HL	67
2C	INC L	53
2D	DEC L	55
2E20	LD L,N	13
2F	CPL	57
302E	JR NC,DIS	88
318405	LD SP,NN	24
328405	LD (NN),A	21
33	INC SP	65
34	INC (HL)	53
35	DEC (HL)	55
3620	LD (HL),N	17
37	SCF	58
382E	JR C,DIS	87
39	ADD HL,SP	63
3A8405	LD A,(NN)	19
3B	DEC SP	67
3C	INC A	53
3D	DEC A	55
3E20	LD A,N	13
3F	CCF	58
40	LD B,B	13
41	LD B,C	13
42	LD B,D	13
43	LD B,E	13
44	LD B,H	13
45	LD B,L	13
46	LD B,(HL)	14
47	LD B,A	13
48	LD C,B	13
49	LD C,C	13
4A	LD C,D	13
4B	LD C,E	13
4C	LD C,H	13
4D	LD C,L	13
4E	LD C,(HL)	14
4F	LD C,A	13
50	LD D,B	13
51	LD D,C	13
52	LD D,D	13
53	LD D,E	13
54	LD D,H	13
55	LD D,L	13
56	LD D,(HL)	14
57	LD D,A	13
58	LD E,B	13
59	LD E,C	13
5A	LD E,D	13
5B	LD E,E	13
5C	LD E,H	13
5D	LD E,L	13
5E	LD E,(HL)	14
5F	LD E,A	13
60	LD H,B	13
61	LD H,C	13
62	LD H,D	13
63	LD H,E	13
64	LD H,H	13
65	LD H,L	13
66	LD H,(HL)	14
67	LD H,A	13
68	LD L,B	13
69	LD L,C	13

OBJECT CODE	MNEMONICS	PAGE #
6A	LD L,D	13
6B	LD L,E	13
6C	LD L,H	13
6D	LD L,L	13
6E	LD L,(HL)	14
6F	LD L,A	13
70	LD (HL),B	15
71	LD (HL),C	15
72	LD (HL),D	15
73	LD (HL),E	15
74	LD (HL),H	15
75	LD (HL),L	15
76	HALT	59
77	LD (HL),A	15
78	LD A,B	13
79	LD A,C	13
7A	LD A,D	13
7B	LD A,E	13
7C	LD A,H	13
7D	LD A,L	13
7E	LD A,HL	14
7F	LD A,A	13
80	ADD A,B	43
81	ADD A,C	43
82	ADD A,D	43
83	ADD A,E	43
84	ADD A,H	43
85	ADD A,L	43
86	ADD A,(HL)	44
87	ADD A,A	43
88	ADC A,B	46
89	ADC A,C	46
8A	ADC A,D	46
8B	ADC A,E	46
8C	ADC A,H	46
8D	ADC A,L	46
8E	ADC A,(HL)	46
8F	ADC A,A	46
90	SUB B	47
91	SUB C	47
92	SUB D	47
93	SUB E	47
94	SUB H	47
95	SUB L	47
96	SUB (HL)	47
97	SUB A	47
98	SBC A,B	48
99	SBC A,C	48
9A	SBC A,D	48
9B	SBC A,E	48
9C	SBC A,H	48
9D	SBC A,L	48
9E	SBC A,(HL)	48
9F	SBC A,A	48
A0	AND B	49
A1	AND C	49
A2	AND D	49
A3	AND E	49
A4	AND H	49
A5	AND L	49
A6	AND (HL)	49
A7	AND A	49
A8	XOR B	51
A9	XOR C	51
AA	XOR D	51
AB	XOR E	51
AC	XOR H	51
AD	XOR L	51
AE	XOR (HL)	51
AF	XOR A	51
B0	OR B	50
B1	OR C	50
B2	OR D	50
B3	OR E	50
B4	OR H	50
B5	OR L	50
B6	OR (HL)	50
B7	OR A	50
B8	CP B	52
B9	CP C	52
BA	CP D	52
BB	CP E	52
BC	CP H	52
BD	CP L	52
BE	CP (HL)	52
BF	CP A	52
C0	RET NZ	95
C1	POP BC	32
C28405	JP NZ,NN	86
C38405	JP NN	86
C48405	CALL NZ,NN	93
C5	PUSH BC	31
C620	ADD A,N	43
C7	RST 0	97
C8	RET Z	95
C9	RET	94
CA8405	JP Z,NN	86
CB00	RLC B	71
CB01	RLC C	71
CB02	RLC D	71
CB03	RLC E	71
CB04	RLC H	71
CB05	RLC L	71
CB06	RLC (HL)	71
CB07	RLC A	71
CB08	RRC B	74
CB09	RRC C	74
CB0A	RRC D	74
CB0B	RRC E	74
CB0C	RRC H	74
CB0D	RRC L	74
CB0E	RRC (HL)	74
CB0F	RRC A	74
CB10	RL B	73
CB11	RL C	73
CB12	RL D	73
CB13	RL E	73
CB14	RL H	73
CB15	RL L	73
CB16	RL (HL)	73
CB17	RL A	73

OBJECT CODE	MNEMONICS	PAGE #
CB18	RR B	75
CB19	RR C	75
CB1A	RR D	75
CB1B	RR E	75
CB1C	RR H	75
CB1D	RR L	75
CB1E	RR (HL)	75
CB1F	RR A	75
CB20	SLA B	76
CB21	SLA C	76
CB22	SLA D	76
CB23	SLA E	76
CB24	SLA H	76
CB25	SLA L	76
CB26	SLA (HL)	76
CB27	SLA A	76
CB28	SRA B	77
CB29	SRA C	77
CB2A	SRA D	77
CB2B	SRA E	77
CB2C	SRA H	77
CB2D	SRA L	77
CB2E	SRA (HL)	77
CB2F	SRA A	77
CB38	SRL B	78
CB39	SRL C	78
CB3A	SRL D	78
CB3B	SRL E	78
CB3C	SRL H	78
CB3D	SRL L	78
CB3E	SRL (HL)	78
CB3F	SRL A	78
CB40	BIT 0,B	81
CB41	BIT 0,C	81
CB42	BIT 0,D	81
CB43	BIT 0,E	81
CB44	BIT 0,H	81
CB45	BIT 0,L	81
CB46	BIT 0,(HL)	81
CB47	BIT 0,A	81
CB48	BIT 1,B	81
CB49	BIT 1,C	81
CB4A	BIT 1,D	81
CB4B	BIT 1,E	81
CB4C	BIT 1,H	81
CB4D	BIT 1,L	81
CB4E	BIT 1,(HL)	81
CB4F	BIT 1,A	81
CB50	BIT 2,B	81
CB51	BIT 2,C	81
CB52	BIT 2,D	81
CB53	BIT 2,E	81
CB54	BIT 2,H	81
CB55	BIT 2,L	81
CB56	BIT 2,(HL)	81
CB57	BIT 2,A	81
CB58	BIT 3,B	81
CB59	BIT 3,C	81
CB5A	BIT 3,D	81
CB5B	BIT 3,E	81
CB5C	BIT 3,H	81
CB5D	BIT 3,L	81
CB5E	BIT 3,(HL)	81
CB5F	BIT 3,A	81
CB60	BIT 4,B	81
CB61	BIT 4,C	81
CB62	BIT 4,D	81
CB63	BIT 4,E	81
CB64	BIT 4,H	81
CB65	BIT 4,L	81
CB66	BIT 4,(HL)	81
CB67	BIT 4,A	81
CB68	BIT 5,B	81
CB69	BIT 5,C	81
CB6A	BIT 5,D	81
CB6B	BIT 5,E	81
CB6C	BIT 5,H	81
CB6D	BIT 5,L	81
CB6E	BIT 5,(HL)	81
CB6F	BIT 5,A	81
CB70	BIT 6,B	81
CB71	BIT 6,C	81
CB72	BIT 6,D	81
CB73	BIT 6,E	81
CB74	BIT 6,H	81
CB75	BIT 6,L	81
CB76	BIT 6,(HL)	81
CB77	BIT 6,A	81
CB78	BIT 7,B	81
CB79	BIT 7,C	81
CB7A	BIT 7,D	81
CB7B	BIT 7,E	81
CB7C	BIT 7,H	81
CB7D	BIT 7,L	81
CB7E	BIT 7,(HL)	81
CB7F	BIT 7,A	81
CB80	RES 0,B	85
CB81	RES 0,C	85
CB82	RES 0,D	85
CB83	RES 0,E	85
CB84	RES 0,H	85
CB85	RES 0,L	85
CB86	RES 0,(HL)	85
CB87	RES 0,A	85
CB88	RES 1,B	85
CB89	RES 1,C	85
CB8A	RES 1,D	85
CB8B	RES 1,E	85
CB8C	RES 1,H	85
CB8D	RES 1,L	85
CB8E	RES 1,(HL)	85
CB8F	RES 1,A	85
CB90	RES 2,B	85
CB91	RES 2,C	85
CB92	RES 2,D	85
CB93	RES 2,E	85
CB94	RES 2,H	85
CB95	RES 2,L	85
CB96	RES 2,(HL)	85
CB97	RES 2,A	85
CB98	RES 3,B	85
CB99	RES 3,C	85

OBJECT CODE	MNEMONICS	PAGE #
CB9A	RES 3,D	85
CB9B	RES 3,E	85
CB9C	RES 3,H	85
CB9D	RES 3,L	85
CB9E	RES 3,(HL)	85
CB9F	RES 3,A	85
CBA0	RES 4,B	85
CBA1	RES 4,C	85
CBA2	RES 4,D	85
CBA3	RES 4,E	85
CBA4	RES 4,H	85
CBA5	RES 4,L	85
CBA6	RES 4,(HL)	85
CBA7	RES 4,A	85
CBA8	RES 5,B	85
CBA9	RES 5,C	85
CBAA	RES 5,D	85
CBAB	RES 5,E	85
CBAC	RES 5,H	85
CBAD	RES 5,L	85
CBAE	RES 5,(HL)	85
CBAF	RES 5,A	85
CBB0	RES 6,B	85
CBB1	RES 6,C	85
CBB2	RES 6,D	85
CBB3	RES 6,E	85
CBB4	RES 6,H	85
CBB5	RES 6,L	85
CBB6	RES 6,(HL)	85
CBB7	RES 6,A	85
CBB8	RES 7,B	85
CBB9	RES 7,C	85
CBBA	RES 7,D	85
CBBB	RES 7,E	85
CBBC	RES 7,H	85
CBBD	RES 7,L	85
CBBE	RES 7,(HL)	85
CBBF	RES 7,A	85
CBC0	SET 0,B	83
CBC1	SET 0,C	83
CBC2	SET 0,D	83
CBC3	SET 0,E	83
CBC4	SET 0,H	83
CBC5	SET 0,L	83
CBC6	SET 0,(HL)	83
CBC7	SET 0,A	83
CBC8	SET 1,B	83
CBC9	SET 1,C	83
CBCA	SET 1,D	83
CBCB	SET 1,E	83
CBCC	SET 1,H	83
CBCD	SET 1,L	83
CBCE	SET 1,(HL)	83
CBCF	SET 1,A	83
CBD0	SET 2,B	83
CBD1	SET 2,C	83
CBD2	SET 2,D	83
CBD3	SET 2,E	83
CBD4	SET 2,H	83
CBD5	SET 2,L	83
CBD6	SET 2,(HL)	83
CBD7	SET 2,A	83
CBD8	SET 3,B	83
CBD9	SET 3,C	83
CBDA	SET 3,D	83
CBDB	SET 3,E	83
CBDC	SET 3,H	83
CBDD	SET 3,L	83
CBDE	SET 3,(HL)	83
CBDF	SET 3,A	83
CBE0	SET 4,B	83
CBE1	SET 4,C	83
CBE2	SET 4,D	83
CBE3	SET 4,E	83
CBE4	SET 4,H	83
CBE5	SET 4,L	83
CBE6	SET 4,(HL)	83
CBE7	SET 4,A	83
CBE8	SET 5,B	83
CBE9	SET 5,C	83
CBEA	SET 5,D	83
CBEB	SET 5,E	83
CBEC	SET 5,H	83
CBED	SET 5,L	83
CBEE	SET 5,(HL)	83
CBEF	SET 5,A	83
CBF0	SET 6,B	83
CBF1	SET 6,C	83
CBF2	SET 6,D	83
CBF3	SET 6,E	83
CBF4	SET 6,H	83
CBF5	SET 6,L	83
CBF6	SET 6,(HL)	83
CBF7	SET 6,A	83
CBF8	SET 7,B	83
CBF9	SET 7,C	83
CBFA	SET 7,D	83
CBFB	SET 7,E	83
CBFC	SET 7,H	83
CBFD	SET 7,L	83
CBFE	SET 7,(HL)	83
CBFF	SET 7,A	83
CC8405	CALLZ,NN	93
CD8405	CALLNN	92
CE20	ADC A,N	46
CF	RST 8	97
D0	RET NC	95
D1	POP DE	32
D28405	JP NC,NN	86
D320	OUT (N),A	103
D48405	CALLNC,NN	93
D5	PUSHDE	31
D620	SUB N	47
D7	RST 10H	97
D8	RET C	95
D9	EXX	35
DA8405	JP C,NN	86
DB20	IN A,(N)	98
DC8405	CALLC,NN	93
DD09	ADD IX,BC	64
DD19	ADD IX,DE	64
DD218405	LD IX,NN	24
DD228405	LD (NN),IX	28

