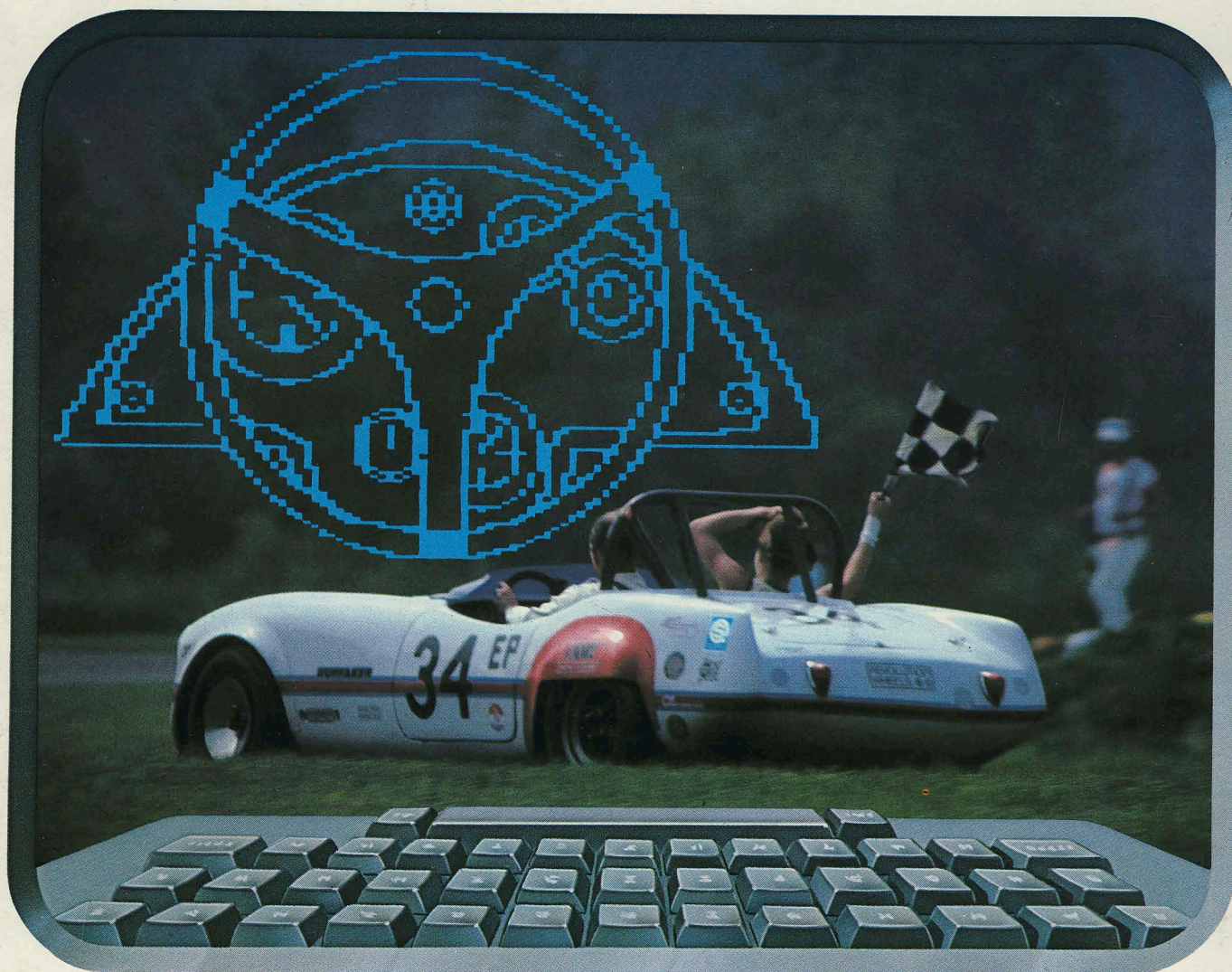


# MICRO™

THE 6502/6809 JOURNAL



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## PET Feature

Growing Knowledge Trees

6502 and 6809 Memory Moves

Apple Printer Utilities

---





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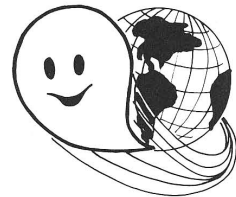
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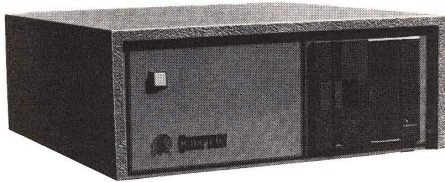
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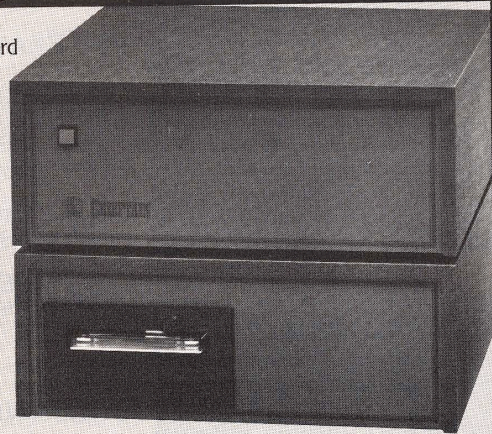
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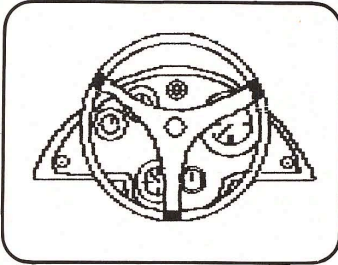
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## About the Cover



This month's cover gets MICRO off to a flying start at the races. Increasing software and hardware sophistication make simulations possible that put you in the driver's seat. The MIT Artificial Intelligence lab has produced a microcomputer-videodisk combination that lets you simulate a drive through Aspen, Colorado, seeing on TV just what you would see through your windshield if you were actually there.

The cover graphic was generated on an Apple Graphics Tablet, and the output was produced on an IDS Color Printer by Susan Maras at Computerland of Nashua, New Hampshire.

Cover photo: Betsey Bolton  
Art Alive! Gallery  
200 Merrimack St.  
Lowell, MA

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# MICRO<sup>™</sup>

## Editorial

### Present Shock

Turning on Commodore's new SuperPET is a startling experience. The system's introductory menu modestly offers access to: BASIC; Pascal; FORTRAN; APL; Assembly; and Monitor. Merely hit the appropriate key!

The development of the microcomputer is proceeding at breathtaking speed. A ferociously efficient combination of high technology, intense international competition, and ready venture capital is generating new hardware faster than society can absorb the old. How rapidly the aerospace industry progressed, we once thought, marvelling at the short span between Kitty Hawk and the Moon. But microcomputers are advancing much more swiftly. Incredibly, the arrival of the new SuperPET coincides with ongoing use of the KIM-1, a 1977 single-board system still covered by MICRO. As a special effect, such an eerie foreshortening of time belongs in a *Star Trek* episode, like Commodore's imagemaster, William Shatner.

As we admire the development of ever-more-sophisticated microcomputer hardware, we should remember that each new system requires of its users an enormous investment of time. A case in point: IBM's new Personal Computer. Announced last year to universal acclaim, the system almost entirely lacks software that exploits its 16-bit potential. While the software industry strains to fill the huge gap that appeared the day the Personal Computer was introduced, even more advanced machines are being developed.