OBJECT CODE	MNEMONICS	PAGE #
DD23	INC IX	66
DD29	ADD IX, IX	64
DD2A0405	LD IX, (NN)	26
DD2B	DEC IX	67
DD3405	INC (IX+IND)	54
DD3505	DEC (IX+IND)	55
DD360520	LD (IX+IND), N	17
DD39	ADD IX, SP	64
DD4605	LD B, (IX+IND)	14
DD4E05	LD C, (IX+IND)	14
DD5605	LD D, (IX+IND)	14
DD5E05	LD E, (IX+IND)	14
DD6605	LD H, (IX+IND)	14
DD6E05	LD L, (IX+IND)	14
DD7005	LD (IX+IND), B	16
DD7105	LD (IX+IND), C	16
DD7205	LD (IX+IND), D	16
DD7305	LD (IX+IND), E	16
DD7405	LD (IX+IND), H	16
DD7505	LD (IX+IND), L	16
DD7705	LD (IX+IND), A	16
DD7E05	LD A, (IX+IND)	14
DD8605	ADD A, (IX+IND)	44
DD8E05	ADC A, (IX+IND)	46
DD9605	SUB (IX+IND)	47
DD9E05	SBC A, (IX+IND)	48
DDA605	AND (IX+IND)	49
DDAE05	XOR (IX+IND)	51
DDB605	OR (IX+IND)	50
DDBE05	CP (IX+IND)	52
DDCB0506	RLC (IX+IND)	72
DDCB050E	RRC (IX+IND)	74
DDCB0516	RL (IX+IND)	73
DDCB051E	RR (IX+IND)	75
DDCB0526	SLA (IX+IND)	76
DDCB052E	SRA (IX+IND)	77
DDCB053E	SRL (IX+IND)	78
DDCB0546	BIT 0, (IX+IND)	82
DDCB054E	BIT 1, (IX+IND)	82
DDCB0556	BIT 2, (IX+IND)	82
DDCB055E	BIT 3, (IX+IND)	82
DDCB0566	BIT 4, (IX+IND)	82
DDCB056E	BIT 5, (IX+IND)	82
DDCB0576	BIT 6, (IX+IND)	82
DDCB057E	BIT 7, (IX+IND)	82
DDCB0586	RES 0, (IX+IND)	85
DDCB058E	RES 1, (IX+IND)	85
DDCB0596	RES 2, (IX+IND)	85
DDCB059E	RES 3, (IX+IND)	85
DDCB05A6	RES 4, (IX+IND)	85
DDCB05AE	RES 5, (IX+IND)	85
DDCB05B6	RES 6, (IX+IND)	85
DDCB05BE	RES 7, (IX+IND)	85
DDCB05C6	SET 0, (IX+IND)	84
DDCB05CE	SET 1, (IX+IND)	84
DDCB05D6	SET 2, (IX+IND)	84
DDCB05DE	SET 3, (IX+IND)	84
DDCB05E6	SET 4, (IX+IND)	84
DDCB05EE	SET 5, (IX+IND)	84
DDCB05F6	SET 6, (IX+IND)	84
DDCB05FE	SET 7, (IX+IND)	84
DDE1	POP IX	33
DDE3	EX (SP), IX	36
DDE5	PUSHIX	31
DDE9	JP (IX)	90
DDF9	LD SP, IX	30
DE20	SBC A, N	48
DF	RST 18H	97
E0	RET PO	95
E1	POP HL	32
E20405	JP PO, NN	86
E3	EX (SP), HL	35
E40405	CALLPO, NN	93
E5	PUSHHL	31
E620	AND N	49
E7	RST 20H	97
E8	RET PE	95
E9	JP (HL)	89
EA0405	JP PE, NN	86
EB	EX DE, HL	34
EC0405	CALL PE, NN	93
ED40	IN B, (C)	98
ED41	OUT (C), B	103
ED42	SBC HL, BC	64
ED430405	LD (NN), BC	28
ED44	NEG	57
ED4455	RETN	96
ED46	IM 0	61
ED47	LD I, A	22
ED48	IN C, (C)	98
ED49	OUT (C), C	103
ED4A	ADC HL, BC	63
ED4B0405	LD BC, (NN)	26
ED4D	RETI	96
ED4F	LD R, A	23
ED50	IN D, (C)	98
ED51	OUT (C), D	103
ED52	SBC HL, DE	64
ED530405	LD (NN), DE	28
ED56	IM 1	61
ED57	LD A, I	21
ED58	IN E, (C)	98
ED59	OUT (C), E	103
ED5A	ADC HL, DE	63
ED5B0405	LD DE, (NN)	26
ED5E	IM 2	62
ED5F	LD A, R	22
ED60	IN H, (C)	98
ED61	OUT (C), H	103
ED62	SBC HL, HL	64
ED67	RRD	80
ED68	IN L, (C)	98
ED69	OUT (C), L	103
ED6A	ADC HL, HL	63
ED6F	RLD	79
ED72	SBC HL, SP	64
ED730405	LD (NN), SP	28
ED78	IN A, (C)	98
ED79	OUT (C), A	103
ED7A	ADC HL, SP	63
ED7B0405	LD SP, (NN)	26
EDA0	LDI	37
EDA1	CPI	41
EDA2	INI	99
EDA3	OUTI	104
EDA8	LDD	39
EDA9	CPD	42
EDAA	IND	101
EDAB	OUTD	106
EDB0	LDIR	38
EDB1	CPIR	41
EDB2	INIR	100
EDB3	OTIR	105
EDB8	LDDR	40
EDB9	CPDR	42
EDBA	INDR	102
EDBB	OTDR	107
EE20	XOR N	51
EF	RST 28H	97
F0	RET P	95
F1	POP AF	32
F20405	JP P, NN	86
F3	DI	60
F40405	CALL P, NN	93
F5	PUSH AF	31
F620	OR N	50
F7	RST 30H	97
F8	RET M	95
F9	LD SP, HL	29
FA0405	JP M, NN	86
FB	EI	60
FC0405	CALL M, NN	93
FD09	ADD IY, BC	65
FD19	ADD IY, DE	65
FD210405	LD IY, NN	25
FD220405	LD (NN), IY	29
FD23	INC IY	66
FD29	ADD IY, IY	65
FD2A0405	LD IY, (NN)	27
FD2B	DEC IY	68
FD3405	INC (IY+IND)	54
FD3505	DEC (IY+IND)	55
FD360520	LD (IY+IND), N	18
FD39	ADD IY, SP	65
FD4605	LD B, (IY+IND)	15
FD4E05	LD C, (IY+IND)	15
FD5605	LD D, (IY+IND)	15
FD5E05	LD E, (IY+IND)	15
FD6605	LD H, (IY+IND)	15
FD6E05	LD L, (IY+IND)	15
FD7005	LD (IY+IND), B	16
FD7105	LD (IY+IND), C	16
FD7205	LD (IY+IND), D	16
FD7305	LD (IY+IND), E	16
FD7405	LD (IY+IND), H	16
FD7505	LD (IY+IND), L	16
FD7705	LD (IY+IND), A	16
FD7E05	LD A, (IY+IND)	15
FD8605	ADD A, (IY+IND)	45
FD8E05	ADC A, (IY+IND)	46
FD9605	SUB (IY+IND)	47
FD9E05	SBC A, (IY+IND)	48
FDA605	AND (IY+IND)	49
FDAE05	XOR (IY+IND)	51
FDB605	OR (IY+IND)	50
FDBE05	CP (IY+IND)	52
FDCB0506	RLC (IY+IND)	72
FDCB050E	RRC (IY+IND)	74
FDCB0516	RL (IY+IND)	73
FDCB051E	RR (IY+IND)	75
FDCB0526	SLA (IY+IND)	76
FDCB052E	SRA (IY+IND)	77
FDCB053E	SRL (IY+IND)	78
FDCB0546	CP 0, (IY+IND)	82
FDCB054E	BIT 1, (IY+IND)	82
FDCB0556	BIT 2, (IY+IND)	82
FDCB055E	BIT 3, (IY+IND)	82
FDCB0566	BIT 4, (IY+IND)	82
FDCB056E	BIT 5, (IY+IND)	82
FDCB0576	BIT 6, (IY+IND)	82
FDCB057E	BIT 7, (IY+IND)	• 82
FDCB0586	RES 0, (IY+IND)	85
FDCB058E	RES 1, (IY+IND)	85
FDCB0596	RES 2, (IY+IND)	85
FDCB059E	RES 3, (IY+IND)	85
FDCB05A6	RES 4, (IY+IND)	85
FDCB05AE	RES 5, (IY+IND)	85
FDCB05B6	RES 6, (IY+IND)	85
FDCB05BE	RES 7, (IY+IND)	85
FDCB05C6	SET 0, (IY+IND)	84
FDCB05CE	SET 1, (IY+IND)	84
FDCB05D6	SET 2, (IY+IND)	84
FDCB05DE	SET 3, (IY+IND)	84
FDCB05E6	SET 4, (IY+IND)	84
FDCB05EE	SET 5, (IY+IND)	84
FDCB05F6	SET 6, (IY+IND)	84
FDCB05FE	SET 7, (IY+IND)	84
FDE1	POP IY	33
FDE3	EX (SP), IY	36
FDE5	PUSH IY	32
FDE9	JP (IY)	90
FDF9	LD SP, IY	30
FE20	CP N	52
FF	RST 38H	97

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Accountants Aid

James H. Sheats
2036 Headland Drive
East Point, GA 30344

From time to time accountants, bookkeepers, analysts and the rest of the number-scribbling fraternity (by whatever name called) pick up a sheet of columnar work paper, print a report title and date at the top, print columnar headings across the page, and start filling in lines and columns of figures.

Usually these sheets have both line and column totals, which should be equal when cross-footed. After considerable work with an adding machine and an eraser they usually are. Finally.

The Accountant's Writeup Aid is designed to eliminate some of the pain associated with this process. The program can be adapted to a number of purposes in its present state and can be customized to your own needs.

This program is written for a TRS-80, Level II, with a 132 column line printer (in the author's case, an IDS Paper Tiger). 4K of memory is plenty, since the program is very short, about 874 bytes.

```
10 REM "SPREAD SHEET"
20 REM PROGRAMMED BY JAMES H. SHEATS
30 REM                2036 HEADLAND DRIVE
40 REM                EAST POINT, GEORGIA 30344
50 REM                404-766-0857
52 CLEAR2000
53 DEFDBL C,T
55 CLS:LPRINT CHR$(31):LPRINT:LPRINT
60 PRINT"SPREAD SHEET PROGRAM"
65 INPUT"REPORT NAME";R$:LPRINT TAB(30)R$:LPRINT:LPRINT
68 INPUT"DATE";D$:LPRINT TAB(35)D$:LPRINT:LPRINT
70 INPUT"INPUT LINE NAME";L$
75 INPUT" NUMBER OF COLUMNS WANTED ";N
76 DIM C$(N),C(N),CT(N)
77 LPRINT USING"%            %"; L$;
80 FOR X=1 TO N
90 INPUT"COLUMN NAME";C$(X)
100 LPRINT USING"%        %";C$(X);
120 NEXT
125 LPRINT"TOTAL"
130 PRINTL$:INPUT L
140 IF L=999 THEN 200
144 LPRINT USING"###########";L;
145 T=0
150 FOR X=1 TO N
155 C(X)=0
160 PRINT C$(X),:INPUT C(X):T=T+C(X)
165 LPRINT USING"#######.##";C(X);
170 CT(X)=CT(X)+C(X)
180 NEXT X
185 PRINT "TOTAL";T:LPRINT USING"#######.##";T
190 GOTO 130
200 CLS:LPRINT: PRINT "TOTALS":LPRINT"TOTALS    ";:FOR X=1 TO N
204 PRINT C$(X),CT(X),
205 TT=TT+CT(X)
208 LPRINT USING"#######.##";CT(X);
210 NEXT X
220 PRINT "GRAND TOTAL ";TT
230 LPRINT USING"#######.##";TT
240 END
```

Program Listing

The Program

The program uses both screen and printer output, but users without printers can eliminate all LPRINT statements and still have a useful program.

The command on Line 55, LPRINT CHR$ (31), is a Paper Tiger control command that adjusts the line length to 132 characters. It may not be necessary with other printers. Lines 65 and 68 allow you to input a Report Name and Date. Both of these lines are unnecessary without a printer.

Line 70 is the reference name. This can be Date, Check Number, Invoice Number or other suitable reference. This entry is not used for any computations.

In Line 75, input the number of columns that you want for a particular task. This version of the program is written with 10 characters per column and will print the reference column, 11 data columns and a line total column. (See Fig. 1.) You may customize your LPRINT USING statements for more or fewer columns.

Lines 80-125 form a routine to input heading names for the columns.

In Lines 130-190, numerical data is input. Each entry may be positive, negative or zero. After accepting an entry for each column, the program prints a line total, and the routine is repeated for the next line. If an input error is made, the same reference number can be re-entered, zero quantities entered for the unchanged columns, and corrections made in the erroneous columns. This procedure is demonstrated in Fig. 1 for day 4.

This program loop is exited by inputting a reference number of 999, but you may establish your own loop exit. Upon exit from the loop, the program prints column totals and a grand total. At that point, the program terminates. This routine is in Lines 200-240.

One Disadvantage

One disadvantage to this program is that an entry must be made in each column, each time. However, a zero or an ENTER will do. No heading routines for second and subsequent pages are provided, either.

Still, for the computer owner/businessman, this simple program has a great deal of flexibility and should be in his library along with the amortization, checkbook balancing, depreciation and all the rest of the so-called "business" programs. ■

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2	2.15	2.75	2.75	1.50	3.50	0.60	0.60	12.18	2.55	0.00	45.00	73.58
3	2.50	2.90	18.95	5.00	0.00	0.60	1.20	3.50	6.75	0.00	45.00	86.40
4	200.00	2.25	3.25	1.50	6.75	0.60	1.20	3.50	2.75	350.00	0.00	571.80
4	-200.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-200.00
4	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00
5	0.00	0.00	6.15	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.40
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Fig. 1.

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Display your buffer contents in hex, ASCII or decimal.

Buffer Analysis

Robert M. Chambers
74 Stinson Ave.
Nepean, Ontario
Canada K2H 6N4

In my efforts to discover the various TRS-80 tape formats, I found that I had to write several assembler and BASIC programs to do little bits and pieces of the work.

To overcome the awkwardness of frequently loading the different programs, I decided to write one program which would do all the jobs.

Buffer Analyser is a program which displays the TRS-80's I/O buffer in ASCII, decimal or hexadecimal format.

The whole idea of this program is to read a record into the I/O buffer and display it on the screen in hex, decimal or ASCII. Using the I/O buffer overcomes the problem of truncated data which often occurs when a string variable is used.

According to the memory map provided in the Level II BASIC Reference Manual, the address of the I/O buffer begins at 16870 and ends at 17127. Using the PEEK instruction within FOR-NEXT loops and referencing this area, one byte at a time is accessed and processed for the chosen display format.

When the command menu is displayed, you press A for ASCII, H for hexadecimal, D for decimal, N to read the next tape record, C to clear the buffer and X to stop the run.

Hexadecimal display is most useful for my purposes and I have, therefore, supplied the list of compression codes in that (Table 1) form. This list is useful in analyzing BASIC program tapes and useful information to use for writing programs to renumber or change BASIC programs. These codes are used in memory and on tapes to reduce the amount of storage needed for BASIC programs.

The Level II manual also mentions that each line of BASIC code contains a carriage return, a two-byte line pointer and a two-byte line number. The TRS-80 Microcomputer Technical Reference Handbook says that a CSAVE will generate 128 zero bits, an A5 hex byte for synchronizing a read, a two-byte start address, a two-byte end address, the data and, finally, a one-byte check sum. The check sum is the sum of all the data.

When you examine the buffer you will not see a lot of this. A BASIC program in hex will start 00 2C D3 D3 D3. Presumably, this portion follows the sync byte A5, which is not shown. Using the code compression table below, you can find the start of the program statements and proceed to decipher the program. ■

ABS	D9	GET	A4	PUT	A5		
AND	D2	GOSUB	91	RANDOM	86		
ASC	F6	GOTO	8D	READ	8B		
ATN	E4	IF	8F	REM	93		
AUTO	B7	INKEY$	C9	RESET	82		
CDBL	F1	INP	DB	RESUME	9F		
CHR$	F7	INPUT	89	RESTORE	90		
CINT	EF	INSTR	C5	RETURN	92		
CLEAR	B8	INT	D8	RIGHT$	F9		
CLOAD	B9	KILL	AA	RND	DE		
CLOSE	A6	LEFT$	F8	RSET	AC		
CLS	84	LEN	F3	RUN	8E		
CMD	85	LET	8C	SAVE	AD		
CONT	B3	LINE	9C	SET	83		
COS	E1	LIST	B4	SGN	D7		
CSAVE	BA	LLIST	B5	SIN	E2		
CSNG	F0	LOAD	A7	SQR	DD		
CVD	E8	LOC	EA	STEP	CC		
CVI	E6	LOF	EB	STOP	94		
CVS	E7	LOG	DF	STR$	F4		
DATA	88	LPRINT	AF	STRING$	C4		
DEF	B0	LSET	AB	TAB(	BC		
DEFDBL	9B	MEM	C8	TAN	E3		
DEFINT	99	MERGE	A8	THEN	CA		
DEFSNG	9A	MID$	FA	TIME$	C7		
DEFSTR	98	MKD$	EE	TO	BD		
DELETE	B6	MKI$	EC	TROFF	97		
DIM	8A	MKS$	ED	TRON	96		
EDIT	9D	NAME	A9	USING	BF		
ELSE	95	NEW	BB	USR	C1		
END	80	NEXT	87	VAL	F5		
EOF	E9	NOT	CB	VARPTR	C0		
ERL	C2	ON	A1	+	CD		
ERR	C3	OPEN	A2	−	CE		
ERROR	9E	OR	D3	*	CF		
EXP	E0	OUT	A0	/	D0		
FIELD	A3	PEEK	E5	↑	D1		
FIX	F2	POINT	C6	>	D4		
FN	BE	POKE	B1	=	D5		
FOR	81	POS	DC	<	D6		
FRE	DA	PRINT	B2				

Table 1. Level II BASIC Compression Codes.

Program Listing.

```
1 CLEAR1000
5 A$="0123456789ABCDEF"
10 CLS:PRINTCHR$(23):PRINT@528,"BUFFER ANALYZER";:FORZ=
    1TO1200:NEXTZ
15 GOTO30        REM >>>>>>> TO MAIN LINE START <<<<<<<<
20 CLS:AF$=CHR$(0):PRINT@530,"PRESS A KEY TO READ THE N
    EXT RECORD";
25 AF$=INKEY$:IFAF$<CHR$(1)THEN25ELSECLS:PRINT@534,"TAP
    E RECORD BEING READ";:INPUT#-1,B$
30 AF$=CHR$(0):CLS:PRINT@412,"PRESS";:PRINT@515,"A FOR
    ASCII, H FOR HEX, D FOR DECIMAL N FOR NEXT OR X TO
     END";:PRINT@658,"PRESS C TO CLEAR THE BUFFER";
35 AF$=INKEY$:IFAF$<CHR$(1)THEN35
40 IFAF$="A"THENGOSUB176:GOTO500
45 IFAF$="H"THENGOSUB95: GOTO500
50 IFAF$="D"THENGOSUB200:GOTO500
55 IFAF$="N"THEN          GOTO20
60 IFAF$="X"THENCLS:     GOTO999
65 IFAF$="C"THENGOSUB700:GOTO30
90 GOTO30
94 '**************************************************
    *****
95 '***** THE CONVERT BUFFER AND DISPAY IN HEX ROUTINE
    *****
96 '**************************************************
    *****
100 CLS
150 FORX=16870TO17127:A=PEEK(X)
```

```
155 B=FIX(A/16):C=B*16:D=A-C
160 PRINTMID$(A$,B+1,1);MID$(A$,D+1,1);" ";
165 NEXTX
170 RETURN
175 '**************************************************
     *****
176 '***** THE READ BUFFER AND DISPLAY IN ASCII ROUTINE
     ****
177 '**************************************************
     *****
180 CLS
185 FORX=16870TO17127:PRINTCHR$(PEEK(X));" ";:NEXTX
190 RETURN
199 '**************************************************
     *****
200 '**** THE READ BUFFER AND DISPLAY IN DECIMAL ROUTIN
    E ***
201 '**************************************************
     *****
205 CLS
210 FORX=16870TO17127:PRINTPEEK(X);:NEXTX
234 RETURN
235 '**************************************************
     *****
500 '******** THE DELAY AT END OF DISPLAY ROUTINE *****
     *****
501 '**************************************************
     *****
505 AF$=CHR$(0)
510 AF$=INKEY$:IFAF$<CHR$(1)THEN510
515 GOTO30:        REM BACK TO MAIN LINE
599 '**************************************************
     *****
700 '************** CLEAR BUFFER ROUTINE **************
     *****
701 '**************************************************
     *****
702 CLS:PRINT@540,"CLEARING";
705 FORX=16870TO17127:POKEX,0:NEXTX
706 CLS:PRINT@540,"CLEARED!";:FORZ=1TO333:NEXTZ
710 RETURN
997 '***************** THE END ROUTINE ****************
     *****
998 '**************************************************
     *****
999 END
1000 '*************************************************
     *****
```


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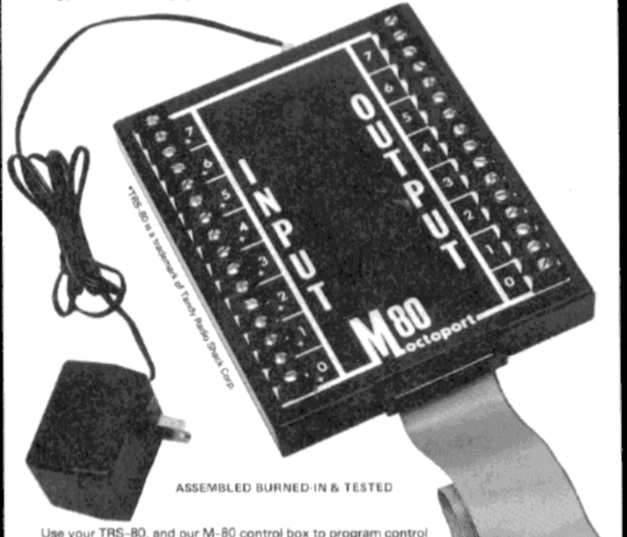

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Display Formatting

Allan S. Joffe W3KBM
1005 Twining Road
Dresher PA 19025

The time will soon arrive when you wish to display large numbers of data bits on your monitor. You have been aware of the formatting aids, such as the four printing zones and the TAB function, built into the TRS-80. As a start, enter Listing 1 and Listing 2 and run first one and then the other for comparison.

You may have to carefully examine Listing 2 to fathom how you got the same 40 numbers that Listing 1 gave you. The item of concern is really the difference in format. In Listing 1 the consecutive numbering is basically horizontal, while in Listing 2 the consecutive numbering pattern is basically vertical. While it is a matter of choice, I prefer the Listing 1 approach when formatting data on the video screen.

Modifications

Now consider this slightly revised version of Listing 1. If you are working with this article at your computer (which is the way to fly), just make the appropriate changes in the listing on your screen (see Example 1). In line 7 there are three spaces between each X, X↑3 couplet.

When you run this program, you will see we have added some data to illustrate the formatting look. Beside each value of X (1 to 40) we now show the cube of each X value. If your TRS-80 has the same firmware quirk that my machine has, it will show a value of 8000.01 as the cube of 20. Now look at Example 2.

Line 70 may be a momentary headscratcher, but if you worked out how line 70 in Listing 2 functioned, the new line 70 in Example 2 will fall into place. Once again the difference in formats is a matter of taste and what you are used to. I personally opt for Listing 2.

Another formatting aid is shown in Listing 3. The equation in line 20 is a centigrade (Celsius) to Fahrenheit conversion based on the fact that −40 degrees is a point of numerical equality for both systems. Line 10 prints out Celsius temperatures from 0 to 102 degrees in steps of 2 degrees (in conjunction with line 30), and with the further aid of line 30, prints the corresponding Fahrenheit temperature beside the Celsius temperature.

The real value you get from this effort will only come if you enter the programs into your computer. Once you have a feel for and an understanding of the methods outlined here, then comes the fun. You can experiment and improvise, and in so doing you are in great danger of becoming a better programmer. Don't say I didn't warn you! ■

```
5  CLS
10 FOR X = 1 TO 40
20 PRINT X,
30 NEXT X
40 END
```

Listing 1.

```
50 CLS
60 FOR X = 1 TO 10
70 PRINT X,X + 10,X + 20,X + 30
80 NEXT X
90 END
```

Listing 2.

```
5  CLS
7  PRINT @0,"X   X↑3","X   X↑3","X   X↑3","X   X↑3"
10 FOR X = 1 TO 40
20 PRINT X; X↑3,
30 NEXT X
40 END
```

Example 1.

```
50 CLS
55 PRINT @0, "X   X↑3", "X   X↑3", "X   X↑3", "X   X↑3"
60 FOR X = 1 TO 10
70 PRINT X;X↑3,X + 10;(X + 10)↑3,X + 20;(X + 20)↑3, X + 30;(X + 30)↑3
80 NEXT X
90 END
```

Example 2.

```
5  CLS
10 FOR C = 0 TO 24 STEP 2
20 F = ((C + 40)*1.8) - 40
30 PRINT C;F,C + 26;F + 46.8,C + 52;F + 93.6,C + 78;F + 140.4
40 NEXT C
```

Listing 3.

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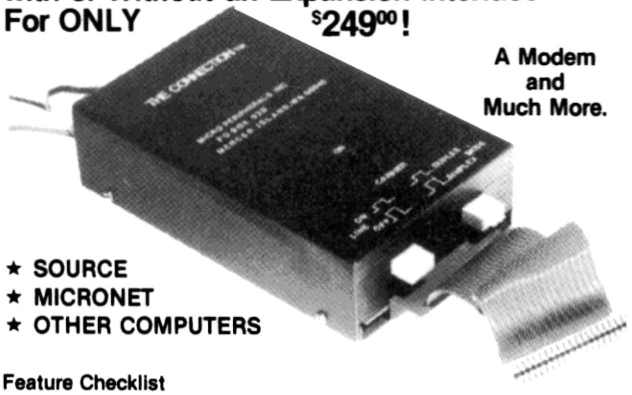

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```
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S H N O B T X A D O F R E E I D E A S E E D S R P V Y X X O N
V L T W G Y R O S G R E D P V J K L M R H E C T V X H N A F H
B J E L F E Q A Z G Z P P C R Y P T O U P Z A X Z Q J E J T S
Z D Q I N K F S N A G T H L G F J S E Y W T V N P F J V Z V C
B V L F G U L M N S N E K O T T S C Y M B C G W B Q O F M P O
U O V Z K B F I Ø E P U Y A S E X M O L E R Z J X A C H Y R U
P K B M Y U C W O C G L D M R X S E W M C Z T I O N G U L Y K
Z M H O U P X B L K A C A P J J U K B F L I P C N E F Q A F E
J W T A Y C J G W H E T M N H A Q Z Q J L O W E R C A S E T H
H R S S K V C D G C B O A P T G T H T X T P M L E I L R E T Q
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Have you ever wanted to use your computer as part of a measurement system? Soon after getting a computer, I began to wish that I could use it for recording and analyzing measurements from test instruments.

The thought of my computer functioning as a data logging tool was enticing, but the thought of having to manually key in the data was not. There had to be a better way!

Parallel Ports

Fortunately there is a better way. I am referring to the parallel port, that neglected feature commonly used for little more than reading keyboards or driving printers.

You can create both the hardware and software necessary to link your computer to outside measuring instruments without having to learn assembly language, since everything can be done under BASIC.

Although most of what is presented is oriented toward the TRS-80, it is by no means limited to it. The S-100 bus computers are equally usable. Let's look at some of the requirements for linking test equipment to a computer.

First, the data must be in a computer recognizable format and at TTL compatible levels. However, this does not mean that we are restricted to using only binary numbers. Binary code makes the most efficient use in space of a given number of bits but it is not always the easiest code to use.

By redefining the meaning of each bit position in an eight-bit-word, we can make the code easier to work with in terms of the outside world. This is called binary coded decimal, or BCD for short.

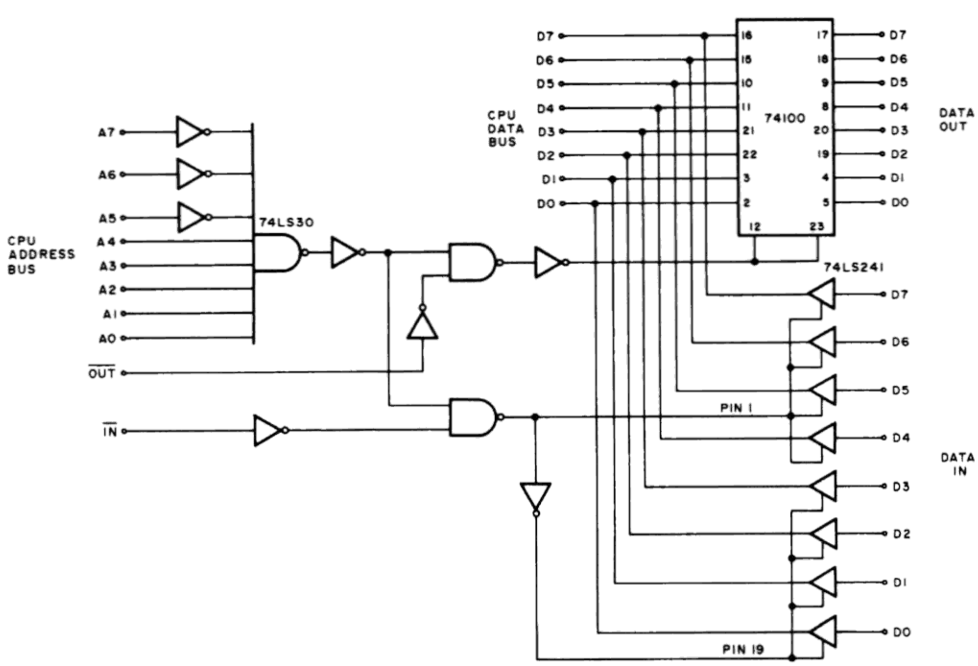

Fig. 1. One Parallel I/O Port. This example shows address 31 decoded.

BCD Data

A single eight-bit-word can express any binary value from 00000000 to 11111111, or from 0 to 255 decimal. In a single-decimal-digit, it takes four bits to specify any of the possible values from 0 to 9. The remaining binary combinations from 11 to 15 are discarded.

Since the computer operates on eight-bit-data, it is only logical to use the remaining four bit positions to represent another digit. Thus an eight-bit-word can be used to represent any number between 0 and 99 in BCD format. Unlike a straight binary format, we now have some bit patterns that are illegal. Example 1 shows how this process works.

Why go to BCD? A quick look through an IC catalog will give part of the answer. Many common components such as counters, A/D converters, and clock chips have BCD outputs already available. Many commercially available measuring instruments have auxiliary outputs that are BCD coded.

In addition, it is easier to tailor your computer to the number of digits you wish to resolve by using BCD.

BCD also has some disadvantages. First is the need for a method of converting between BCD and binary.

Second, to have a large number of BCD interfaces you must also have a large number of interconnections. Remember that each digit requires four bits, therefore four leads will be needed. For a six-digit frequency counter this means 24 bulky connections. (Multiplexing can cut this down but that gets more complicated.)

Hardware

Let's look at what it takes to get parallel data in and out of our computer. The TRS-80 has an edge connector on the back left that provides access to the CPU bus inside.

An explanation of the pinout can be found in the back of the Level I manual. Oddly enough, this diagram was omitted from the Level II manual in the system I worked on. You will need Level II BASIC to make both the hardware and software function properly.

The parts of the bus that interest us are the address lines, the data lines and the two control lines labelled $\overline{IN}$ and $\overline{OUT}$. The Z-80 CPU can address up to 256 I/O ports. When this is done in the TRS-80, the CPU places the port address (0-255) on the lower eight address lines and issues the appropriate $\overline{IN}$ or $\overline{OUT}$ control command at the rear connector.

If a word is being written to the port, the data bus will contain the byte being output and the $\overline{OUT}$ line will be strobed low. If an input byte is requested, the data bus is tri-stated to allow the input port hardware to place its byte on the bus and the $\overline{IN}$ line is strobed low.

Whether a specific port number is used for input or output depends upon the design of the external hardware. It can be both.

The first requirement in setting up a parallel port is for the computer to recognize its port address. This means we must decode a particular address. At the same time we must check to see if either the $\overline{IN}$ or $\overline{OUT}$ line is valid. These control lines tell us that the address is a port and not a memory.

Fig. 1 shows an example of how this works. First we must pick an address that is not already in use. Let's use 31 as an example.

The address bus has the appropriate lines inverted to make the inputs to the eight input NAND gate high when address 31 is given. This signal is inverted and gated with the inverted $\overline{OUT}$ command to form a strobe pulse for the latch.

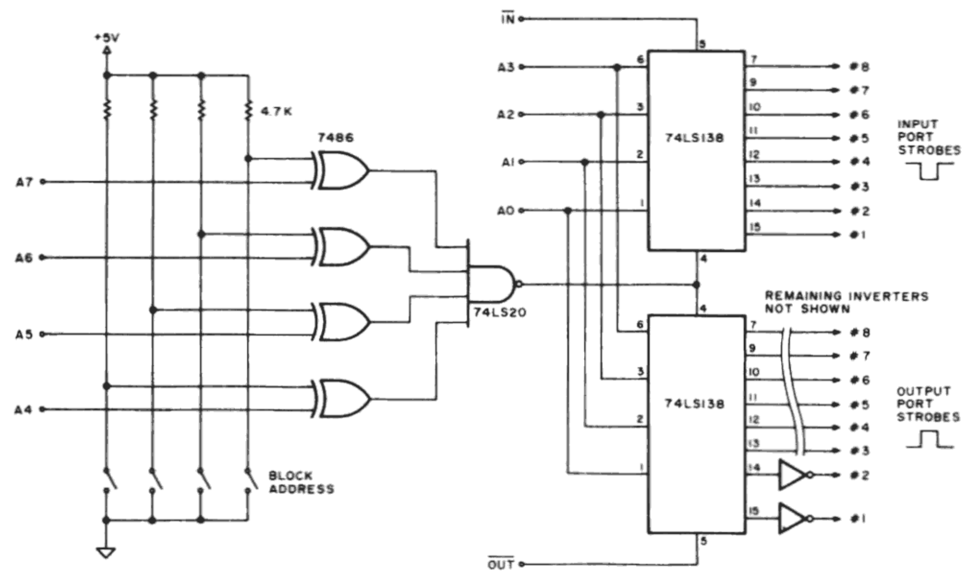

Fig. 2. Decoding 8 Parallel I/O Ports. Input & output circuits are the same as Fig. 2.

For an input port we decode the address in the same way except we use the $\overline{IN}$ line. Instead of a latch, we must now use a tri-state buffer to place the input byte on the data bus. Note that it is possible for an input and an output port to have the same numerical address. The control lines tell which of the two is to be active.

Multiple Ports

Obviously, a single I/O port will not suffice for all measurement applications. In order to address at least four, and preferably eight ports, the address is decoded differently.

First, we will say that all port addresses will be contiguous, or numerically sequential. The lowest address will be the boundary of the block. Since eight ports will require three bits for the address within the block, this leaves five bits to define the block boundary.

Addressing a specific port now requires three events to be true: The proper boundary as defined by A3–A7; the proper three-bit address as defined by A0–A2; and the $\overline{IN}$ or $\overline{OUT}$ command as appropriate. Fig. 2 illustrates this. (There are other ways of implementing parallel I/O ports. This method is shown because of its simplicity and the low cost of the parts.)

If a full eight ports are placed on the bus, it should be buffered. If not, there is the possibility of overloading the bus with all the additional decoding and latching circuitry.

Also, if you locate your interface at the end of several feet of cable, you can introduce error causing reflections onto the bus. As a final thought, consider the consequences if something goes haywire externally; you end up damaging some ICs and your connections are straight onto the bus. Need I say more?

I built my buffer using tri-state gates on a small card that plugged straight into the edge connector. The buffer in turn had its own edge connector where the cable from the expansion interface was attached. I retained full use of the extra memory and the disk drive.

Circuit speed posed no problem. The $\overline{IN}$ and $\overline{OUT}$ signals are 1.4 microseconds wide, more than adequate settling time.

Incidentally, the manual showed one of the pins on the edge connector providing +5 volts. Check before you use it as mine turned out to be a ground. Because of the power draw of an eight port interface, plan on building a separate power supply.

(If you are working with an S-100 computer, see the article on building parallel port interfaces in the Oct. '77 issue of *Microcomputing*, pp. 102-108. Although the mechanics of decoding differ slightly, all other

BINARY	BCD	DECIMAL
01010010	10000010	82
01001101	01111001	79
00000011	00000011	3
10000000	ILLEGAL	128

01010110 BCD = 56 DECIMAL

Example 1. Binary, BCD and Decimal Equivalents. One byte can represent any two digit number.

```
1000 REM BCD SUBROUTINE
1010 N = INP(8)             N = 10010101 = 95 BCD
1020 N1 = N AND 15          N1 = 00000101 = 5
1030 N2 = N AND 240         N2 = 10010000 = 9
1040 N2 = N2/16             N = 10 * 9 + 5 = 95
1050 N = 10 * N2 + N1
1060 RETURN
```

Example 2. Subroutine to read an decode two BCD digits. Bit masking and shifting are employed.

principles remain the same.)