We must learn to recognize how conservative we are with our most precious investment, time. Otherwise, costly mistakes will be hard to avoid. For example, those who promoted novel keyboard designs in hopes of replacing the standard QWERTY arrangement have convinced almost no one, the marketplace least of all. We have invested far too much time in learning QWERTY to leave it even for a significantly better keyboard design. The zeal with which microcomputer owners go

on developing systems that are technological antiques should warn us that these systems, like QWERTY, will be with us for a long time to come. And as more and more new systems are introduced, sopping up more and more available time and energy, the gap between a new system's potential and the availability of resources to develop that potential seems likely to widen.

The solution to this problem is certainly not to stop building more advanced computers. The limits of the microelectronics revolution are not yet in sight, and we can look forward to ever more powerful microcomputers. What we must do is understand that the most important component in a working computer system — people — cannot fully process change at such a fast rate. Nor can we afford to discard huge investments of our time. Therefore, we must find ways to keep that investment on board. The SuperPET, for example, includes both the older 6502 and the newer 6809 processor, and can therefore run older as well as newer software. Radio Shack's recently announced Model 16 incorporates the even newer 68000 processor, yet also uses a Z-80. All older Model II software can still be used. In fact, it will even be possible to upgrade Model IIs with the 68000 board.

MICRO supports design decisions that make software compatible with different generations of a system. The same generation of people will be using many generations of computers. To stay in touch with us, the microcomputer revolution must be made compatible with the need imposed by human limits to use our time wisely.

This issue of MICRO spotlights Commodore's PET. Europe's most popular microcomputer, the PET is steadily attracting more American users. The program accompanying David Heise's feature article, "Growing Knowledge Trees," was written especially for the PET. However, the insight it offers MICRO readers into the concept of artificial intelligence makes it must reading for all.

*Laurence Kepple*



Dear Editor:

I would strongly recommend against your readers' taking, at face value, the comments made in your December 1981 Letterbox, "Atari Ad Attacked."

Mr. Kirby does not define "adapting." If Mr. Kirby takes an Atari program and makes a "similar" program, he may end up in the Austin court he mentions in his letter. The same rules apply to a computer program as to books, etc. It is not necessary to make a 100% duplicate in order to be found guilty of copyright infringement. For example, if he were to use an unusual approach or algorithm in only a part of his new "adapted" program (assuming that the Atari program itself makes it obvious that the contents are copyrighted), the remainder of the "adapted program" could be totally different, yet a copyright infringement could easily be regarded by the court as having occurred. Mr. Kirby will then be subject to a number of possible actions, ranging from criminal penalties, damages, court injunctions... or all of them.

A helpful publication, costing about \$12.00, is "The Copyright Kit," published by the National Attorney's Publications, Inc., P.O. Box 150, East Setauket, N.Y. This book explains copyrighting in layman's terms and clears up the muddy waters created by December's "intellectual property law" expert.

Stephen C. Carpenter  
Mondriaanstraat 14  
3262 TH Oud-Beijerland  
The Netherlands

Dear Editor:

Your magazine is a very good one. My opinion might be illustrated by my collection of your issues. I started reading your magazine in late 1979. I currently have 38 issues, one reprint collection covering six more issues, and am requesting a recently missed issue. When I receive this issue, I will have access to information from 45 of the 46 issues you have placed on the market at this time.

I own an Apple II with 48K of memory, an Applesoft language card, and one DOS 3.3 disk drive. I find your coverage of the Apple to be not only very large in quantity but fine in quality. I also get a lot of ideas from the articles dealing with the other 6502/6809 machines.

Are there any plans to publish articles which describe the other CPU boards which run in the Apple? Even though you are a 6502/6809 journal, an article describing how a 6502 works with a Z80, 6800, 6809, 8088, and other chips would be very interesting.

Also, are any of your readers familiar with the new MTU 6502 machine? I recently received some literature describing it and it isn't too far from a "dream machine" itself. It appears to have hardware 18-bit addressing (yes, 18 not 16) and great bit map graphics. It also has a very sophisticated operating system.

I do have one final problem: A few months back, you had an article which described an operating system for the 6809. I believe it was OS/9 or something similar. But I don't remember seeing a manufacturer's name or address (or price for that matter). Did I simply overlook these or were they missing? Could you re-supply them? Does this operating system come in a format for the Apple II's various 6809 boards?

Larry W. Virden  
1207 Rosehill Rd., Apt. 104  
Reynoldsburg, OH 43068

*Editor's note: The MICRO staff is very interested in hearing from readers who have experience using any of these CPU boards. Since these boards use the 6502 to handle the I/O and other functions, it would be valuable to see how the two CPU's cooperate with each other. Possible areas of coverage could include how the dual CPU's deal with cycle stealing, address translations, interrupts, parameter passing, etc.*

*The OS-9 operating system is available for the MILL 6809 card through Stellation Two, P.O. Box 2342, Santa Barbara, CA 93120; (805) 966-1140.*

Dear Editor:

I just finished reading the March issue of MICRO. As an OSI user (I have a C2-4P MF system) I wish to thank you for your editorial "Hello, OSI?" and also for making the March issue an OSI Feature.

Let's hope that the cover photo is not a group of OSI users watching the OSI personal computer division going up in flames.

After reading the notation about the cover photo, I looked through my collection of computer manuals and found a copy of the manual prepared by Professors J.G. Kemeny and T.E. Kurtz dated June 1965. A statement of interest in the manual is: "The language that you will use is BASIC (Beginner's All-purpose Symbolic Instruction Code) which is at the same time precise, simple, and easy to understand."

J. Edward Loeffler, Jr.  
Elkins Lake, Box 278  
Huntsville, TX 77340

Dear Apple Owners:

In conjunction with the release of The Graphics Magician and the updated Complete Graphics System II, Penguin Software is announcing a new policy with our applications software for the Apple. The Complete Graphics System II, Special Effects, and The Graphics Magician will all now be available on non-protected disks.

We've been torn between two points of view. As computer users, we appreciate the ability to have several working copies of our applications software, and even the ability to go in and modify the code, if desired. We'd use programs such as VisiCalc or DB Master for dozens of other applications if we could have them running off several separate disks and didn't have to guard our master copies with such extreme care. Disks are fragile; we handle thousands of them, and no disk is absolutely 100% error-proof. Being programmers also, occasionally we'd like to adapt a program slightly to our system or our needs. On locked disks, much of a software product's potential usage goes untapped. (Continued)



## Letter Box *(Continued)*

But as publishers we've been drawn into the prevailing point of view that lack of copy protection means greatly decreased sales due to casual "piracy." This is not just a crazed overreaction; we've all been to user-group meetings, homes of acquaintances, and even some computer stores, where we've been aghast at the almost encouraging attitude toward copying copyrighted software, most of which took authors months, maybe years, to perfect. The real scare here is that many of us have decided to take a risk on a very new industry and trust our livelihoods to it. Suddenly, individuals out there become statistics, some of which say that for every non-protected program sold, there are at least a dozen "pirated" copies. Those kinds of numbers could really wreak havoc on paying the bills. Scary? Yes.

From these conflicting points of view, our desire to make a good product

better won, but not by much over our fear of tampering with something that is already going well. Our policies, from pricing to support, have always been very consumer-oriented. Ultimately, it is from that viewpoint that we decided to go ahead with removing the protection. We feel that you, the consumer, are entitled to software as useful as possible for the money you spend. Our hope is that the added convenience will result in more sales, not fewer, and that the software market has matured to the point where people realize that the result of illegal copying is less convenience for everyone with all software. We hope that people will think twice before accepting copies from friends, and we hope to be able to continue this policy and start a new trend toward improved usability of all applications software. Please don't abuse our trust in you.