Check your work by instructing the processor to write a specific byte to a port. Verify this with any instruments, from an LED to an oscilloscope.

At the same time make sure that none of the other output ports are affected.

To check an input port, selectively ground each bit and verify that the binary number returned changes by the appropriate power of two.

Software

Now that the hardware has been resolved, let's look at the necessary software. Under Level II BASIC we will make use of some special commands. The first are INP(X) and OUT(X,Y).

The statement A = INP(8) instructs the computer to read input port #8 and equate the value there to the variable A. (Note that at this time A can be from 0 to 255 decimal.)

To write to a port, tell the computer to OUT 8,Y and the value of Y in binary (not BCD) will appear on port #8. In the examples I am describing we cannot handle floating point numbers.

Now we need the ability to selectively examine specific bits for deciphering the incoming BCD data. Earlier I said that one byte, and therefore one port, can represent two BCD digits. Since the computer uses binary and we are using BCD, some translating will be necessary.

Assume we are using port #8 and that it contains the BCD representation of the number 95. Our program must read the port and return the number 95 in binary to the processor.

The first step reads the port and places the number in the variable N. Next we mask off, or zero, the four most significant bits, leaving only the units digit. This is directly equated to the variable N1 for temporary storage.

Then the four least significant bits of N are masked and the remaining bits are shifted right four places. This number is directly equated to N2 for storage. An artificial binary number is now created from each half of the BCD byte. Since the four least significant bits equate directly to 0–9 (not counting the illegals), the interpreted digit must lie in the four least significant bit positions. Anything else will give an erroneous result.

The final step is to multiply N2 by 10, add it to N1 and return the number as N. If this process is made into a subroutine, any portion of the program can get a two-digit number from port #8.

Example 2 shows the mechanics and the coding in more detail. Try it longhand to convince yourself that it works.

```
1000 REM 6 DIGIT BCD READ
1010 N1 = INP(8)
1020 N2 = INP(9)
1030 N3 = INP(10)
1040 N1 = N1 AND 15 + (N1 AND 240)/16 * 10
1050 N2 = N2 AND 15 + (N2 AND 240)/16 * 10
1060 N3 = N3 AND 15 + (N3 AND 240)/16 * 10
1070 N = N1 + 100*N2 + 10000*N3
1080 RETURN
```

Example 3. 6 digit BCD read subroutine.

Masking

The masking process is the key step in the conversion. Using the AND command makes it possible to selectively turn off any combination of bits in a word and leave the remainder unchanged.

Think of each bit in the input byte as one input to an AND gate and the other gate input as being the corresponding bit position in the mask word. If the mask bit is high, the gate output equals the second input bit.

If the mask bit is a zero, then the gate output is a zero, regardless of the state of the other bit. This command will act on all eight bits at once.

To determine the numerical value of the mask word, add the binary weight of the bit positions you want left unchanged.

Following the masking process (which leaves the tens digit), the shift right by four is accomplished through dividing by 16. Since dividing by two is the same as shifting every bit position right by one, it follows that a division by 16 will produce four shifts to the right. The code in Example 2 is shown one step at a time for clarity.

To obtain more than two digits of resolution (one part in a hundred is inadequate in many cases) use some of the additional ports to give whatever amount is necessary.

Each port is treated as in Example 2 except that the decoded numbers are scaled by the appropriate power of ten before being added. Remember when I said how easy it was to scale the system for any number of digits? All you have to do is to allocate sufficient ports and do the appropriate decimal scaling on the numbers. Example 3 shows a subroutine for reading a six-digit frequency counter connected to three input ports.

Output ports can be used to control relays, triacs, D/A converters, etc. One port can be used to control eight separate circuits by means of TTL compatible reed relays or optical isolators. The OR command controls any specific bit without affecting the others.

To establish how fast I could transfer values in and out I tried a couple of benchmark programs. In each case the program transferred 1000 values to a single port in a FOR NEXT loop while doing nothing else. The output was finished in 6.4 seconds while the input took 7.3 seconds. Using the subroutine in Example 3 took 115 seconds.

Obviously the calculations

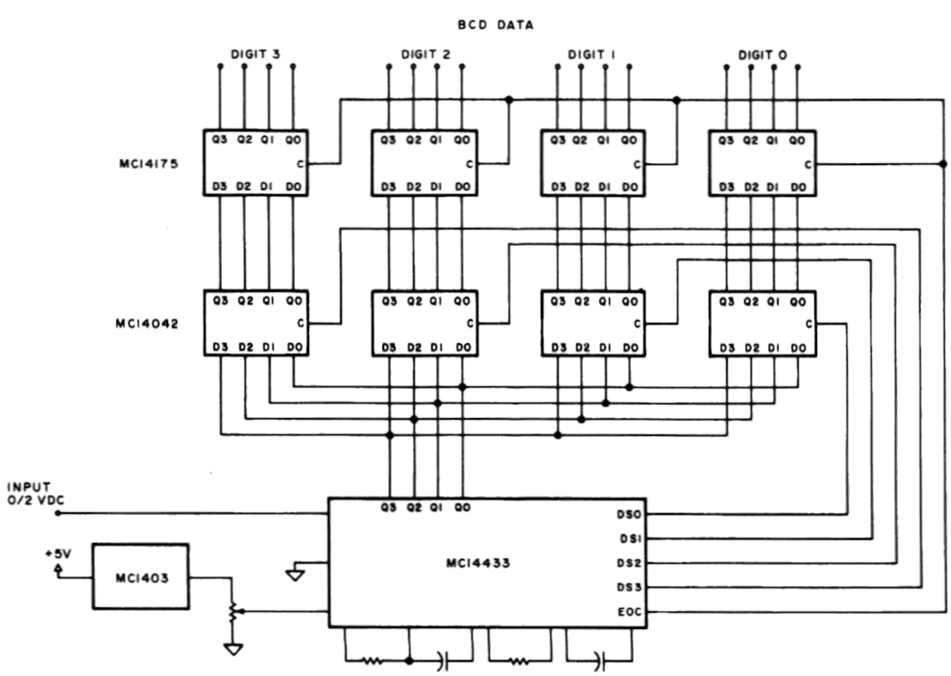

Fig. 3. Interfacing a DVM chip. Multiplexed data is in latched parallel format.

take their toll in speed. Consider however, the application you will be involved with, and if your experience echoes mine, the comparatively low speed is of little matter.

What is important is that the computer is now doing more work and the programmer less! Also, it is almost always necessary for the computer to wait idly while the external instrument makes its measurement.

A do nothing FOR NEXT loop can be used as a timer for such occasions. I have found that 340 iterations take one second.

Examples

Let's look at a circuit that uses the methods I have described. Fig. 3 shows an analog to a digital converter using the Motorola MC14433 IC. This chip is the basic building block for a 3½ digit DVM.

Note that most of the parts are used to convert the multiplexed BCD output to parallel latched BCD, which is compatible with the software described. This is a typical requirement for most instruments. In this application the multiplexing works against us. It is possible to directly read a multiplexed output, but it requires an intimate knowledge of the timing of both the instrument and the computer.

To do this, the computer must test the digit position it needs to read. When that digit is enabled, it must be read before the scan continues. All digits must be read in one scan so that an erroneous reading will not be returned. This would occur if the measuring instrument updated its reading to a new value while the computer was still trying to read the remainder of the original one.

Taking two readings and comparing them before returning to the calling program is a worthwhile check, if BASIC reads the data.

The circuit shown in Fig. 3 illustrates a typical requirement for latching multiplexed data. If you intend to build it, or need more information on this particular device, consult the Motorola CMOS manual.

You can also call a machine-language program from BASIC to demultiplex the data in software and POKE the digit pairs into successive memory locations. This eliminates the demultiplexing hardware.

The subroutine in BASIC would then be modified to PEEK the memory locations as a source of data. Since the final program will depend on the specific instrument being interfaced I will leave the rest to you. ■

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What about the time you designed a real-time two-player video game and tried to process several keys at once? Again you were left hanging, since INKEY only processes the last key pressed. You can overcome these INKEY limitations by directly accessing your keyboard memory, PEEKing.

The Keyboard

The TRS-80 keyboard consists of 53 single-pole single-throw normally open keys. The keyboard is designed as an 8 by 8 matrix with the eight address lines (A0–A7) running horizontally and the eight data lines (D0–D7) running vertically (Fig. 1).

The keys are divided into eight groups, most of them having eight keys per group. Each key represents an intersection of one address line and one data line. The CPU scans the data lines looking for an 'on' condition (logical 1); once this is found it begins scanning the address lines for a similar 'on' condition.

For example, if C is pressed the data value eight is stored into decimal address 14337; likewise if 5 is pressed the data value 32 is stored into decimal address 14352. This informatoin is then processed by the Level II ROM which checks to see if the shift key has been pressed and then converts the code into the correct ASCII equivalent.

Program Listing 1 generates Fig. 1 using Level II BASIC. Use it in the future when a program requires direct access to keyboard memory.

The reason direct access to keyboard memory is so useful is because a key's value can be repeated. The instant a key of a certain group is held down the address of that group will continue to have that key's data value as long as the key is held down. Once the key is let up, the value in that address immediately goes to zero. As long as a certain data value is contained within a group address you can execute a set of instructions. This function eliminates the frustration of using INKEY in your quick interactive games.

Another INKEY weakness is that it can only return one keystroke at any given time. Using PEEK you can detect two, three or even more keys being held down.

There are two ways of doing this depending on what type of processing you need. If you need speed, design your program to use keys of the same group—one PEEK and several IF statements in a row.

When looking for a single key pressed, use whatever data value is associated with that particular key. To check for two keys being pressed at the same time, take the data value of both keys, add them together and that is the value to check for.

For example, suppose we want to make a game that moves a rocket up and down the left side of the screen and fires to the right from wherever it is currently located. The program might work as follows: to go up, press the up arrow; to go down, press the down arrow; to fire, press both the up and the down arrows.

Note that the arrows are located in key group A6. The keyboard routine might look something like this:

```
100 Z = PEEK(14400)
200 IF Z = 8 GOTO 600
300 IF Z = 16 GOTO 700
400 IF Z = 24 GOTO 800
500 GOTO 100
    REM CONTINUE KEYBOARD
```

```
10 CLS:PRINT TAB(21)"KEYBOARD INTERROGATION":PRINT
20 PRINT"ADDRESS":X=14337:D=1:C=64:Z=192:Y=Z
30 FORI=1TO4:GOSUB500:NEXTI
40 C=48:FORI=1TO2:GOSUB500:NEXTI
50 PRINT@Y,X:Y=Y+8:PRINT@Y,"ENTER  CLEAR  BREAK";
60 C=91:Y=Y+23:FORI=1TO4:PRINT@Y,CHR$(C);
70 C=C+1:Y=Y+7:NEXTI
80 PRINT@Y-2,"SPACE";:Z=Z+64:X=X+D
90 PRINT@Z,X:PRINT@Z+8,"SHIFT";
100 PRINT@731,"DATA VALUE";
110 Y=777:D=1
120 FORI=1TO8:PRINT@Y,D:D=D*2:Y=Y+7
130 NEXTI
140 GOTO140
500 PRINT@Y,X:Y=Y+3:FORJ=1TO8
510 Y=Y+7:IFC>90THEN PRINT@Y," ":GOTO530
520 PRINT@Y,CHR$(C):C=C+1:IFC=60 THEN C=44
530 NEXTJ:Z=Z+64:Y=Z:X=X+D:D=D*2
540 RETURN
550 END
```

Program Listing 1.

```
1000 CLS
1100 DIMH(3)::H(1)=32:H(2)=32:H(3)=32:X=16349:Y=0
1200 PRINT@  1,"     *                    THIS PROGRAM DEMONSTRATES               *"
1300 PRINT@ 65,"  ***             >>>  ALTERNATE KEYBOARD SCAN  <<<             ***"
1400 PRINT@129,"***** >>>  SIMULTANEOUS PROCESSING OF MULTIPLE KEYS  <<< *****"
1500 PRINT@193,"  ***       >>>  SINGLE AND REPEAT KEY FUNCTION  <<<            ***"
1600 PRINT@257,"     *      >>>  ALL USING THE BASIC PEEK FUNCTION  <<<         *"
1700 PRINT@402,CHR$(91)" - MOVES ROCKET UP"
1800 PRINT@466,CHR$(92)" - MOVES ROCKET DOWN"
1900 PRINT@530,CHR$(93)" - MOVES ROCKET LEFT"
2000 PRINT@594,CHR$(94)" - MOVES ROCKET RIGHT"
2100 PRINT@654,CHR$(91)" + "CHR$(93)" - MOVES ROCKET UP AND LEFT"
2200 PRINT@718,CHR$(91)" + "CHR$(94)" - MOVES ROCKET UP AND RIGHT"
2300 PRINT@782,CHR$(92)" + "CHR$(93)" - MOVES ROCKET DOWN AND LEFT"
2400 PRINT@846,CHR$(92)" + "CHR$(94)" - MOVES ROCKET DOWN AND RIGHT"
2500 POKEX-1,H(1):POKEX,H(2):POKEX+1,H(3)
2600 X=X+Y:H(1)=PEEK(X-1):H(2)=PEEK(X):H(3)=PEEK(X+1)
2700 POKEX-1,188:POKEX,143:POKEX+1,188
2800 GOSUB3600
2900 IFX+Y-1<15360ANDY=-67THENY=-3
3000 IFX+Y-1<15360ANDY=-61THENY=3
3100 IFX+Y-1<15360THENY=0
3200 IFX+Y+1>16383ANDY=67THENY=3
3300 IFX+Y+1>16383ANDY=61THENY=-3
3400 IFX+Y+1>16383THENY=0
3500 GOTO2500
3600 Z=PEEK(14400)
3700 IFZ=8THENY=-64
3800 IFZ=16THENY=64
3900 IFZ=32THENY=-3
4000 IFZ=64THENY=3
4100 IFZ=40THENY=-67
4200 IFZ=72THENY=-61
4300 IFZ=48THENY=61
4400 IFZ=80THENY=67
4500 IFZ=0THEN3600
4600 RETURN
```

Program Listing 2.

600 Process up arrow and GOTO 100
700 Process down arrow and GOTO 100
800 Process both arrows and GOTO 100

Two or more keys pressed that are not in the same group must be checked separately. For example, if you are looking for the A and L keys pressed at the same time you can check it as follows:

```
X=PEEK(14337)
Y=PEEK(14338)
IF X=2 AND Y=16 GOTO ____
```

Keyboard Interrogation

Program Listing 2 is a demonstration of keyboard memory interrogation. The following is a brief description of each routine in Program 2:

1000–2400	Set up screen
2500–2700	Saves next rocket position Restores old position Moves rocket to next position
2800	Call keyboard scan
2900–3400	Make sure rocket doesn't go off top or bottom
3500	Continue looping
.....	KEYBOARD SCAN
3600	Get data value
3700	Checks for up arrow
3800	Checks for down arrow
3900	Checks for left arrow
4000	Checks for right arrow
4100	Checks for up and left arrows
4200	Checks for up and right arrows
4300	Checks for down and left arrows
4400	Checks for down and right arrows
4500	Checks for no input—branches if true
4600	Return to main program

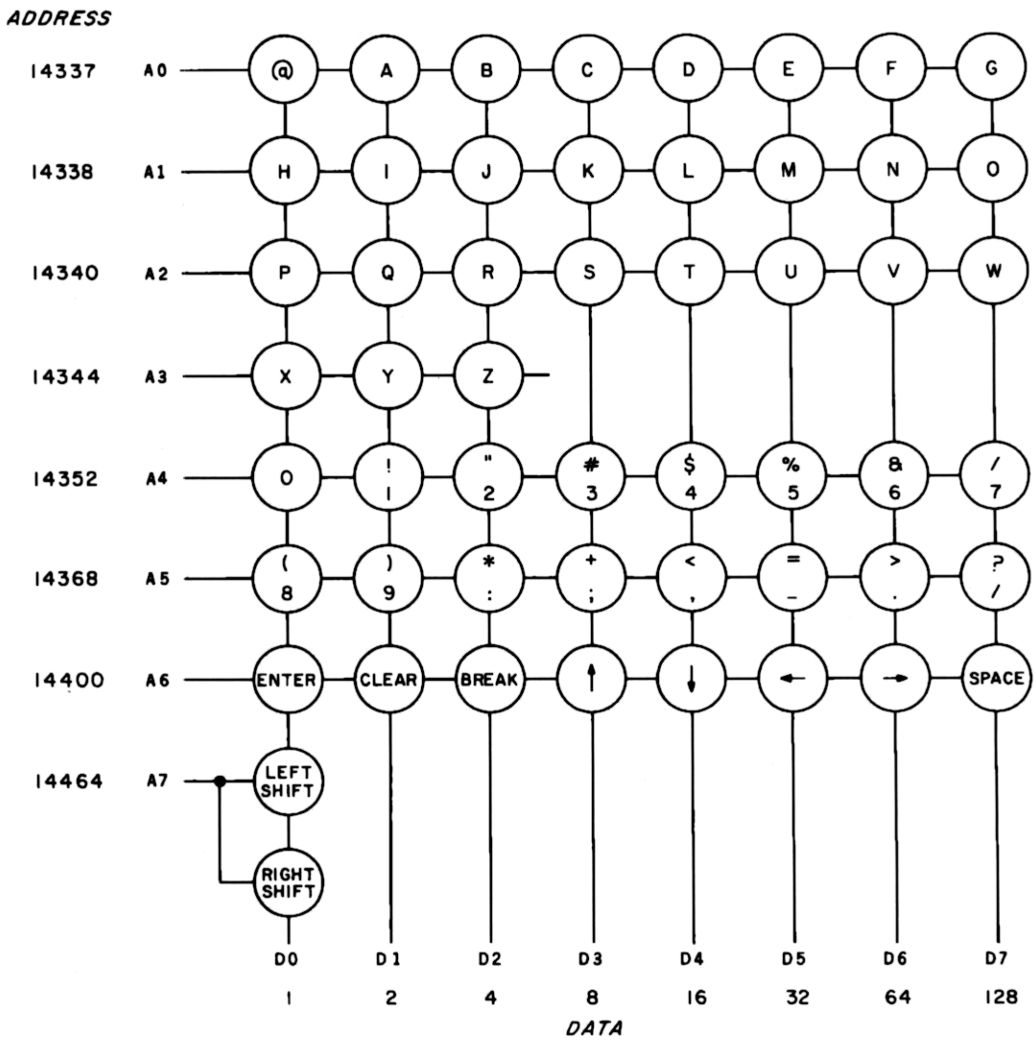

Fig. 1.

Conclusion

In order to receive a response using the PEEK function, the key must be held down at the time the PEEK statement is executed. You will receive the same response as long as you hold down the key.

You can access all the keys using PEEK, except for BREAK and CLEAR. The reason being the Level II ROM Interpreter is constantly checking these keys and has priority over them.

INKEY remains a powerful function that allows input of an ASCII character (string) that can be used without further processing. Using a combination of INKEY and directly accessing the keyboard memory, PEEK, you will be able to meet most of your programming needs. ■

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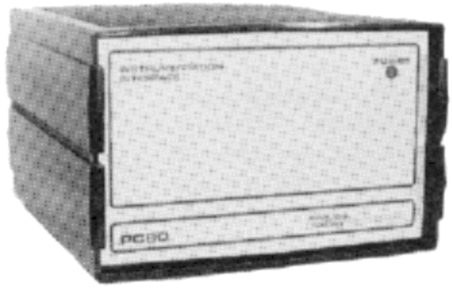

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Use a Model 33 with your TRS-80, with no hardware modifications to your CPU.

Teletype Interface

Peter E. Noeth
6906 Lenwood Way
San Jose CA 95120

Perhaps, like myself, you don't have a line printer to obtain hard copy from your TRS-80 but do have access to a Model 33 Teletype. The following circuit and assembly language program provides the necessary interface to the TRS-80 CPU (keyboard) through a 40-pin ribbon cable without making any modifications to the unit. It requires the Level II ROM modification.

Whenever you power up your TRS-80, this program must be entered and started. If a program you are running crashes and you get "memory size" displayed on your screen, the program must be restarted because the normal initialization routine within the ROM will place the regular line printer pointer (058DH) in location 4026H and 4027H. If this happens, the teletype will still print but will not provide a line feed for each carriage return.

The Circuit

The address decoder section, made up of the 74LS30, 74LS139, 74LS155 and one gate of the 74LS04, decodes the address 37E8H. This is the memory mapped address for the line printer. When it is available on the address bus and RD line is pulsed low, pin-5 of the 74LS155 goes low enabling the Tri-State Buffer 74LS367. This places the binary bits 0011 or 3H on data lines D4-D7. The printer status routine within the ROM is looking for this combination to determine that the printer is ready for a character. The four bits are associated to the logic within the TRS-80 line printer. This interface only requires the use of one bit to indicate the printer is busy with an output.

If the WR is pulsed low when the address is decoded, pin-11 of the 74LS155 goes low taking pin-25 (TBRL) low on the UART. This loads the character on the data lines into the UART's internal buffer. Then, it is transferred to the transmit register for output as serial data on pin-25 (TRO).

The Intersil IM6402 UART that I used has two signals which indicate this activity.

Pin-22 (TRBE) goes low when the buffer is being loaded. Pin-24 (TRE) goes low for the duration of the output of the character on Pin-25 (TRO).

These two signals are ANDed together by the 74LS03. Its output is used to indicate "busy" status to the TRS-80. See Fig. 1 for the timing diagram.

The UART's reset is tied to the TRS-80 system reset line so that when you hit the reset button on your TRS-80, the UART will also be reset and will clear its internal registers.

The NE555 timer chip is used to provide the necessary clock input to the UART. The clock rate is 16×, therefore, an input frequency of 1.76 KHz will provide serial output of 110 Baud. The adjustment can be made with a frequency meter on pin-3 of the timer, if you have one, or can be adjusted using the teletype itself as follows: input the following basic program and enter run.

```
10 LPRINT "This is a test"
20 GOTO 10
```

This provides a continuous output to the teletype. Adjust the 50K potentiometer until the teletype begins to type the line correctly. Continue to turn the potentiometer until the teletype stops printing the message correctly. Noting the number of turns between these two points, readjust the potentiometer to a point midway. This should then provide the proper Baud rate.

The output at Pin-25 (TRO) is input to a gate of the 74LS04 which is used as a buffer for the 20MA current loop circuit. The two points marked + and − should be tied to the printer magnets in your Model 33 teletype using its instruction manual for the proper connections.

Hardware

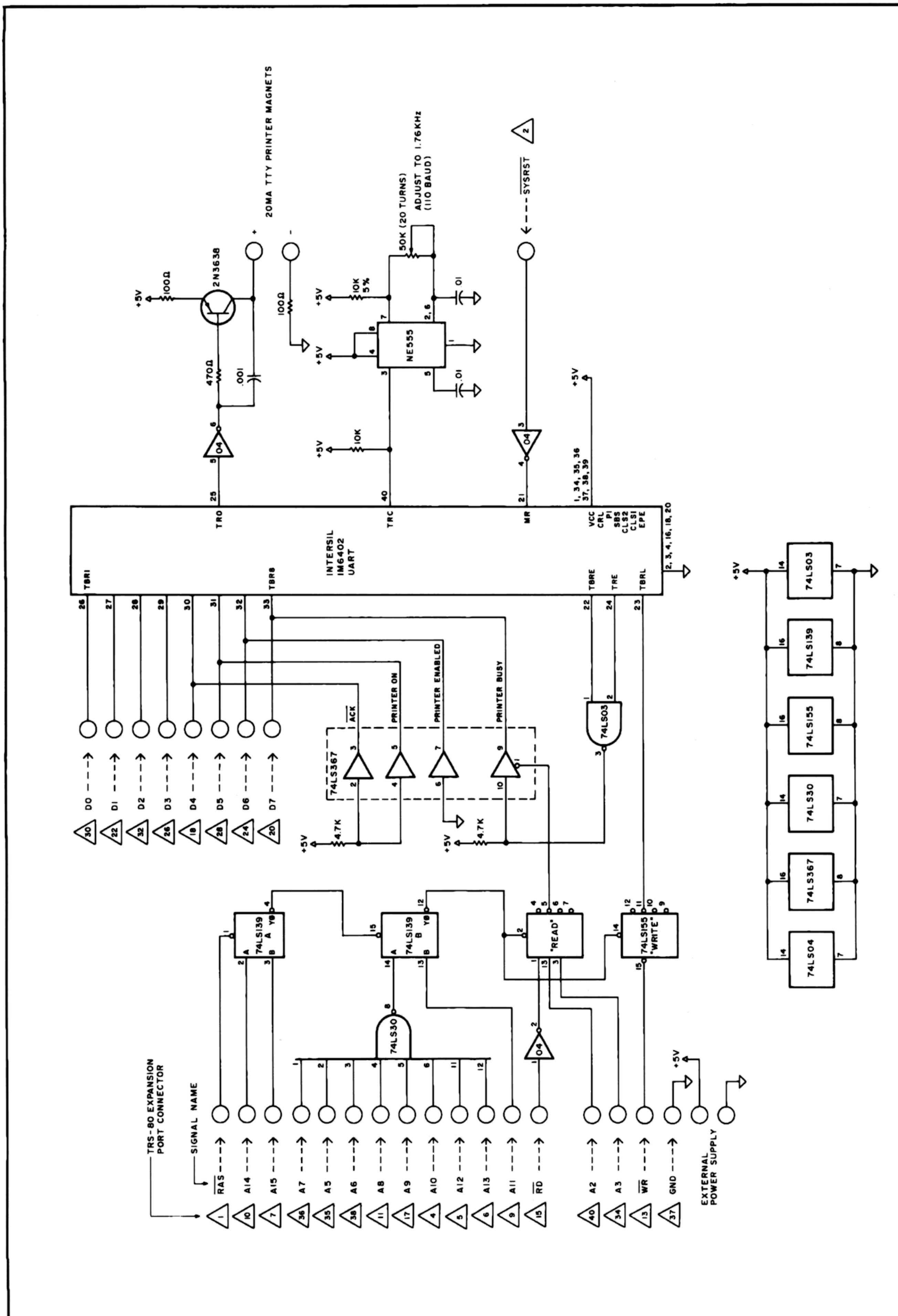
I built my interface on a general purpose wirewrap card with a 44-pin card edge connector using sockets for all ICs. The ribbon cable was soldered to a 44-pin card edge connector as were the connections for the teletype and external +5V power supply.

The only caution with this interface is the IM6402 UART which is a CMOS device and requires the normal grounding for static when handling. Also, remember not to insert or remove this device with the power turned on.

The parts can be purchased

Quantity	Description
1	UART—Intersil IM6402
1	74LS139 2-line to 4-line decoder
1	74LS155 2-line to 4-line decoder
1	74LS04 Hex Inverter
1	74LS03 2-input nand-open col.
1	74LS30 8-input nand gate
1	74LS367 Tri-state buffer
1	NE555 Timer
1	2N3638 PNP transistor
2	4.7K 1/4W Carb. Comp. Resistor
2	100 ohm 1/4W Carb. Comp. Resistor
1	470 ohm 1/4W Carb. Comp. Resistor
1	10K 1/4W Carb. Comp. Resistor
1	10K 5% 1/4 Carb. Comp. Resistor
1	50K 20-turn P.C. Board Pot
2	.01 uf Mylar caps
1	.001 uf Mylar caps
	Misc.
1	40-Pin IC socket
3	16-Pin IC socket
3	14-Pin IC socket
1	8-Pin IC socket
1	General purpose 4.5 in. P.C. Board w/44-Pin card edge connector
1	44-Pin card edge connector
A/R	.1 uf Bypass caps (for I.C.s)
1	40-Pin ribbon cable w/connector
1	+5V 1 amp Power Supply

Parts list.



TRS-80 Teletype Interface.

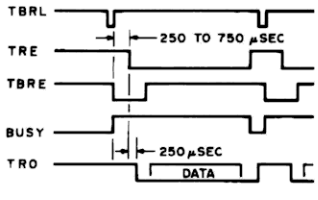


Fig. 1. UART timing diagram.

from most of the suppliers who advertise in *80-Microcomputing*. All parts, except the UART and the ribbon cable can also be purchased from any Radio Shack store. A three-foot ribbon cable with 40-Pin card edge connector can be purchased from Electronic Systems, San Jose CA, part number 3CAB40 and the IM6402 UART from Advanced Computer Products, Irvine CA.

Any +5V DC power source can be used or a small one can be built. Don't attempt to borrow +5V from your computer because with the Level II modification and 16K RAM the power output is running close to maximum.

```
                     ORG     7F62H             ;32610 DECIMAL
7F62    267F         LD      H,7FH
7F64    2E6F         LD      L,6FH
7F66    22264Ø       LD      (4Ø26H),HL        ;NEW LINE PRINTER POINTER ADDRESS
7F69    3E39         LD      A,39H             ;56 LINES/PAGE
7F6B    32284Ø       LD      (4Ø28H),A
7F6E    CAØØ4Ø       JP      4ØØØH             ;REENTER BASIC WITH "SYNTAX ERROR"
                                               ;DISPLAYED ON SCREEN

7F6F    79           LD      A,C
7F7Ø    B7           OR      A
7F71    CAD1Ø5       JP      Ø5D1H             ;PRINTER STATUS ROUTINE IN ROM
7F74    F5           PUSH    AF
7F75    CDD1Ø5       CALL    Ø5D1H
7F78    2ØFB         JR      NZ,$-3            ;LOOP UNTIL PRINTER IS READY
7F7A    F1           POP     AF
7F7B    32E837       LD      (37E8H),A         ;OUTPUT THE CHARACTER
7F7E    FEØD         CP      ØDH               ;IS IT A "CR"?
7F8Ø    CØ           RET     NZ
7F81    CDD1Ø5       CALL    Ø5D1H             ;YES, WAIT UNTIL PRINTER IS READY
7F84    2ØFB         JR      NZ,$-3
7F86    3E8A         LD      A,ØAH             ;ASCII LINE FEED
7F88    32E837       LD      (37E8H),A         ;OUTPUT A "LF"
7F8B    DD34Ø4       INC     (IX+Ø4)           ;INCREMENT LINE COUNTER
7F8E    DD7EØ4       LD      A,(IX+Ø4H)
7F91    DDBEØ3       CP      (IX+Ø3H)          ;COMPARE TO LINES/PAGE (56)
7F94    79           LD      A,C
7F95    CØ           RET     NZ                ;IF NOT 56 LINES CONTINUE
7F96    DD36Ø4ØØ     LD      (IX+Ø4H),ØØH      ;ZERO THE LINE COUNTER
7F9A    Ø6Ø9         LD      B,Ø9H             ;LOOP COUNT FOR 9 LINE FEEDS
7F9C    CDD1Ø5       CALL    Ø5D1H
7F9F    2ØFB         JR      NZ,$-3
7FA1    3E8A         LD      A,ØAH
7FA3    32E837       LD      (37E8H),A         ;OUTPUT "LF"
7FA6    1ØF4         DJNZ    7F9CH             ;LOOP UNTIL (9) LF'S ARE OUTPUT
7FA8    C9           RET
```

Fig. 2. Assembly language program to interface a teletype to a TRS-80 16K, Level II.

Software

The assembly language program is shown in Fig. 2. The initialization routine loads the new line printer pointer into location 4026H and 4027H as well as changes the lines per page to 56. The routine checks for printer status (call 05D1H) and outputs the character when ready. It checks each character for a carriage return (0DH) and if it is found, outputs a line feed (0AH). It then increments the lines/page counter, compares it to the line/page number (39H) and if 56 lines have been printed, zeros the line counter and outputs nine line feeds. This extra line feed activity creates a typed page consisting of a top margin of nine spaces, and 56 lines of type for a sheet length of 11.0 inches. I have also included the routine in BASIC for those who do not have either "TBUG" or the "EDITOR/ASSEMBLER" to enter this program. See Fig. 3.

```
1Ø  REM *  Teletype Interface - 16K TRS-80 Level II*
2Ø  REM *  P.E. Noeth, San Jose, CA. May, 1979*
3Ø  REM *  Answer Memory Size? -- 3261Ø*
4Ø  REM *  Run this Program - Enter System Command*
5Ø  REM *  Answer Prompt with /3261Ø*
7Ø  For I = 3261Ø to 32680
8Ø  Read D
9Ø  Poke I, D
1ØØ Next I
11Ø End
12Ø Data  38, 127, 46, 111, 34, 38, 64, 62, 57, 50, 40, 118, 121, 183
13Ø Data  202, 209, 05, 245, 205, 209, 05, 32, 251, 241, 50, 232, 55
14Ø Data  254, 13, 192, 205, 209, 05, 32, 251, 62,  1Ø, 50, 232, 55
15Ø Data  221, 52, 04, 221, 126, 04, 221, 190, 03, 121, 192, 221
16Ø Data  54, 04, Ø, 06, 09, 205, 209, 05, 32, 251, 62, 1Ø
17Ø Data  50, 232, 55, 16, 244, 201
```

Fig. 3. BASIC program to interface a teletype to a TRS-80.

After turning on the CPU answer the memory size question with "/32610." This protects the interface program from any BASIC program you enter. Enter the interface program, using either BASIC or assembly language. Enter the "System" command and answer the prompt with "/32610". The display will return a "SN ERROR" and a READY> prompt.

This is because of the JP 4000H in the initialization routine. (I have not as yet found the entry point in ROM which returns a "ready" without re-initializating the various pointers in RAM.) The program is now ready and use of LPRINT and LLIST provides a line feed after each carriage return. ■

Scanned by Ira Goldklang - www.trs-80.com

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Treat assembly language tapes like BASIC with this interesting technique.