Mark Pelczarski, President  
Penguin Software  
1206 Kings Circle  
West Chicago, IL 60185

Dear Editor:

It would be extremely helpful if some of your readers could direct me to sources for two items: 1) a program in BASIC or machine language for OSI, Apple II, TRS-80, or PET, to score Gymnastics Meets; 2) a 16K dynamic RAM (4116) board to add to OSI Super-board II.


I have been looking for both of these for some time and have had no luck.

Bro. Felix Neussendorfer  
Monasterio San Antonio Abad  
Box 729  
Humacao, PR 00661

*If you have comments you'd like to share with MICRO's readers, why not send a letter to the editor?*


Editor  
MICRO  
Box 6502  
Chelmsford, MA 01824

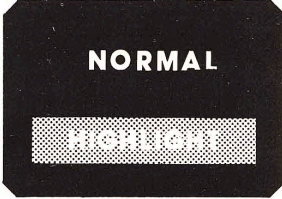
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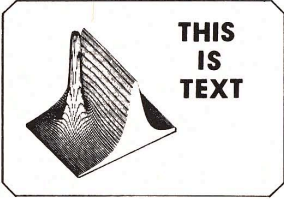
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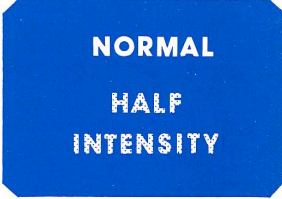


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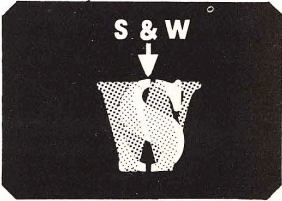
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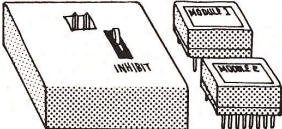
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MICRO — The 6502/6809 Journal



# Memory Map Relocator

by Preston R. Black

**This short program relocates a previous memory map program. Thus, even your longest program won't be written over by the memory map program.**

**MEMORY MAP Relocator**  
requires:  
**Apple II**

The MEMORY MAP program by Peter Cook (MICRO 36:45) is a very elegant way to assess memory usage by the Apple II computer. I have found this program to be particularly useful as a tool in program development. It gives me an up-to-date account of the size of my program and the space reserved for variable storage.

One of the drawbacks of the program is its location in memory (\$3200). While this does not interfere with most of my programs, it is annoying to have to frequently reload a large program because parts of it have been written over by MEMORY MAP. This can be disastrous if the program you are developing has not been saved. Moreover, MEMORY MAP keeps reminding me that there is free space to use with my programs. Wouldn't it be great if MEMORY MAP were always loaded into that free space, leaving your program intact?

As Mr. Cook points out in his article, MEMORY MAP is not readily relocatable since there are frequent absolute references within the program. To relocate the program by hand would be most tedious. Obviously, a relocating loader for MEMORY MAP is what we need.

MEMORY MAP RELOCATOR is such a relocating loader. This program defines the free space in RAM and loads MEMORY MAP into that area. MEMORY MAP RELOCATOR then updates the relocated program to make it internally consistent and jumps to the beginning of the relocated program to run MEMORY MAP.

## Memory Map Relocator

```

; *****
; *
; *
; *      MEMORY MAP RELOCATOR
; *      BY
; *      PRESTON R BLACK MD
; *      MAY 1981
; *
; *
; * THIS PROGRAM WILL RELOCATE
; * THE MEMORY MAP PROGRAM
; * WRITTEN BY PETER A. COOK
; * (MICRO 36:45) TO RESIDE
; * IN RAM WHERE THERE IS FREE
; * SPACE AND WILL NOT WRITE
; * OVER THE BASIC PROGRAM
; * ALREADY IN MEMORY
; *
; *****
;
; EQUATES
;
; NADDRL EPZ $06
; NADDRH EPZ $07
; NENDL  EPZ $08
; NENDH  EPZ $09
; BUFFL  EPZ $19
; DIFF   EPZ $1B
; BUFFH  EPZ $1C
; LENGTH EPZ $2F
; PROMPT EPZ $33
; PGENDL EPZ $AF
; PGENDH EPZ $B0
; OLDADL EPZ $32
; OLDADH EPZ $39
; PGPTRL EPZ $CA
; PGPTRH EPZ $CB
; RSTPG3 EQU $9E25
; RSTRTS EQU $9E30
; INSDS2 EQU $F88E
; COUT   EQU $FDED
;
;      ORG $300
;
0300 4C1303 START JMP INIT
0303
; THIS ROUTINE RESTORES PAGE THREE DOS POINTERS
; WHICH ARE WRITTEN OVER BY THIS ROUTINE
0303
;
0303 A960 RSTORE LDA ##60 ; PLACE 'RTS' WHERE
0305 BD309E STA RSTRTS ; WE WANT IT BEFORE
0308 20259E JSR RSTPG3 ; WE JUMP TO RESTORE ROUTINE
030B
;
030B A9AD LDA ##AD ; RESTORE CHANGED DOS BYTE AND
030D BD309E STA RSTRTS ; JUMP TO RELOCATED MEMORY MAP
0310 6C1900 JMP (BUFFL)
0313
; THE TRUE BEGINNING OF THE PROGRAM
0313
;
0313 A533 INIT LDA $33 ; WHICH LANGUAGE?
0315 C9BE CMP #">" ; INTEGER BASIC?
0317 F00C BEQ INIT1
0319 E6B0 INC PGENDH ; NO, THEN ADD ONE TO H.O. BYTE
031B A5B0 LDA PGENDH ; APPLESOFT EOP POINTER
031D 8507 STA NADDRH ; TO MAKE SURE WE ARE OVER
031F 851A STA BUFFL+1 ; THE PROGRAM
0321 C6B0 DEC PGENDH
0323 D009 BNE INIT2
0325 38 INIT1 SEC ; YES, USE INTEGER BASIC
0326 A5CB LDA PGPTRH ; POINTERS
0328 E90C SBC #$0C ; ALLOW ENOUGH SPACE BELOW
032A 8507 STA NADDRH ; PROGRAM FOR MEMORY MAP

```

(Continued)



## How it Works

The first step in relocating MEMORY MAP is to define the area of free space in RAM. Both Applesoft and Integer BASIC have pointers to the end of the program stored in memory. Unfortunately, they are not the same bytes. In addition, programs are not stored the same way in the two languages. Applesoft begins storing programs at \$801 and succeeding bytes are added above this. Integer BASIC begins storing programs at HIMEM and places all succeeding bytes below this. Thus, the pointers to the end of the program in the two languages must be treated differently.

For Applesoft we must load MEMORY MAP above the program already in memory. If we take the high order byte of the address of the end of the program and add one to it, we can be certain that we are above the program in memory. MEMORY MAP requires slightly less than \$C00 bytes of memory if we include the area used by the printing routine. Therefore, in Integer BASIC we must go at least this far below the program to load MEMORY MAP. Otherwise we will overwrite the BASIC program already in memory.

During initialization of MEMORY MAP RELOCATOR we can determine the current language by checking which prompt is used. Appropriate adjustments must be made to the high order byte of the program end. We now have a starting address within the free space to place MEMORY MAP. Calculate the ending address of the relocated program by adding the length of MEMORY MAP to the new starting address.