CLOAD Assembly Language

Alfred S. Baker, II
2327 S. Westminster St.
Wheaton, IL 60187

Have you used the Radio Shack T-BUG program, In Memory Information program or Editor/Assembler? If you have, then you are probably wondering how these programs steal the computer away from Level I BASIC. You type CLOAD, load the tape, and then the unexpected happens. Instead of getting the READY message, you are suddenly running the program on the tape. What happened to BASIC? Where did it go? How did Radio Shack do that?

I had to find out. Beyond simple curiosity, I needed to do it myself. In this article you will see the detection process I used to discover how Radio Shack uses the CLOAD command to load assembly language programs. I also provide a section of program code that will help you do the same thing with your assembly language programs.

Why Bother?

There are two ways to load an assembly language tape on a Level I TRS-80. The way Radio Shack tells you to do it is crazy. First, set the tape volume for Level I tapes and CLOAD the Editor/Assembler System tape. Next, change the volume to handle Level II tapes, type in the name of the assembly program's object file, and load that tape. And now comes the good part. The program should now be in the machine, but you still have to run it. To do this, type a slash (/) followed by the memory address of the program . . . in *decimal*, no less!

I had written a simple assembly language game for my two-year-old to play. My wife knows nothing about computers. Can you imagine me explaining this to her? Can you imagine the look she'd give me if I tried? You can also imagine how often she would do it. I'll pass her most likely comment on to Radio Shack: "You've got to be kidding!"

Fortunately, there is another way of doing it. The Editor/Assembler System tape, as well as the other programs I mentioned above, are all written in assembly language. They are all loaded with the CLOAD command. Unfortunately, how this is done is not documented. If my son was to enjoy the "benefits" of a computer-assisted education, then I had to figure it out.

The first step was to go to my friendly Radio Shack store and buy the T-BUG program. This useful little product lets the user look around in memory and, in general, find out what is going on. If you plan to write very many assembly programs, I recommend that you get it.

If I was going to figure out how to successfully abuse the CLOAD command, I needed an hypothesis.

The one I developed was based on the way I write large programs for Z-80-type computers. I assumed that the CLOAD routine gets control from the statement-reading routine via standard Z-80 CALL-RET Logic.

The statement routine reads the word CLOAD from the keyboard and does a CALL to the CLOAD routine. The CALL instruction in the Z-80 places the address of the next instruction in the statement-reading routine on the stack.

When the CLOAD routine has finished reading in a tape file, it issues a RET instruction. This instruction takes the top address off the stack and branches to it. This takes the computer back to the statement-reading routine.

Suppose the program being CLOADed replaces the address on the stack with its own address? Once the CLOAD routine is done it will pick up this new address and return to it. Voila! The CLOADed program has taken control of the computer away from BASIC!

There were two problems though. I didn't know where BASIC kept its stack, and even if I did, I still didn't know where on the stack the CALL instruction would place the return address from the CLOAD routine. If I was going to replace it, I had to know where it was.

First I had to find the stack. This turned out to be simple. At the back of the Editor/Assembler manual is a list of the addresses for important routines. One of the addresses, 01C9H, is the entry point for Level I BASIC. I loaded T-BUG and, using its MEMORY command, looked at the routine beginning at 01C9H. One of the first things BASIC would have to do would be to set up the location of its stack. The first three bytes at this location were 310042. Paydirt!

If you know your Z-80 machine language (or have a reference book), you'll recognize these three bytes as the in-

```
;REPLACE THE CORRECT STACK LOCATION.
41FE            00100   ORG 41FEH
41FE 0042       00200 TESTAD DEFW TEST
;SET UP THE LOOP VALUES:
;  HL->TV SCREEN
;  A= THE LOWEST CHARACTER VALUE
0000            00300 TEST DEFS 0
4200 21003C     00400   LD HL,3C00H ;TV
4203 97         00500   SUB A
;NOW FOR THE LOOP.  EACH SUCCESSIVE
;CHARACTER IS PLACED IN EACH
;SUCCESSIVE SCREEN POSITION UNTIL WE
;ARE BACK TO CHARACTER 00.
0000            00600 LOOP1 DEFS 0
4204 77         00700   LD (HL),A
4205 23         00800   INC HL
4206 3C         00900   INC A
4207 20FB       01000   JR NZ,LOOP1
;THE PROGRAM IS DONE.  PROVE IT BY
;LOOPING FOREVER.
0000            01100 LOOP2 DEFS 0
4209 18FE       01200   JR LOOP2
0000            01300   END
```

Fig. 1. Testing the CLOAD hypothesis.

```
;DEFINE THE PROGRAM START AND OTHER
;IMPORTANT SYSTEM ADDRESSES.
4400             00100   ORG 4400H
0000             00200 BEGIN DEFS 0
0FE9             00300 CASON EQU 0FE9H
0F4B             00400 CASOUT EQU 0F4BH
0EF4             00500 CASIN EQU 0EF4H
01C9             00600 BASIC EQU 01C9H
4200             00700 BSTACK EQU 4200H
; SET UP THE TWO ENTRY POINTS. THE
;FIRST IS USED TO RUN THE PROGRAM FROM
;TBUG. THE SECOND IS USED TO CREAT A
;CLOADABLE TAPE.
4400 C35044      00800   JP RUN
4403 C31144      00900   JP CREATE
;THE LOAD ROUTINE IS READ IN BY THE
;CLOAD COMMAND BEGINNING WITH THE
;INSTRUCTION LABELED LOADAD. ONCE
;LOADED,IT GETS CONTROL AND LOADS IN
;THE REST OF THE PROGRAM AND EXECUTES
;IT.
4406 0042        01000 LOADAD DEFW BSTACK
0000             01100 LOAD DEFS 0
4408 CDE90F      01200   CALL CASON
440B CDF40E      01300   CALL CASIN
440E C35044      01400   JP RUN
000B             01500 LOA100 EQU $-LOADAD
;THE CREATE ROUTINE DOES ALL THE SETUP
;WORK. IT MOVES THE LOAD ROUTINE DOWN
;TO LOCATION 41EFH AND THEN CREATES
;THE CLOADABLE TAPE FOUR TIMES FOR
;SAFETY. EACH OF THE FOUR SETS CON-
;SISTS OF TWO FILES: THE LOAD ROUTINE
;AT 41FEH AND THE ENTIRE PROGRAM AT
;4400H
;
;FIRST, THE LOAD ROUTINE IS MOVED:
0000             01600 CREATE DEFS 0
4411 31B444      01700   LD SP,ENDIT+32
4414 210644      01800   LD HL,LOADAD
4417 11FE41      01900   LD DE,BSTACK-2
441A 010B00      02000   LD BC,LOA100
441D EDB0        02100   LDIR
;NOW SET UP FOR FOUR COPIES.
441F 0604        02200   LD B,4
0000             02300 CRE100 DEFS 0
4421 C5          02400   PUSH BC

;WRITE THE FIRST FILE: THE LOADER.
4422 CDE90F      02500   CALL CASON
4425 21FE41      02600   LD HL,BSTACK-2
4428 210942      02700   LD DE,BSTACK-2+
                                 LOA100
442B CD4B0F      02800   CALL CASOUT
;NOW WAIT A BIT
442E 210000      02900   LD HL,0
0000             03000 CRE150 DEFS 0
4431 23          03100   INC HL
4432 7C          03200   LD A,H
4433 B5          03300   OR L
4434 20FB        03400   JR NZ,CRE150
;OUTPUT THE REAL THING: THE PROGRAM
4436 CDE90F      03500   CALL CASON
4439 210044      03600   LD HL,BEGIN
443C 115044      03700   LD DE,ENDIT
443F CD4B0F      03800   CALL CASOUT
;WAIT A BIT AGAIN
4442 210000      03900   LD HL,0
0000             04000 CRE200 DEFS 0
4445 23          04100   INC HL
4446 7C          04200   LD A,H
4447 B5          04300   OR L
4448 20FB        04400   JR NZ,CRE200
;THE BOTTOM SIDE OF THE 4 TIMES LOOP
444A C1          04500   POP BC
444B 10D4        04600   DJNZ CRE100
444D C3C901      04700   JP BASIC
;THIS IS THE PROGRAM START LOCATION:
0000             04800 RUN DEFS 0
;
;
;       PLACE THE PROGRAM TO BE
;       CLOADED HERE.
;
;
0000             04900 ENDIT DEFS 0
0000             05000   END
```

Listing 1. The instructions needed to prepare an assembly- language program for loading with the CLOAD command.

struction "LD SP,4200H." SP is the stack register and 4200H is where the BASIC stack is located. One down and one to go.

Now I had to find out which address on the stack I had to replace. Again, a little thought presented me with an easy answer. I had just loaded T-BUG, hadn't I? T-BUG is one of those enigmatic programs that already was doing what I was trying to do. *If* it didn't use the same stack and *if* it didn't cover its trail, then somewhere on the BASIC stack should be the starting address for T-BUG, 40B1H.

This address is provided in the Editor/Assembler documentation. I took a look at the addresses on the BASIC stack using the T-BUG memory command. Again success! The T-BUG starting address was sitting at location 41FEH, the first position on the BASIC stack.

Into the Lab

So far, I only thought I knew what was going on. Now I had to run an experiment. The test I decided on was quick, but it presented a slight gamble. I assumed that T-BUG didn't use the 13 bytes between memory locations 41FEH and 420AH. Using the memory command, I hand loaded the machine language code for the program in Fig. 1. I then used the T-BUG tape Punch command to put it on tape. I had a tape that *should* CLOAD on a Level I TRS-80.

Studying the program in Fig. 1 will tell you that it prints out the entire set of characters on the TV screen and then loops forever. I turned off the computer and then turned it back on. I wanted to make sure that the test wouldn't be fouled by anything left in memory.

Next, I CLOADed my test tape. It suddenly became difficult to read the screen. It was filled up with a large collection of characters. Not only that, but the keyboard wouldn't respond. The computer had gone into a loop. I had successfully CLOADed a home grown assembly language program.

Doing It Right

So much for the prototype. I needed a "production" version of this code. I needed a program or routine that could be used to create a CLOAD-able version of any assembly language program. Listing 1 contains the result. I place this piece code at the beginning of each of my assembly language programs. It divides the program into three logical components: CREATE, LOAD and RUN.

The easiest way to describe this program addition is to take the three parts in reverse order. The RUN component is the original assembly language program unchanged. The only difference is that the line ENDIT DEFS 0 is added just before the END line.

The LOAD routine contains three statements. It turns on the cassette tape, reads in a file and then jumps to the RUN program. Which file does it read in? Oddly enough, it is reading in everything: the CREATE, LOAD and RUN programs. How can a program read itself in? This is handled by the first component of the program.

The CREATE routine performs the actual magic of this act. First, it copies the LOAD routine down to locations 41FEH to 4208H. The condition for CLOADing an assembly program has been met. The location on the stack that must be replaced, 41FEH, now points to 4200H. Location 4200H now contains a routine that will load a tape file containing the RUN routine and jump to it.

Now that the conditions have been set up, a tape must be prepared. The tape is written out four times. I never trust data on tape just once. The repeated section of code generates two tape files separated by a time delay loop. The first file is the LOAD routine beginning at location 41FEH. The second file is the complete program. We now have a tape of an assembly language program that can be loaded with the CLOAD command.

Why didn't I let the entire program begin at location 41FEH instead of moving a load routine down to that location? I had two reasons. I use T-BUG, which sits in locations 4000H to 43FFH. Also, when I flip between my program and BASIC, BASIC destroys the contents of 41FEH. That is where its stack is, remember?

Conclusion

What have we learned? First, even with a computer with poor or missing system documentation, such as the TRS-80, it is still possible to learn a lot about the behind-the-scenes software. All that is needed is a little careful thought and some diligent experimentation. You must also have at least a few simple tools to work with, but without the former, they are nearly useless.

Finally, we now have a simple method for loading TRS-80 assembly language programs. A process that Radio Shack made too complicated can now be done by my six-year-old daughter. As for two-year-old Nathan, his mother is having a ball teaching him on "her" computer.■

Use your disks to store questions and answers.

Quiz Master

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Because of the microcomputer revolution presently occurring, it is feasible for individual departments of universities or colleges to purchase sophisticated computing equipment that can be used in a myriad of different applications.

One such application creates question and answer files for exams and quizzes. Such a technique is used by the Physics and Chemistry Departments of the Catholic University of Puerto Rico in multi-section introductory courses.

The university recently purchased a Radio Shack TRS-80 microcomputer with expansion interface, dual mini-floppies and a friction feed line printer. The total cost was slightly more than $3000.

Two computer programs written in TRS-80 Disk BASIC form the heart of our exam-creation technique. The first program (Listing 1) permits a professor or secretary to add questions to a file on a mini-diskette. The second program (Listing 2) is used to prepare a quiz with questions selected from a given file either at random or by the professor.

Once the questions have been selected, they are printed out on a ditto master on the line printer. The professor can then run off as many copies of his quiz as he desires.

File Creation

The first program reserves string space for all of the string variables used in the program, including 255 bytes for the characters used in a question. This number was determined by our decision to use just one physical record (255 bytes) for each question.

In practice our courses are divided into chapter-size units with common objectives. We create one file for each unit, which usually means some 50 to 100 questions. Since the capacity of a Radio Shack formatted data diskette is 85,760 bytes, we can place up to 335 questions on one disk. This means some three to six course units per disk, and, depending on the course, some four to eight diskettes for all of the questions in a course. (Since our project has just begun, we have actually created only four question files on one diskette.)

After clearing string space, the first program gives the user instructions. First, he is told to place the correct diskette in position and then asked the name of the file (course unit) to which he is going to add questions. The variable used for this name is Y$. The program requests the number of the last

Program Listing 1.

```
10 REM  <THIS PROGRAM WAS WRITTEN BY RICHARD R. ECKERT>
20 REM  <BOX 145, STATION 6, PONCE, PUERTO RICO  00731>
30 REM  <ITS PURPOSE IS TO STORE QUIZ QUESTIONS IN A DI
    SKETTE FILE>
40 CLS
50 CLEAR1000
60 PRINT
70 PRINT"PUT THE CORRECT DISKETTE IN DISK DRIVE # 1"
80 PRINT"TELL ME THE NAME OF THE QUESTION FILE YOU WISH
     TO USE"
90 INPUTY$
95 Y$=Y$+":1"
100 PRINT"WHAT IS THE NUMBER OF THE LAST QUESTION FILED
     ";
110 INPUTN
120 PRINT"HOW MANY QUESTIONS DO YOU WANT TO FILE NOW";
130 INPUTM
140 PRINT
150 PRINT"WHEN YOU ARE ENTERING A QUESTION, DO NOT USE
     THE <ENTER>"
160 PRINT"KEY UNTIL YOU HAVE FINISHED IT.  IF YOU COME
     TO THE END"
170 PRINT"OF A LINE BEFORE THE END OF THE QUESTION, USE
     THE DOWN ARROW"
180 PRINT"IN ORDER TO CONTINUE ON THE NEXT LINE.   WHEN
     YOU HAVE FIN-"
190 PRINT"A QUESTION, HIT <ENTER>, AND THE COMPUTER WIL
     L ECHO BACK EX-"
200 PRINT"ACTLY WHAT IT HAS RECEIVED.  YOU WILL THEN HA
     VE THE CHANCE"
210 PRINT"TO ENTER THE QUESTION AGAIN IF THERE ARE ERRO
     RS."
220 PRINT
230 PRINT"WHEN YOU SEE THE SIGN ==>, BEGIN TO ENTER A Q
     UESTION."
240 PRINT"HERE WE GO."
250 PRINT
260 FORI=1TOM
270 PRINT"QUESTION #";I+N
280 PRINT"==>";
290 LINEINPUTA$
300 CLS
310 PRINTA$
320 PRINT
330 PRINT"ARE THERE ANY ERRORS (YES OR NO)";
340 INPUTC$
350 IFC$="YES"THEN270
360 PRINT
370 PRINT"NOW WE'LL FILE THE QUESTION"
379 REM  <OPEN THE FILE AS A RANDOM ACCESS FILE USING B
     UFFER # 1>
380 OPEN"R",1,Y$
389 REM  <FIELD THE BUFFER---HERE WE MAKE ALL 255 BYTES
     AVAILABLE FOR THE QUESTION>
390 FIELD1,255 AS D$
399 REM  <PLACE THE QUESTION IN THE BUFFER>
400 LSETD$=A$
409 REM  <PUT THE CONTENTS OF THE BUFFER INTO RECORD NU
     MBER I+N OF THE FILE>
410 PUT1,I+N
420 CLOSE
430 NEXT
```

question filed (N); if it is a new unit he should answer with a zero. The next few print statements describe the way in which the user should enter questions.

The important point here is that when the user comes to the end of a line, but not the end of the question, he should use the down arrow instead of the ENTER key. This is necessary since the LINEINPUT instruction (used later in the program) terminates the input of a string when it receives an ENTER (ASCII code 10 or 13). The down arrow (ASCII code 26) causes the computer to jump to the next line without terminating the input of the string.

After the program finishes giving the user instructions, the loop beginning at line 260 asks for a question, receives it in the variable A$ through the LINEINPUT instruction (line 290), prints the question as received and asks if there are errors or not (lines 300 to 330). If so, the user must enter the question again. If not, lines 370 to 420 file the question A$ in the appropriate record (I + N) of the appropriate file Y$. The file is then closed, and the loop repeats.

Selecting Questions

The second program selects questions from a file and prints them on a ditto master in the line printer. The user must insert the correct diskette, give the computer the name of the question file desired (Y$), the total number of questions in the file (N), the number of questions to be selected for the quiz (M), and whether they are to be chosen at random or by the user.

If they are to be selected at random, the computer will make the selection without duplications (lines 260 to 320), print out the numbers chosen, and ask whether they are satisfactory (lines 330 to 370). If not, it will choose another random group. If the user wishes to choose his own questions, the computer will request the numbers desired (lines 210 to 240).

The program finally instructs the user to place a blank ditto master in the line printer, and, when everything is ready, proceeds to get the selected questions from the file and prints out the quiz (lines 410 to 520).

General Comments

Although we are just starting to use the exam-creation technique it seems especially helpful to those instructors who have many sections of the same course and wish to give frequent quizzes without duplicating questions.

Also in small departments which do not have a full-time secretary (such as in our Physics Department), the technique can be of enormous value, as countless hours of typing time are saved.

In the near future we hope to modify the technique so that the question files can be created on cassette tape using a simple TRS-80 Level II BASIC system. Entering these questions is really time-consuming! ■

Program Listing 2.

```
10 REM  <THIS PROGRAM WAS WRITTEN BY RICHARD R. ECKERT>
20 REM  <ITS PURPOSE IS TO SELECT QUESTIONS FROM A DISK
     ETTE FILE AND>
30 REM  <TO PRINT THEM ON A DITTO MASTER IN THE LINE PR
     INTER."> 
40 PRINT
50 DIMZ(20)
60 CLS
70 CLEAR1000
80 PRINT"PLACE THE CORRECT DISKETTE IN DISK DRIVE # 1."
90 PRINT"TELL ME THE NAME OF THE QUESTION FILE YOU WISH
     TO USE."
100 INPUTY$
110 PRINT"WHAT IS THE NUMBER OF QUESTIONS IN THE FILE";
120 INPUTN
130 PRINT"HOW MANY QUESTIONS DO YOU WANT IN YOUR QUIZ";
140 INPUTM
150 PRINT
160 PRINT"NOW WE'LL SELECT THE QUESTIONS---IF YOU WANT
     THEM AT RANDOM,"
170 PRINT"ANSWER WITH AN  'R'"
180 PRINT"IF YOU WANT TO SELECT THEM YOURSELF, USE ANY
     OTHER KEY."
190 INPUTC$
200 IFC$="R"THEN260
210 PRINT"ENTER THE NUMBERS OF THE QUESTIONS YOU DESIRE
     ---ONE BY ONE"
220 FORJ=1TOM
230 INPUTZ(J)
240 NEXT
250 GOTO400
259 REM  <THE FOLLOWING ROUTINE SELECTS THE QUESTIONS A
     T RANDOM>
260 FORJ=1TOM
270 Z(J)=RND(N)
280 IFJ=1THEN320
290 FORL=1TOJ-1
300 IFZ(L)=Z(J)THEN270
310 NEXTL
320 NEXTJ
330 PRINT"THE QUESTIONS CHOSEN WERE:"
340 FORJ=1TOM
350 PRINTZ(J)
360 NEXTJ
370 PRINT"IS THE SELECTION SATISFACTORY (YES OR NO)";
380 INPUTE$
390 IFE$="NO"THENPRINT"WE'LL TRY AGAIN":GOTO260
400 PRINT
410 PRINT"NOW WE'LL GET THE QUESTIONS FROM THE FILE AND
     PRINT THEM"
420 PRINT"ON A DITTO MASTER IN THE LINE PRINTER."
430 PRINT"PUT THE DITTO MASTER IN THE PRINTER AND TURN
     IT ON."
440 PRINT"WHEN YOU'RE READY HIT ANY KEY."
450 INPUTF$
459 REM  <OPEN THE FILE AS A RANDOM ACCESS FILE USING B
     UFFER # 1>
460 OPEN"R",1,Y$
469 REM  <FIELD THE BUFFER---ALL 255 BYTES FOR A QUESTI
     ON, AS IN THE FILING PROGRAM>
470 FIELD 1, 255 AS D$
479 REM  <BEGIN LOOP TO GET AND PRINT THE QUESTIONS CHO
     SEN>
480 FORJ=1TOM
489 REM  <GET RECORD # Z(J) FROM THE FILE AND PLACE IT
     IN THE BUFFER>
490 GET1,Z(J)
499 REM  <PRINT OUT ON THE LINE PRINTER THE QUESTION SE
     LECTED>
500 LPRINTD$
510 NEXT
520 CLOSE
```


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TRS-80 is a trademark of the Radio Shack Division of Tandy Corporation

COORDINATED BUSINESS SYSTEMS

SMALL BUSINESS SYSTEMS GROUP

- EACH MODULE CAN BE OPERATED INDIVIDUALLY OR AS A COORDINATED SYSTEM.
- TURN-KEY ERROR CATCHING OPERATION FOR BEGINNERS
- FREE 30-DAY TELEPHONE CONSULTATION WITH SBSG
- EACH MODULE CAN BE FORMATTED TO SPAN DATA ON UPTO 4 DISK DRIVES.
- COMPLETE MANUAL AND DOCUMENTATION ACCOMPANY EACH MANUAL
- MINIMUM SYSTEM REQUIREMENTS - 2 DISK DRIVES FOR MODEL I...1-DISK DRIVE FOR MODEL II

ACCOUNTS PAYABLE

The accounts payable system receives data concerning purchases from suppliers and produces checks in payment of outstanding invoices. In addition, it produces cash management reports. This system aids in tight financial control over all cash disbursements of the business. Several reports are available and supply information needed for the analysis of payments, expenses, purchases and cash requirements. All A/P data feeds General Ledger so that data is entered into the system just once. These programs were developed 5 years ago for the Wang micro-computer and have been tested in many environments since then. The package has been converted to the TRS-80™ and is now a well documented, on-line, interactive micro-computer system with the capabilities of (or exceeding many larger systems.

CAPABILITIES

★ menu driven; easy to use; full screen prompting and cursor control
★ invoice oriented; everything revolves around the invoice; handles new invoice or credit memo or debit memo
★ invoice information recorded; invoice #, description, buyer, check register #, invoice date, age date, amount of invoice, discount (in %), freight, tax ($), total payable
★ transaction print and file maintenance procedures insure accuracy
★ flexible check calculation procedure; allows checks to be calculated for a set of vendors - or - for specific vendors
★ program prints your checks; contiguous computer checks with your company letterhead can be purchased from SBSG
★ reports include (samples on back):
  • open item listing/closed item listing - both detail and summary
  • debit memo listing/credit memo listing
  • aging
  • check register report (to give an audit trail of checks printed)
  • vendor listing and vendor activity (activity of the whole year)
★ fully linked to GENERAL LEDGER; each invoice can be distributed to as many as five (5) different GL accounts; sysem automatically posts to cash and A/P accounts

ACCOUNTS RECEIVABLE

The objective of a computerized A/R system is to prepare accurate and timeley monthly statements to credit customers. Management can generate information required to control the amount of credit extended and the collection of money owed in order to maximize profitable credit sales while minimizing losses from bad debts. The programs composing this system were developed 5 years ago, especially for small businesses using the Wang Microcomputer. They have been tested in many environments since then. Each module can be used stand alone or can feed General Ledger for a fully integrated system.

CAPABILITIES

★ menu driven; easy to use; full screen prompting and cursor control
★ invoice oriented; invoices can be entered before ready for billing, when ready for billing, after billing or after paid
★ allows entry of new invoice, credit memo, debit memo, or change/delete invoice
★ allows for progress payment
★ transaction information includes:
  • type of A/R transaction
  • customer P.O. #
  • description of P.O.
  • billing date
  • general ledger account number
  • invoice amount
  • shipping/transportation charges
  • tax charges
  • payment
  • progress payment information
  • transaction print and file maintenance procedures insure accuracy
★ customer statements printed; computer statements with your company letterhead can be purchased from SBSG
★ reports include; (samples on back)
  • listing of invoices not yet billed
  • open items (unpaid invoices)
  • closed items (paid invoices)
  • aging
★ fully linked to General Ledger; will post to applicable accounts: debits A/R, credits account you specify

PAYROLL

Payroll invoices many complex calculations and the production of reports and documents, many of which are required by government agencies. It is an ideal candidate for the computer. With this Payroll system in-house, you can promptly and accurately pay your employees and generate accruate documents/reports to management, employees, and appropriate government agencies concerning earnings, taxes, and other deductions. The package has been converted to the TRS-80™ and is now a well documented, on-line, interactive micro-computer system with the capabilities of (or exceeding) many larger systems.

CAPABILITIES:

★ performs all necessary payroll tasks including:
  • file maintenance, pay data entry and verification
  • computation of pay and deduction amounts
  • printing of reports and checks
★ can handle salaried and hourly employees
★ employees can receive:
  • hourly or salary wage
  • vacation pay
  • holiday pay
  • piecework pay
  • overtime pay

(Continued on next page)

(PAYROLL CAPABILITIES CONTINUED)

★ employees can be paid using any combination of pay types (except, hourly cannot receive salary & salary cannot receive hourly)
★ special non-taxable or taxable lump sums can be paid regularly or one time (bonus, reimbursements, etc)
★ health & welfare deductions can be automatically calculated for each employee
★ earnings-to-date are accumulated and added to permanent records; taxes are computed and deducted: US income tax, Social Security tax, state income tax, other deductions (regular or one time)
★ paychecks are printed; computer checks with your company letterhead can be purchased from SBSG
★ calculations are accumulated for; employee pay history, 941A report, W-2 report, insurance report, absentee report
★ fully linked to General Ledger. Each employee's payroll information can be distributed to as many as (12) twelve different GL accounts; system automatically posts to cash account.

INVENTORY/CONTROL INVOICING

- OVER 1000 ITEMS ON MODEL I
- OVER 3000 ITEMS ON MODEL II
- LOW STOCK ALARM
- INVOICING DEDUCTS FROM INVENTORY
- COMPLETE INVENTORY REPORTS
- REORDER POINT REPORT
- QUICK ITEM ACCESS

CLIENT BILLING, STOCK CONTROL, DENTAL BILLING, COMMODITIES
Medicare/Medicaid billing also available

MODEL I **$125 Per Module**
$495 Complete System

MODEL II **$225 Per Module**
$995 Complete System

WE ARE THE ONLY SOFTWARE COMPANY THAT OFFERS A REFUND WITHIN 30 DAYS ON ALL SOFTWARE (H & E COMPUTRONICS MONTHLY NEWSMAGAZINE SUBSCRIBERS ONLY). WE DO CHARGE A $3 PENALTY TO COVER POSTAGE AND HANDLING.

GENERAL LEDGER

The General Ledger accounting system consolidates financial data from other accounting subsystems (A/R, A/P, Payroll, direct posting) in an accurate and timely manner. Major reports include the Income Statement and Balance Sheet and a "special" report designed by management. The beauty of this General Ledger system is that it is completely user formatted. You "customize" the account numbers, descriptions, and report formats to suit your particular business requirements. These programs were developed 5 years ago for the Wang micro-computer and have been tested in many environments since then. The package has been converted to the TRS-80™ and is now a well documented, on-line, interactive microcomputer system with the capabilities of (or exceeding) many larger systems.

CAPABILITIES

★ more than 200 chart of accounts can be handled
★ account number structure is user defined and controlled
★ more than 1,750 transactions may be entered via:
  - direct posting; done by hand; validated against the account file before acceptance
  - external posting; generated by A/R, A/P, Payroll or any other user source
★ data is maintained and reported by:
  - month
  - quarter
  - year
  - previous three quarters
★ reports (samples on back) include:
  - trial balances
  - income statement
  - balance sheet
  - special accounts reports and more . . . .
★ user formats reports with the following designed as you wish:
  - titles
  - headings
  - account numbers
  - descriptions
  - subtotals
  - totals
  - skip lines
  - skip pages
★ up to eight levels of totals - fully user designated
★ menu driven; easy to use; full screen prompting and cursor control

COMPUTRONICS
MATHEMATICAL APPLICATIONS SERVICE™ ✓9
Box 149 New City, New York 10956

24 HOUR ORDER LINE
(914) 425-1535

PLEASE SEND ME:

MODEL I $125 PER MODULE _____
$495 COMPLETE SYSTEM _____
MODEL II $225 PER MODULE _____
$995 COMPLETE SYSTEM _____

CREDIT CARD NUMBER ______________________ EXP. DATE __________
SIGNATURE ______________________
NAME ______________________
ADDRESS ______________________ STATE __________ ZIP __________

*** ADD $6/YEAR (CANADA, MEXICO) - ADD $12/YEAR AIR MAIL - OUTSIDE OF U.S.A., CANADA & MEXICO ***

✓Reader Service—see page 162

Fit an external fuse to your power supply.

Fuse Fix

William P. Winter Jr.
O'Higgins 3168
1429 Buenos Aires
Argentina

Having just purchased a TRS-80 keyboard/CPU, adding a TV monitor and cassette recorder, I had the system up and running, when—poof!—a fuse blew.

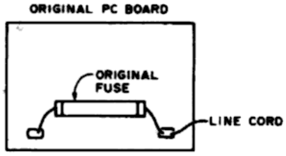

Fig. 1. Original PC Board.

Off went the TRS-80.

To get to the fuse I cut open the plastic power supply case (badly designed by Radio Shack). The fuse, soldered to the printed circuit board, has pigtails. I soldered leads to a similar fuse and then turned on the TRS-80 again. (Radio Shack had incorrectly installed fast blow fuses, instead of the required slow blow, in a production run.)

Everything worked fine for a half hour or so and then off it went.

During the next few days the story repeated itself, and each time the fuse went, so did whatever program I was working on.

Change Your Fuse

I knew the fuse was there to protect the expensive chips and that the TRS-80 designers probably wanted to keep inexperienced users from installing too heavy a fuse. However, it was also impractical to send the unit to a service center every half hour from Argentina.

If you have similar trouble you can remedy the situation by following these steps:

1. Remove the fuse and solder a jumper wire in its place.

2. Remove the line cord lead from the printed circuit board and insert an in-line fuse holder in series with the line cord lead just removed. Cut one lead of the fuse holder long enough to pass through the opening at the base of the supply and solder this lead to the hole previously occupied by the line cord lead.

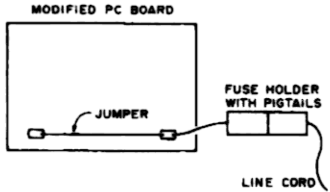

Fig. 2. Modified PC Board.

You can now solder the other fuse holder lead to the line cord, or do as I did and solder the line cord directly to the contact inside the fuse holder. This requires more work but makes for a much neater job.

3. Replace the fuse with a slow blow fuse of the same current rating.

4. You can now glue the case back together. Use the special plastic cement available at toy and hobby shops.

Since performing this minor surgery, I haven't blown a single fuse.■

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Announces
WORDSCRIBE for TRS-80's

Let **WORDSCRIBE** transform your Model I or Model II TRS-80 into a high quality word processing system.

WORDSCRIBE features include: full screen editing, margin justification, line insertion, line deletion, block move, block copy, find, change, and much much more.

Model II $149.95
req. 1 disk, 64k mem.
Model I disk version ....$ 99.95
req. 1 disk, 48k mem.
Documentation only ....$ 9.95
(can be applied to later purchase)

STOCK MARKET DATA TAPES for TRS-80 Model I !!

Each tape cassette contains one months data for the NYSE or AMEX stock of your choice. Data includes daily high, low, close, and volume information. Can be read by any Level II Basic program with simple input statements. Available for Jan. 1979 to present. Please specify month and stock name.

one months data ....$ 5.95
charting program $49.95
(plots high, low, close and 2 moving avgs.)

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11223 E. 45 St. So. #314
Tulsa, Ok. 74145
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DISASSEMBLED HANDBOOK FOR TRS-80

VOLUME 1—$10. POSTPAID

Using ROM Calls in assembly language programming
Self-programmed learning course—10 Chapters
All BASIC ROM Calls—ROM ancillary functions
CINT, CSNG & CDBL arith/trig/log/etc. demo pgms

VOLUME 2—$15. POSTPAID

Advanced assembly language course—13 Chapters
Storing video in MEM for later use & recall
Split-screen video with scroll/store/recall
Decoding single & double precision numbers

COMMENTS

COMPUTER INFORMATION EXCHANGE—ship 100 Vol. 2
George Blank—Vol. 1 good intro. to ROM CALLs
SOFTSIDE—will reprint 3000 copies of Vol. 1
Alan Moluff—I especially recommend this book
S-80 BULLETIN—A must for every 80 bookshelf
Charles Butler—most informative and accurate
INTERFACE—save you 1 year's assy. lang. study
Joni Kosloski—we sold over 500 first 30 days
THE ALTERNATE SOURCE—std. text for using ROM
Miller Microcomputing—ship us a carton ASAP
CHICATRUG—ship us another carton via Air Mail
Bill McLaughlin—ship another 300 air freight

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accounts receivable

This program was developed for our family business. The goal was an orderly transition from hand-kept books to computerized bookkeeping. Accounts receivable including sales tax was the most time consuming, thus the beginning. Time spent on accounts receivable has been cut in half. More detailed statements sent earlier have decreased the outstanding receivables.