Next load MEMORY MAP into the free area. This is done by constructing a string consisting of "BLOAD MEMORY MAP,A,\$xx00". The xx is the high order byte for the new starting address that we determined during initialization. But before we can place this number into our string, it must be converted into the ASCII representation of that number. This is done by first dividing the number into two nibbles (a nibble is equal to four bits) and converting the nibbles into the Apple ASCII code for the respective numbers. The Apple ASCII codes for the numbers from 0 to 9 are \$B0 to \$B9 respectively. Thus, to convert these numbers, we simply add \$B0 to them. (The numbers \$A to \$F must have \$B7 added to them to convert them into ASCII.) Once the numbers have been converted to ASCII, they are added to our string to complete it. We then use COUT (\$FDED) to pass the string to DOS to be executed.

## Memory Map Relocator (Continued)

```

032C 851A      STA BUFFL+1
032E 18        INIT2  CLC
032F 6906      ADC  #B06      ; FIND END OF
0331 8509      STA NENDH      ; RELOCATED PROGRAM
0333 851C      STA BUFFH      ; AND SAVE IN BUFFERS
0335 A9E0      LDA  #E0
0337 8508      STA NENDL
0339 A900      LDA  #00
033B 8504      STA NADDRL
033D 8519      STA BUFFL
033F A507      BLOAD  LDA NADDRH      ; TAKE H.O. BYTE OF NEW START
0341 290F      AND  #0F      ; LOOK AT L.O. NIBBLE
0343 C90A      CMP  #0A      ; IS IT <10
0345 9006      BLT  BLOAD1
0347 18        CLC
0348 69B7      ADC  #B7      ; NO, CONVERT TO ASCII
034A 4C5003    JMP  BLOAD2    ; FOR 'A'-'F'
034D 18        CLC
034E 69B0      ADC  #B0      ; YES, CONVERT TO ASCII
0350 A201      BLOAD2 LDX  #01      ; FOR '0'-'9'
0352 9DF803    STA  LOAD1,X   ; STORE IN STRING
0354 A507      LDA  NADDRH
0357 4A        LSR
0358 4A        LSR      ; NOW LOOK AT H.O. NIBBLE
0359 4A        LSR      ; AND CONVERT TO ASCII
035A 4A        LSR      ; AND STORE IN STRING
035B C90A      CMP  #0A
035D 9006      BLT  BLOAD3
035F 18        CLC
0360 69B7      ADC  #B7
0362 4C6803    JMP  BLOAD4
0365 18        BLOAD3 CLC
0366 69B0      ADC  #B0
0368 CA        BLOAD4 DEX
0369 9DF803    STA  LOAD1,X   ; USE COUT TO
036C BDE203    BLOAD5 LDA  LOAD,X   ; PASS BLOAD COMMAND TO
036F F006      BEQ  UPDATE    ; DOS WITH RELOCATING
0371 20E0FD    JSR  COUT      ; STARTING ADDRESS
0374 EB        INX
0375 D0F5      BNE  BLOAD5
0377 38        UPDATE SEC
0378 A507      LDA  NADDRH    ; FIRST FIND OFFSET
037A E932      SBC  #OLDADL   ; BETWEEN ORIGINAL
037C 851B      STA  DIFF      ; AND RELOCATED PROGRAM
037E A000      UPDAT1 LDY  #00      ; AND SAVE
0380 B106      LDA  (NADDRL),Y
0382 20BEFB    JSR  INSDS2    ; FIND LENGTH OF
0385 A52F      LDA  LENGTH    ; OP CODE
0387 AB        TAY
0388 C902      CMP  #02      ; IF < 3 THEN NEXT ONE
038A D01D      BNE  UPDAT3
038C B106      LDA  (NADDRL),Y ; IF = 3 THEN
038E C932      CMP  #OLDADL   ; SEE IF ADDRESS IS
0390 9017      BLT  UPDAT3    ; WITHIN PROGRAM
0392 C939      CMP  #OLDADH   ; BOUNDARIES
0394 8013      BGE  UPDAT3    ; IF NOT, THEN
0396 C938      CMP  #OLDADH-1 ; GOTO NEXT OP CODE
0398 D008      BNE  UPDAT2
039A 88        DEY
039B B106      LDA  (NADDRL),Y
039D C8        INY
039E C9E0      CMP  #E0
03A0 B007      BGE  UPDAT3
03A2 18        UPDAT2 CLC
03A3 B106      LDA  (NADDRL),Y ; IF ADDRESS WITHIN PROGRAM
03A5 651B      ADC  DIFF      ; ADD OFFSET TO CHANGE
03A7 9106      STA  (NADDRL),Y ; TO RELOCATED ADDRESS
03A9 C8        UPDAT3 INY
03AA 98        TYA
03AB 18        CLC
03AC 6506      ADC  NADDRL    ; UPDATE TO NEXT
03AE 8504      STA  NADDRL   ; OP CODE
03B0 9002      BCC  UPDAT4
03B2 E607      INC  NADDRH
03B4 38        UPDAT4 SEC
03B5 A508      LDA  NENDL    ; END OF THE
03B7 E506      SBC  NADDRL   ; RELOCATED PROGRAM?
03B9 A509      LDA  NENDH
03BB E507      SBC  NADDRH
03BD 9003      BCC  UPDAT5
03BF 4C7E03    JMP  UPDAT1
03C2 A51C      UPDAT5 LDA  BUFFH ; NO, CONTINUE UPDATE
03C4 A06F      LDY  #6F      ; YES, REPLACE #6F
03C6 9119      STA  (BUFFL),Y ; WITH PROPER ADDRESS
03C8          ;
03C8          ; NOW CORRECT THE ADDRESSES OF THE STARTING PAGES
03C8          ; FOR PRINTING THE MOVED TEXT PAGE
03C8          ;
03C8 A51C      LDA  BUFFH
03CA 8509      STA  NENDH
03CC A900      LDA  #00
03CE 8508      STA  NENDL

```



### Memory Map Relocator (Continued)

```

03D0 A0B3      LDY  ##B3
03D2 18        UFDAT6 CLC
03D3 B108      LDA (NENDL), Y
03D5 651E      ADC DIFF
03D7 9108      STA (NENDL), Y
03D9 C8        INY
03DA C8        INY
03DB C0E0      CPY  ##E0
03DD 90F3      BLT UPDAT6
03DF           ;
03DF           ; WHEN FINISHED RESTORE PAGE THREE POINTERS
03DF           ; BEFORE RUNNING RELOCATED MEMORY MAP
03DF           ;
03DF 4C0303     JMP RSTORE
03E2 8DBD84     LOAD  HEX 8DBD84
03E5 C2CCCF     ASC  "BLOAD MEMORY MAP, A#"
03E8 C1C4A0
03EB CDC5CD
03EE CFD2D9
03F1 A0DC1
03F4 D0ACC1
03F7 A4
03FB 000B0     LOAD1 HEX 000B0B0B00
03FB B0BD00
03FE           LENTH EQU *-START
    
```

Once the program has been loaded into memory, we must update it to make internal calls consistent. The algorithm for this is as follows: First, the offset between the original program and the relocated program is calculated. This is the amount that must be added to the original addresses to make them compatible with the relocated program. Using the monitor routine INSDS2, we determine how many bytes are used by each op code. If the op code requires only one or two bytes, then any addressing will be relative and will not require updating. If, however,

the op code is three bytes long, then all addresses used must be absolute.

We must also check to see if that address is within the boundaries of the original program (i.e., from \$3200 to \$38E0). If it is, then we add the offset to the high order byte. If it is not, we go to the next op code. We continue in this fashion until we reach the end of the relocated program. When the relocated program has been completely updated, an indirect jump to the beginning of the relocated program will run MEMORY MAP.

### How to Use the Program

MEMORY MAP RELOCATOR resides on page three of memory. Since it is longer than \$D0 bytes long, it overwrites important DOS vectors located on page three. To insure proper function of DOS after the program is run, a short routine to restore these pointers begins the program. It is placed at the beginning so it will not be destroyed while the pointers are restored.

The routine to restore the pointers makes use of the part of DOS which places the pointers onto page three during the bootstrap. I place an 'RTS' (\$60) in the place that suits my purposes and restore the byte to what it was before performing the indirect jump to run MEMORY MAP.

Once the program has been entered and saved, BRUNning it will place MEMORY MAP into the available free space and run it. Remember that this program is written to run with a program named MEMORY MAP which is normally stored from \$3200 to \$32E0. With minor modifications, this program can be converted to run with a program beginning at any address, and of any length.

Please contact Mr. Black at 16 Durham St., Boston, MA 02115.

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# BASIC to Machine Language Interface

by Christer Engstrom

**Since the AIM lacks a SYS or CALL function, it is difficult to communicate between BASIC and machine language. This interface routine makes theUSR(W) function more flexible and allows entry of the machine language address directly in hexadecimal through the BASIC variable AD%.**

## Interface

requires:

AIM with 4K  
BASIC  
AIM Assembler

I own an AIM with 4K RAM and BASIC and assembler ROMs. The BASIC interpreter is slow, but the machine itself is very fast. Furthermore, there is a lack of cooperation between BASIC and machine language. The only way to jump out from BASIC to execute other code in memory, is to use the USR(W) command. This command lets you jump to a subroutine whose address is given in locations \$04 and \$05, and also pass a floating point value in locations \$B1 - \$B6.

A frequent use of this method results in many POKES, which are done byte-by-byte in decimal. This is not good for readability. I think we need an easier way to jump out, a better way to define where to jump, and a method to pass parameters. We need a general interface.

The best way to define an address is with (ASCII) hex characters. Here's my solution to the problem: every time BASIC executes the USR(W) command, the machine enters the general interface. The integer AD% is supposed to contain the address to jump to, in high-low order. The interface scans the variable table and searches for AD% (which in the machine is interpreted as \$C1C4 - ASCII of 'A' and 'D', each ORed with \$80). If it is found and contains an address > \$00FF, the interface converts the value W specified in the

USR(W) statement, to a signed binary value in locations \$AC to \$AD (subroutine \$BEFE).

Next it loads the byte at location \$AD (LSB of the value) into the accumulator, and jumps to the subroutine. On returning from the subroutine, the accumulator is stored into \$AD, and the signed binary value in \$AC-\$AD is converted back to the floating-point register (subroutine \$COD). Finally, a return to BASIC is made.

## Examples

1. You want to jump to a subroutine at location \$0400.

```
10 AD% = X"0400"  
20 L = USR(0)
```

2. Take advantage of the monitor routine at location \$E97A. Don't forget that the accumulator must be loaded with a value:

```
10 AD% = X"E97A"  
20 L = USR(A)
```

I know, you're thinking that the X"0400" and the X"E97A" are not conforming to general BASIC syntax. But AD% = 1024 and AD% = -576 are! So what we now need is a way to translate all X".." expressions to their decimal equivalents before execution. That is done by the hex converter. If the general interface doesn't find AD% or if AD% is zero, all X".." and Z".." expressions are converted to decimal.

You can see that the hex converter is entered via the general interface. This means that it is easy to modify the interface so that it can execute more functions (with a function code in AD%). You may even want to modify the whole interface. Maybe it is better when used this way:

```
10 AD$ = "E97A"  
20 L = USR(A)
```

Let's get back to the hex converter. If you want to assign an unsigned value > \$7FFF to a BASIC Integer, you must consider this: the interval \$8000 to \$FFFF equals the decimal interval -32768 to -1. This means that \$8000 = -(10000 - \$8000) = -(65536 - 32768) = -32768.

We don't always want to translate the hex string to a signed value, so another type must be defined. This leads us to two different syntaxes. To get a signed decimal value, precede the hex string in quotes with an X. For positive (unsigned) values, use a Z instead.

Example 3:

```
X"9000" = -(65536 - 36864)  
          = -28672 BUT  
Z"9000" = 36864
```

If you define an address, use the X type. Note that only the program part, not the variable part, is hex-converted. Also note that the string within the quotes must consist only of the hex characters (0 - 9, A - F), and have a length of 0 - 4 characters. Left-fill with zeroes is done automatically. For example:

```
10 L = USR(X"A")  
20 A = X"CC"/B
```

After hex conversion,

```
10 L = USR(0010)  
20 A = 00204/B
```

no compression is done. The string beginning with X or Z is replaced by a decimal value of the same length. If the hex string is not enclosed within quotation marks, BASIC will attempt to interpret some strings to function codes during input phase; "DEF" for example.

## Program Description: The Interface

In my version, the interface consists of two parts: the interface and the hex converter. Since only relative branches are made, both parts are relocatable. The interface and the hex conversion need



not cooperate — simply remove one of them. In my version, the interface must know the real start addresses of functions it should handle. The BASIC input buffer (\$14 - \$50) is used as a work area. The interface starts with a lookup of the variable table.

Here are some valuable points:

1. The start address for the table is in locations \$75 and \$76.
2. An integer variable name has \$80 added to the first and second character of its name (thus making AD% = \$C1C4, not \$4144).
3. Every entry in the table consists of seven bytes, the first two for its name.
4. An integer variable has its value (signed) in the two bytes following the name.
5. "End-of-table" is flagged by \$AA in the first location of an entry.

Here is a description of what is done at each label:

ENTRY—Stores the address of the variable table start in a work area.

SCAN—A search for \$C1C4 or end-of-table is done.

NEW—Get address for next entry, scan again.

CHECK—Tests value in leftmost byte of integer AD%.

JUMP—Jumps to subroutine after floating point conversion. At return, converts integer back to floating point array.

OUT—Clears A,X,Y registers and returns back to BASIC.

FUNC—Jumps to functions by testing the rightmost byte of AD%. Invalid functions are ignored.

FUNC.—The functions.

### Hex Converter

This is a fairly long and space-consuming part; the readability is worth more than smart programming.

1. A scan for all strings beginning with X'' and Z'' is done in the program part (page "CHECK PROG").
2. If such a string is found, and the rest of it conforms to the above given

syntax, it is converted to the decimal equivalent (pages "MOVE RIGHT JUST" and "STRING TO HEX").

3. If it is an X'' string with a value > = 32768, a sign-conversion (see example 3) is done (page "SIGN CONVERSION").
4. Finally, the converted value is edited back to the program (pages "EDIT NOW" and "MOVE TO PROG").
5. When the program part is scanned through, a return to the interface is done (page "MAIN LOOP").

### Conclusion

We now have an extended and more flexible way to use BASIC with the rest of the machine. Even some monitor routines can be used without specially written routines. The hex converter allows us to specify constants in hexadecimal mode. This method also cooperates better with the rest of the machine. Finally, the interface can help during the editing of a program (function codes could be used).