This program is designed for business people, not computer or accounting experts. All inputs are structured for fast and efficient operation. If a math check is required, extensions and totals are checked faster than with a calculator. If a math check is not required, only the amount of sale, less any tax, is entered. The program stores sales tax information on all customers and will display the proper tax, if any is required. Nontaxable customers making a taxable purchase, customers from a tax district other than the place of business, picking up at the place of business are easily handled by the program. Amount of tax and taxable sales are compiled and stored for up to 100 sales tax districts.

Every entry can be edited at any time. If an incorrect or missing transaction is found after statements are printed, the corrections can be made and the statement reprinted. Sales tax and monthly data in disk files are adjusted by this process.

Rate of service charge and customers to receive service charge are selected by the user.

Overview and Sample Reports **$5.00**
Documentation **$25.00**
Program Disk & Documentation **$200.00**

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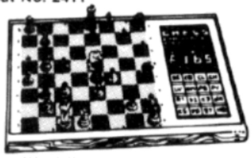
Backgammon Challenger $109.95

You will be challenged and intrigued by this game. Uses all strategies of the game, including a running game, hit and run, blocking and bear off games. YOU handle the dice! Choose offense or defense. Computer responses vary every game. Weight 3 lbs.
Cat No. 2411

Chess Challenger "7" / Chess "VOICE" Challenger

If you're into chess you will love Chess Challenger! 7 levels of play, "Mate in Two" and "Chess by Mail". Like to have your opponent call out the moves? Try "Voice" Chess Challenger. 96,000 Bits of Read Only Memory, and over 8,000 bits of Random Access Memory. Can be used by the blind as the game will audibly call every move, capture, and repeat board position.



Cat No. 2399	Chess Challenger "7"	Wt. 3 lbs.	$112.25
Cat No. 2398	Chess Voice Challenger	Wt. 4 lbs.	$336.95

ATARI® Home Video System

The nation's best selling home video entertainment center is here! Currently supports a library of twenty video game cartridges with over 1300 variations and options. Comes with interchangeable joystick and paddle controllers, special circuits to protect home TV, realistic sound effects and produces crisp, bright colors on your TV screen. Also includes ATARI's "Combat" game with 108 variations and options.

CAT NO.	DESCRIPTION	WT.	PRICE
2375	ATARI Video Computer System	8 lb.	$179.95
2206	Driving Controller-Pair	2 lb.	$ 19.95
2207	Paddle Controller-Pair	2 lb.	$ 19.95
2208	Joystick Controller-Pair	2 lb.	$ 19.95

ATARI Game Cartridges

CAT NO.	DESCRIPTION	WT.	PRICE
2376	Starship	6 oz.	$15.95
2377	Black Jack	6 oz.	$15.95
2378	Space War	6 oz.	$15.95
2379	Surround	6 oz.	$15.95
2380	Slot Machine	6 oz.	$15.95
2381	Outlaw	6 oz.	$17.95
2382	Slot Racer	6 oz.	$17.95
2383	Video Olympics	6 oz.	$17.95
2384	Breakout	6 oz.	$17.95
2385	Canyon Bomber	6 oz.	$19.95
2386	Street Racer	6 oz.	$19.95
2387	Homerun	6 oz.	$19.95
2388	Basketball	6 oz.	$19.95
2389	Football	6 oz.	$19.95
2390	Bowling	6 oz.	$19.95
2391	Skydiver	6 oz.	$19.95
2392	Fun With Numbers	6 oz.	$19.95
2393	Brain Game	6 oz.	$19.95
2394	Superman	6 oz.	$26.95
2395	Casino	6 oz.	$26.95
2396	Backgammon	6 oz.	$44.95
2397	Video Chess	6 oz.	$44.95

NOTE: Not for use with ATARI Programmable Computers

TRS-80/APPLE/EXIDY 16K Memory Add-On Kit $88.00

Everything needed to upgrade your TRS-80, Apple or Exidy! An additional 16K includes illustrated instructions, RAMS and preprogrammed jumpers. No Special tools required. Wt. 4 oz.

CAT NO.	DESCRIPTION
1156	TRS-80 Keyboard Unit
1156-A	TRS-80 Exp. Interface (prior to 4/1/79)
1156-B	TRS-80 Exp. Interface (after 4/1/79)
1156-C	for APPLE II
1156-D	for EXIDY

STAR TREK III

One of the most advanced Star Trek games ever. Locate the 5 Class M Planets, battle Klingons, but watch out for black holes and pulsars. This version is 3 dimensional, not flat like other versions. Watch the Enterprise phasers hit and explode the Klingons! Extensive use of graphics throughout. At the end, return to Star Fleet command, where the data in the ships computer evaluates and rates your performance. Takes about 2 hours to play a game.
Cat No. 1041 TRS-80 level II/16K $14.95

ADVENTURE

Explore an almost endless maze of treasures and pitfalls. Challenging and fun!
TRS-80 L1/L2 16k
Cat No. 1723 $14.95

BARRICADE

Similar to breakout. A real time game, with options of speed balls, angle, etc.
TRS-80 L1/L2 16k
Cat No. 1362 $14.95

SARGON II

Hayden
The champ of champs! Surpasses Microchess, and even Sargon I! Offers complex moves, 7 levels of play, activity indicator, a special "hint" mode, plus more! The best chess program ever!

Cat No. 2082	TRS-80	$29.95
Cat No. 2083	Apple II	$29.95

NOVATION "CAT" ACOUSTIC MODEM

The FIRST compact modem designed for the small computer user. Transmits data over standard telephone lines . . Exchange data or programs with other systems. Data transfer rate up to 30 char/sec. Complete and ready to use. Requires 110 VAC, 60 Hz.
Cat No. 1480 Weight 3 lbs. Price: $189.00

MATCHLESS MS-80 TRS-80 MINI DISK DRIVE

Plugs into the expansion interface. Complete factory tested drive includes installation instructions and software listing to access 3 times faster than Radio Shack drives. 40 tracks instead of 35. Existing 35 track software completely compatable.

Cat No.	Description	Weight	Price
1375	MS-80 Disk Drive	8 lbs.	$395.00
2964	2 Drive Cable	8 oz.	$ 19.95
1396	4 Drive Cable	8 oz.	$ 39.95
1938	Accessing Software, tracks 36-40	4 oz.	$ 10.00
1485 D	MS-80 MPI 51 Manual	2 oz.	$ 1.50
1147	Verbatim Diskettes, (box of 10)	8 oz.	$ 33.00

Page after page of exciting products. Computerized toys and games, personal computers, disk drives, integrated circuits, semi conductors. Add new dimension to your Apple, Atari, TRS-80, etc. with our special application boards and comprehensive software library. Hundreds of products available at terrific Hobbyworld prices. Circle our reader service number or write/phone for your free illustrated flyer today.

VERBATIM 5¼" DISKETTES 10 per box

CAT NO.	TYPE	DESCRIPTION	PRICE
1147	525-01	soft sector, TRS-80, Etc.	$33.00
1148	525-10	10 hole, hard, Apple, North star	$33.00
1149	525-16	16 hole, hard, micropolis	$33.00
2330	577-01	soft sector certified	$49.95
2331	577-10	10 hole, hard, certified	$49.95
2332	577-16	16 hole, hard, certified	$49.95

MICRO SQUARED M2-250 DOUBLE SIDED DISK DRIVES

Two "double sided" drives yield 358k Bytes on TRS-80, 875k Bytes on S-100 systems. Fast transfer rate of 250k Bytes/Sec. No modification of hardware or software necessary. Complete with Power Supply and Cabinet. Factory tested. Life Expectancy 20,000 hours, average media life 3 million passes on a single-track. Pertec drives.

Cat No.	Description	Weight	Price
2054	M2-250 Disk Drives	15 lbs.	$1195.00
2329	#550-16 Hard Sector Diskettes	10 oz.	10 Box/$59.95

HOW TO ORDER

Pay by check, Mastercharge, Visa, or C.O.D. Charge card orders please include expiration date. Payment in U.S. dollars only. Order by phone, mail or at our retail store. MINIMUM ORDER $10.00. Please include phone number and magazine issue you are ordering from. Prices valid thru last day of cover date. SHIPPING: USA: Add $2.00 for first 2 lbs., 35¢ each addt'l lb. for ground. For AIR add $3.00 first 2 lbs., 75¢ each addt'l lb. FOREIGN: surface: $3.00 first 2 lbs., 60¢ each addt'l lb. AIR: $11.00 first 2 lbs., $5.00 each addt'l lb. CODs: add $1.25 addt'l. Not responsible for typographical errors. Some items subject to prior sale or quantity limitations. 120 day guaranteed satisfaction. Exception: partially assembled kits.

TRS-80 To S-100 BUS ADAPTOR-MINI 8100

Mini size, mini price, but maxi-performance. Available with adaptor circuitry and four slot shielded motherboard for direct S-100 use, or with adaptor on S-100 card to plug into external S-100 mainframe. Opens up the vast world of S-100 Bus products to TRS-80 owners. Wt. 3 lb.

Cat No.	Description	Price
1905	Kit w/motherboard, one S-100 Conn.	$115.00
1906	A&T, Motherboard, 4 S-100 Conn.	$155.00
1907	kit, plugs into S-100 mainframe	$ 95.00
1908	A&T, plugs into S-100 mainframe	$125.00

TRS-80 Lower Case Modification Kit

Modifies your machine to display both upper and lower case. Installs in minutes! Requires drill, soldering iron and screw-driver. With complete instructions.
Cat No. 1550 **$19.00**

TRS-80 is a registered trademark of the Tandy Company.

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. . . We have them ALL

All the Disks and Printers that interface to the TRS-80®

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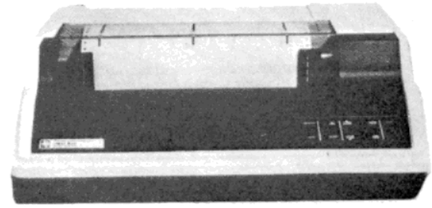

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w/friction and tractor

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779-2 with tractor, List $1350 ..... 1049*
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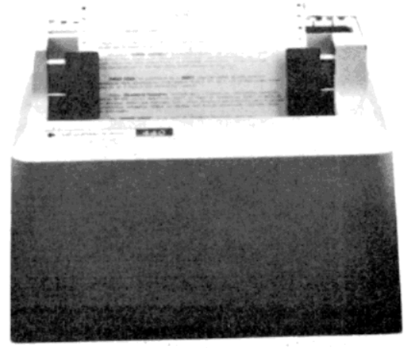

Paper Tiger, List $995 ONLY $895
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IP-225 w/tractor, 1210*, 2K buffer, & graphics options, List $1098 899
TRS-80 cable 45
*1210 option is expanded/compressed print.

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The Fantastic Letter-Quality Printer at 55 cps

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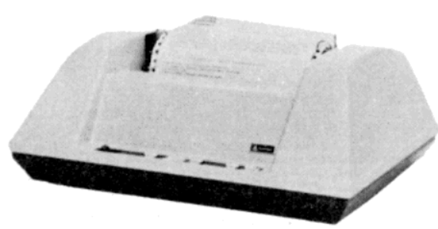
CORVUS 10 megabyte hard disk for Mod. I or II
ONLY $4795

ANADEX

80-COL. DOT MATRIX PRINTER



Complete upper and lower case ASCII char. set, bi-directional at 84 lines/min. Features RS232 20/60 mil current loop and Centronix parallel interface. Ideal for use with TRS-80, Sorcerer, Cromemco, and North Star systems.

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Power Supply & electronics, assembled & tested. You make only a simple solenoid installation (or have the factory do it). Manufactured by Escon.
Parallel version, List $575 ..... ONLY $514
TRS-80 cable (specify MOD I or MOD II) $25

Printers for TRS-80 require Level II machines. Printer cables extra. Call for price and order number.
* Same as Line Printer I
† Same as Line Printer II

SHIPPING AND INSURANCE: Add $5 for Selectric Converter, $6 for disk drives, $10 for Megabox. Centronics printers shipped freight collect. Contact us for shipping information on other printers.
All prices subject to change and all offers subject to withdrawal without notice. Prices in this ad are for prepaid orders. Slightly higher prices prevail for other-than-prepaid orders, i.e., C.O.D., credit card, etc.

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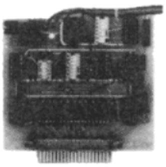
TRS-80 SERIAL I/O

• Can input into basic • Can use LLIST and LPRINT to output, or output continuously • RS-232 compatible • Can be used with or without the expansion bus • On board switch selectable baud rates of 110, 150, 300, 600, 1200, 2400, parity or no parity odd or even, 5 to 8 data bits, and 1 or 2 stop bits. D.T.R. line • Requires +5, -12 VDC • Board only $19.95 Part No. 8010, with parts $59.95 Part No. 8010A, assembled $79.95 Part No. 8010 C. No connectors provided, see below.



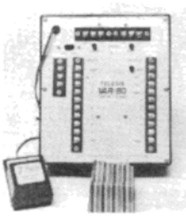
EIA/RS-232 connector Part No. DB25P $6.00, with 9', 8 conductor cable $10.95 Part No. DB25P9.

3' ribbon cable with attached connectors to fit TRS-80 and our serial board $19.95 Part No. 3CA840.

COMPUCRUISE

$129.95; with cruise control $169.95

THE TELESIS VAR-80 INTERFACE UNIT



For the TRS-80 with Level II Basic • Provides 8 outputs • Provides 8 inputs • 2 ft. of interconnecting cable w/connector • Plugs directly into TRS-80 • Power supply provided • Assembled and tested. Part No. VAR80, Introductory price $109.95.

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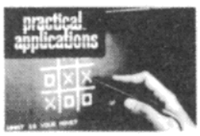

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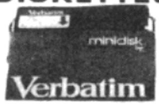

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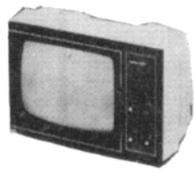

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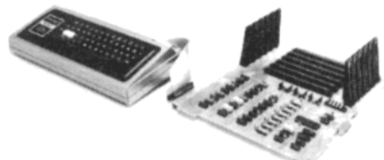
S-100 INTERFACE



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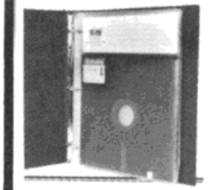

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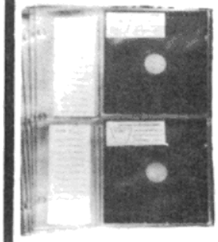

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✓ 26

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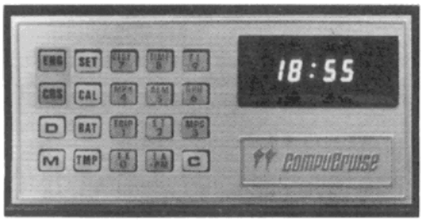

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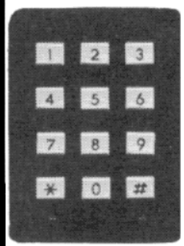

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PREVIEW

THE BASIC SWITCHYARD

Your TRS-80, given the same set of instructions and data, will always arrive at the same conclusion. A railroad train, given the same track and switch settings, will always arrive at the same destination. Using this as an analogy, we investigate the way BASIC works and follow the interpreter through some programs. All aboard for BASIC, next month in 80.

HOME DISTRIBUTION

If you're involved in one of the many home distributorships, or vending is your business, then this article is a must. With it you can save time and make money! The programs given are designed for use by Amway product distributors, but could be adapted for use by many other businesses.

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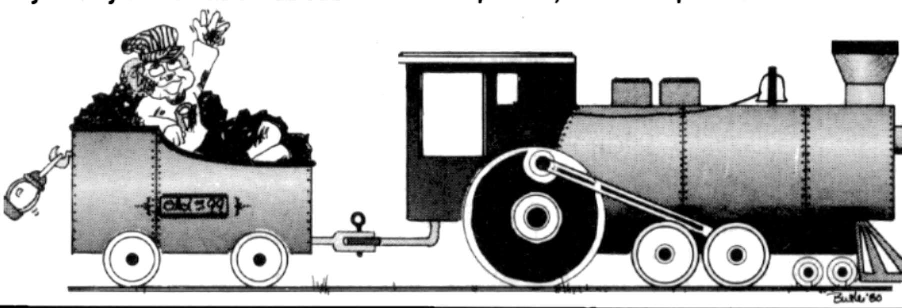

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