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Listing 1: The Interface

```

;*****
;*
;* BASIC INTERFACE *
;*
;* BY CHRISTER ENGSTROM *
;*
;*****
;
; ORG $F81
ENTRY LDX $75
      STX $14
      LDX $76
      STX $15
SCAN  LDY #$00
      LDA ($14),Y
      CMP #$AA
      BEQ FUNCO
      CMP #$C1
      BNE NEW
      INY
      LDA ($14),Y
      CMP #$C4
      BEQ CHECK
      NEW  CLC
          LDA $14
          ADC #$07
          STA $14
          LDA $15
          ADC #$00
          STA $15
          CLC
          BCC SCAN
      CHECK INY
          LDA ($14),Y
          BEQ FUNC
      JUMP JSR $BEFE
          LDA #$4C
          STA $16
          LDY #$02
          LDA ($14),Y
          STA $18
          INY
          LDA ($14),Y
          STA $17
          LDA $AD
          JSR $0016
          STA $AD
          LDA $AC
          LDY $AD
          JSR $COD1
      OUT  LDA #$00
          TAY
          TAX
          RTS
      FUNC INY
          LDA ($14),Y
          CMP #$00
          BEQ FUNCO
          CMP #$01
          BEQ FUNCO
          RTS
      FUNC0 JSR $OE00
          CLC
          BCC OUT
      FUNC1 NOP
          CLC
          BCC OUT
OF81 A675
OF83 8614
OF85 A676
OF87 8615
OF89 A000
OF8B B114
OF8D C9AA
OF8F F051
OF91 C9C1
OF93 D007
OF95 C8
OF96 B114
OF98 C9C4
OF9A F010
OF9C 18
OF9D A514
OF9F 6907
OFA1 8514
OFA3 A515
OFA5 6900
OFA7 8515
OFA9 18
OFAA 90DD
OFAC C8
OFAD B114
OFAF F025
OFB1 20FEFE
OFB4 A94C
OFB6 8516
OFB8 A002
OFBA B114
OFBC 8518
OFBE C8
OFBF B114
OFC1 8517
OFC3 A5AD
OFC5 201600
OFC8 85AD
OFCA A5AC
OFCC A4AD
OFCE 20D1C0
OFD1 A900
OFD3 A8
OFD4 AA
OFD5 60
OFD6 C8
OFD7 B114
OFD9 C900
OFDB F005
OFDD C901
OFDF F007
OFE1 60
OFE2 20000E
OFE5 18
OFE6 90E9
OFE8 EA
OFE9 18
OFEA 90E5

```

Listing 2: Hexadecimal Converter

```

;*****
;*
;* HEX CONVERTER *
;*
;* BY CHRISTER ENGSTROM *
;*
;*****
;
; ORG $OE00
START LDA $73
      STA $14
      LDA $74
      STA $15
;
; START LOOP IN PROG
;
LOOP  LDA $15
      CMP $76
      BMI GO
      LDA $14
      CMP $75
      BMI GO
      RTS
;
GO    JSR SUBR
      CLC
      LDA $14
      ADC #$01
      STA $14
      LDA $15
      ADC #$00
      STA $15
      CLC
      BCC LOOP
;
; CHECK PROGRAM
;
SUBR  CLD
      LDY #$00
      LDA 'X
      CMP ($14),Y
      BEQ CONT
      LDA 'Z
      CMP ($14),Y
      BNE NEXT
;
CONT  STA $16
      LDA ""
      INY
      CMP ($14),Y
      BNE NEXT
      LDX '0
      STX $18
      STX $19
      STX $1A
      STX $1B
      LDX #$00
      STX $34
      LDX #$18
      STX $33
      NOP
;
IN    INY
      LDA ($14),Y
      CMP ""
      BEQ UT
      CPY #$06
      BEQ NEXT
OE00 A573
OE02 8514
OE04 A574
OE06 8515
OE08
OE08
OE08 A515
OE0A C576
OE0C 3007
OE0E A514
OE10 C575
OE12 3001
OE14 60
OE15
OE15 20280E
OE18 18
OE19 A514
OE1B 6901
OE1D 8514
OE1F A515
OE21 6900
OE23 8515
OE25 18
OE26 90E0
OE28
OE28
OE28 D8
OE29 A000
OE2B A958
OE2D D114
OE2F F006
OE31 A95A
OE33 D114
OE35 D037
OE37
OE37 8516
OE39 A922
OE3B C8
OE3C D114
OE3E D02E
OE40 A230
OE42 8618
OE44 8619
OE46 861A
OE48 861B
OE4A A200
OE4C 8634
OE4E A218
OE50 8633
OE52 EA
OE53
OE53 C8
OE54 B114
OE56 C922
OE58 F015
OE5A C006
OE5C F010

```

(Continued)



**Listing 2 (Continued)**

```

OE5E C930      CMP 'O
OE60 300C      BMI NEXT
OE62 C93A      CMP #\$3A
OE64 30ED      BMI IN
OE66 C941      CMP 'A
OE68 3004      BMI NEXT
OE6A C947      CMP 'G
OE6C 30E5      BMI IN
OE6E           ;INVALID/NO STRING
OE6E 60        NEXT RTS
OE6F           ;
OE6F           ;MOVE RIGHT JUST
OE6F           ;
OE6F 8417      UT     STY \$17
OE71 A203      LDX #\$03
OE73 8636      STX \$36
OE75 8435      STY \$35
OE77 C635      IN2    DEC \$35
OE79 A435      LDY \$35
OE7B B114      LDA (\$14),Y
OE7D C922      CMP ""
OE7F F009      BEQ UT2
OE81 A436      LDY \$36
OE83 9133      STA (\$33),Y
OE85 C636      DEC \$36
OE87 18        CLC
OE88 90ED      BCC IN2
OE8A           ;
OE8A           ;STRING TO HEX
OE8A           ;
OE8A A003      UT2    LDY #\$03
OE8C B133      UT2A   LDA (\$33),Y
OE8E 207DEF    JSR \$EA7D
OE91 9133      STA (\$33),Y
OE93 88        DEY
    
```

**Listing 2 (Continued)**

```

OE94 10F6      BPL UT2A
OE96           ;START COUNT LOOP
OE96 A200      LDX #\$00
OE98 8622      STX \$22
OE9A 8623      STX \$23
OE9C 8624      STX \$24
OE9E F8        SED
OE9F A940      LDA #\$40
OEA1 8525      STA \$25
OEA3 A996      LDA #\$96
OEA5 8526      STA \$26
OEA7 A518      LDA \$18
OEA9           ;TEST BIT 1
OEA9 C908      CMP #\$08
OEAB 300D      BMI NOMI
OEAD A516      LDA \$16
OEAF C958      CMP 'X
OEB1 D007      BNE NOMI
OEB3 A9A5      LDA #\$A5
OEB5           ;FLAG < 0
OEB5 8516      STA \$16
OEB7 18        CLC
OEB8 9004      BCC IN3
OEBA A930      NOMI  LDA '0
OEBC           ;FLAG >= 0
OEBC 8516      STA \$16
OEBE C618      IN3    DEC \$18
OECO 3005      BMI UT3
OEC2 20F60E    JSR ADD
OEC5 90F7      BCC IN3
OEC7 A902      UT3    LDA #\$02
OEC9 8525      STA \$25
OECB A956      LDA #\$56
OECD 8526      STA \$26
OECF C619      IN4    DEC \$19
OED1 3005      BMI UT4
OED3 20F60E    JSR ADD
OED6 90F7      BCC IN4
OED8 A900      UT4    LDA #\$00
OEDA 8525      STA \$25
OEDC A916      LDA #\$16
OEDE 8526      STA \$26
OEE0 C61A      IN5    DEC \$1A
OEE2 3005      BMI UT5
OEE4 20F60E    JSR ADD
OEE7 90F7      BCC IN5
OEE9 A901      UT5    LDA #\$01
OEEB 8526      STA \$26
OEED C61B      IN6    DEC \$1B
OEEF 301A      BMI UT6
OEF1 20F60E    JSR ADD
OEF4 90F7      BCC IN6
OEF6           ;ADD TO RESULT
OEF6 18        ADD    CLC
OEF6           ;ADD TO RESULT
OEF7 A524      LDA \$24
OEF9 6526      ADC \$26
OEFB 8524      STA \$24
Oefd A523      LDA \$23
OEFF 6525      ADC \$25
OF01 8523      STA \$23
OF03 A522      LDA \$22
OF05 6900      ADC #\$00
OF07 8522      STA \$22
OF09 18        CLC
OFOA 60        RTS
OF0B           ;
OF0B           ;SIGN CONVERSION
    
```

(Continued)

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**Listing 2 (Continued)**

```

OFOB
OFOB A516      ;
OFOB          ;UT6   LDA $16
OFOD          ;CHECK MINUS
OFOD C9A5      CMP #A5
OFOD D013      BNE IN7
OF11 38        SEC
OF12 A936      LDA #A36
OF14 E524      SEC $24
OF16 8524      STA $24
OF18 A955      LDA #A55
OF1A E523      SEC $23
OF1C 8523      STA $23
OF1E A906      LDA #A06
OF20 E522      SEC $22
OF22 8522      STA $22
OF24          ;
OF24          ;EDIT NOW
OF24          ;
OF24 D8        IN7   CLD
OF25 EA        NOP
OF26 A516      LDA $16
OF28 8535      STA $35
OF2A A522      LDA $22
OF2C 20560F    JSR LEFT
OF2F 8536      STA $36
OF31 A522      LDA $22
OF33 205C0F    JSR RIGHT
OF36 8537      STA $37
OF38 A523      LDA $23
OF3A 20560F    JSR LEFT
OF3D 8538      STA $38
OF3F A523      LDA $23
OF41 205C0F    JSR RIGHT
OF44 8539      STA $39
OF46 A524      LDA $24
OF48 20560F    JSR LEFT
OF4B 853A      STA $3A
OF4D A524      LDA $24
OF4F 205C0F    JSR RIGHT
OF52 853B      STA $3B
OF54 9014      LEFT  BCC UT7
OF56 29F0      AND  #F0
OF58 6A        ROR
OF59 6A        ROR
OF5A 6A        ROR
OF5B 6A        ROR
OF5C 290F      RIGHT AND #F0
OF5E 18        CLC
OF5F 6930      ADC '0
OF61 C93A      CMP #A3A
OF63 1001      BPL MORE
OF65 60        RTS
OF66 6907      MORE  ADC #A07
OF68 18        CLC
OF69 60        RTS
OF6A          ;
OF6A          ;MOVE TO PROG
OF6A          ;
OF6A A935      UT7   LDA #A35
OF6C 8533      STA $33
OF6E A006      LDY #A06
OF70 8416      STY $16
OF72 B133      INB   LDA ($33),Y
OF74 C616      DEC $16
OF76 A417      LDY $17
OF78 9114      STA ($14),Y
OF7A A416      LDY $16
OF7C C617      DEC $17
OF7E 10F2      BPL INB
OF80 60        RTS

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# Memory Moves with the 6502 and 6809

by Gregory Walker and Tom Whiteside

**The authors demonstrate the advantages of the 6809's direct page addressing and 16-bit index registers with a comparison of 6502 and 6809 memory moves.**

In a previous article (MICRO 47:57) we illustrated the advantages of programming the 6809 over the 6502 with a comparison of multiprecision arithmetic routines. We continue in this article with a comparison of the two processors' capabilities in solving memory move problems.

With these two articles, we hope to demonstrate that the MC6809 is not only faster and more byte-efficient than the 6502, but also more straightforward to program. Because the most useful kinds of 6502 indirect addressing must be done through page zero, it is important, particularly with larger operating systems, that page-zero RAM be used wisely. In addition, the 6502 index registers are only eight bits long, limiting indexing to a 256-byte range. These limitations will show themselves especially well in these memory move examples.

Memory moves have a number of practical applications, including word processing, EPROM programming, and program relocation. Similar techniques are involved with string manipulation and table searches.

Figure 1 is a 6502 memory move for fewer than 256 bytes from a fixed absolute address. This routine is not all that useful, since it can only work on two fixed pages due to the limited range of the 6502 index registers. However, it illustrates the real power of the 6502 in terms of byte efficiency and speed over small ranges of memory.

The program uses the fastest form of 6502 indexed addressing — absolute indexed. The Y register will be used

both as a loop index for the move and as a counter for the number of bytes to be moved. The Y register is initialized to the number of bytes to be moved and is decremented each time through the loop. When the Y register decrements to zero, the branch conditions are not met and the loop terminates. This use of the Y register eliminates the need for a CPY immediate instruction in the loop and speeds up the code. A "CNT" value of zero will move 256 bytes.

In these examples, the "LNG" column in figure 1 represents the number of bytes required per instruction. The "TIM" column is the number of machine cycles per instruction. The 6502 memory move for fewer than 256 bytes of memory required only 11 bytes of code and approximately 14 machine cycles per byte moved.

Figure 2 shows the same memory move written in MC6809 code. In this example, the 16-bit X register points to the "FROM" address and the U register points at the "TO" address. The MC6809 addressing mode used is indexed with accumulator offset. The effective address is formed by summing the two's complement contents of the B accumulator with the contents of the index register used. You will notice that the B accumulator is being used in the same manner as the 6502 Y register was in figure 3. Because the offset is two's complement, the MC6809 example is limited to 127 bytes. We included this example to show how similarly the two processors can be used to solve the same problem. The MC6809 took 15 bytes and 15 machine cycles per byte moved.

While the 6502 wins this round by four bytes and one machine cycle per

**Figure 1: 6502 program to move fewer than 256 bytes of memory. Timing = 2 + 14 \* N where N is the number of bytes to move.**

		(LNG TIM)		
	LDY #CNT	2	2	INITIALIZE THE BYTES TO MOVE COUNT
LOOP	LDA FROM-1, Y	3	4	LOOP: GET BYTE TO MOVE
	STA TO-1, Y	3	5	MOVE BYTE
	DEY	1	2	DECREMENT LOOP COUNTER
	BNE LOOP	2	3	LOOP UNTIL ZERO COUNT
		11		

**Figure 2: MC6809 program to move fewer than 128 bytes of memory. Timing = 8 + 15 \* N.**

	LDX #FROM-1	3	3	INITIALIZE "FROM" POINTER
	LDU #TO-1	3	3	INITIALIZE "TO" POINTER
	LDB #CNT	2	2	INITIALIZE BYTES TO MOVE COUNT
LOOP	LDA B, X	2	5	LOOP: GET BYTE
	STA B, U	2	5	AND MOVE IT
	DECB	1	2	DECREMENT LOOP COUNT
	BNE LOOP	2	3	LOOP UNTIL COUNT IS ZERO
		15		

byte over the MC6809, the MC6809 code is more versatile. If this were a subroutine, "LOOP" could be called with X and U pointing anywhere in memory, while the 6502 example would be limited to the 256-byte range of its index registers. Because the MC6809 code holds the pointers in registers instead of memory locations, it is re-entrant and could be used in a real-time operating system.

Since it appears that the 6502 can keep up with the MC6809 on a short memory move, let's try another memory move. This time the code must be able to move *any* number of bytes. A real measure of a processor's power is how much its performance degrades as the complexity of its task increases. In this example, complexity is measured in terms of address range.

Figure 3 shows a 6502 program to move any size block of memory. "CNT" bytes will be moved from address "FROM" to address "TO". The bytes will be moved starting at address "FROM" plus "CNT," with "CNT" decremented each time through the loop. Since the 6502 index registers are only eight bits wide, it is necessary to use indirect indexed addressing to move more than 256 bytes. (We do not count self-modifying code as an option, but as an abomination!)

The first part of the program sets up the two 16-bit zero-page pointers "FROM" and "TO". "CNT" is a 16-bit number stored in the X register (least significant byte) and "COUNT" (most significant byte). The X register is used to store the least significant byte of "CNT" to save three machine cycles per byte moved over using a zero-page variable. The "CNT" most significant byte is initialized to one count higher than desired to eliminate the need for a load/compare step that would have used time and bytes. The pointer least significant bytes are incremented rather than the Y register, since the "FROM" and "TO" least significant bytes might not be the same.

If the above "tricks" seem confusing to you, you are not alone. Tricks cost money in terms of debug time and the time required to recode the routine when some performance requirement is changed. However, we tried to write the best 6502 code possible. The result is typical of commercial practice. Even with all these tricks, the 6502 code was 47 bytes long and approximately 32 machine cycles per byte. This is more than four times the size, and twice the cycles per byte over the short memory move. Now you see what we meant about performance degradation with increased task complexity!

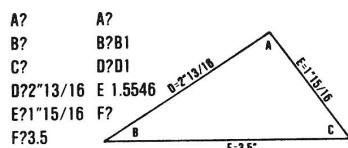
Figures 4 and 5 show two versions of MC6809 memory moves which can handle memory ranges of more than 256 bytes. Both examples are identical except that one (figure 4) moves memory one byte at a time while the other (figure 5) moves two bytes at once. Both require 18 bytes of code, but the second program is eight machine cycles per byte (40%! ) faster than the first.

In both these programs, the X register acts as a pointer to the "FROM" address and the U register acts as a pointer to the "TO" address, just like the program in figure 2. In these routines, however, the index registers are incremented each time through the loop as indicated by the "+" beside the indexed loads and stores. Since the second program moves two bytes at a time, the MC6809 double increment ("++") mode is used to advance to the next word. In both figures, the Y register is a counter to the number of bytes remaining to be counted. The "LEAY" instruction has no 6502 equivalent and indicates that the Y register is to be loaded with the "effective" address indicated in the operand field. In figure 4, the operand field of the LEAY instruction means to load Y with the contents of Y minus 1 like a 16-bit 6502 "DEY".

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Figure 3: 6502 program to move any number of bytes of memory. Timing = 31 + (35 + 28/256) \* N.

	(LNG)	(TIM)	
LDA #FROML	2	2	INITIALIZE INDIRECT "FROM" PTR
STA FROM	2	4	
LDA #FROMH	2	2	
STA FROM+1	2	4	
LDA #TOL	2	2	INITIALIZE INDIRECT "TO" PTR
STA TO	2	3	
LDA #TOH	2	2	
STA TO+1	2	3	
LDA #CNTH+1	2	2	INIT BYTES TO MOVE COUNT MSB
STA COUNT	2	3	TO (COUNT / 256) + 1
LDX #CNTL+1	2	2	INIT X TO THE COUNT LSB
LDY #0	2	2	INITIALIZE INDIRECT POINTER
LOOP LDA (FROM), Y	2	5	LOOP: GET A BYTE
STA (TO), Y	2	6	AND MOVE IT
INC TO	2	5	INCREMENT 16-BIT "TO"
BNE NOINC1	2	4	POINTER
INC TO+1	2	5	
NOINC1 INC FROM	2	5	INCREMENT 16-BIT "FROM"
BNE NOINC2	2	4	POINTER
INC FROM+1	2	5	
NIINC2 DEX	1	2	DECREMENT 16-BIT "CNT"
BNE LOOP	2	4	
DEC COUNT	2	5	
BNE LOOP	2	4	LOOP UNTIL "CNT" IS ZERO
		47	



Figure 4: MC6809 program to move any length of memory. Timing = 10 + 20 \* N.

		(LNG TIM)	
	LDX #FROM	3 3	INITIALIZE 16-BIT "FROM" POINTER
	LDU #TO	3 3	INITIALIZE 16-BIT "TO" POINTER
	LDY #CNT	4 4	INITIALIZE BYTES TO MOVE COUNT
LOOP	LDA , X+	2 6	LOOP: GET BYTE TO MOVE; BUMP
	STA , U+	2 6	POINTER; MOVE WORD; BUMP
	LEAY -1, Y	2 5	POINTER; DECREMENT COUNT
	BNE LOOP	2 3	BY ONE UNTIL COUNT IS ZERO
		18	

Figure 5: MC6809 program to move any length of memory. Timing = 10 + 12 \* N.

		(LNG TIM)	
	LDX #FROM	3 3	INITIALIZE 16-BIT "FROM" POINTER
	LDU #TO	3 3	INITIALIZE 16-BIT "TO" POINTER
	LDY #CNT	4 4	INITIALIZE BYTES TO MOVE COUNT
LOOP	LDD , X++	2 8	LOOP: GET WORD TO MOVE; BUMP
	STD , U++	2 8	POINTER; MOVE WORD; BUMP
	LEAY -2, Y	2 5	POINTER+2; DECREMENT
	BNE LOOP	2 3	COUNT BY TWO UNTIL COUNT IS ZERO
		18	

Since the second program moves words, Y gets decremented with the contents of Y minus 2.

The program in figure 6 combines the code from figures 4 and 5 to produce a fast, general-purpose memory move for the MC6809 which moves any number of bytes, a word (two bytes) at a time. This routine uses the powerful double-byte move code of figure 5, only without the even-byte restriction. The way this is achieved is straightforward. The "CNT" word is tested for odd length by first using the "TFR" instruction to move the "CNT" to the D register. This is followed by a "LSRB" (logical shift right B) which sets the carry bit if "CNT" is odd. If the length is even, the routine branches directly to the double-byte move routine. Otherwise, the "odd" byte is moved first using the figure 2 code. This routine is 29 bytes long and takes approximately 12 machine cycles per byte moved. The general purpose routine takes almost twice the bytes of the MC6809 short move but requires 20% less time per byte!

Figure 7 summarizes the results for the memory moves discussed in figures 1 through 6. The byte ratio column is the number of 6502 bytes for a given comparison. The cycles per byte ratio column is the 6502 cycles required, per byte moved, divided by the MC6809 cycles per byte. For example, the row labeled "<= 256 bytes" shows that the 6502 program from figure 1 used 11 bytes and needed about 14 cycles per byte moved. The MC6809 program in figure 2 needed 15 bytes and used 15 cycles per byte moved. The "byte ratio" is then 11/15 or 0.73. The "cycles per byte ratio" is 14/15 or 0.93.

As the table in figure 7 shows, the 6502 is good at moving small blocks of memory with fixed addressing. The MC6809 code for a move of fewer than 256 bytes comes close to keeping up with the 6502, but requires over a third more bytes. Our general-purpose double-byte move routine is slightly faster than the 6502 but is much more costly in terms of bytes. Since the MC6809 general purpose routine is

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Figure 6: General MC6809 program to move any length of memory. Timing = 41 + 12 \* N.

	(LNG TIM)	
LDX #FROM	3 3	INITIALIZE "FROM" POINTER
LDU #TO	3 3	INITIALIZE "TO" POINTER
LDY #CNT	4 4	INITIALIZE BYTES TO MOVE COUNT
		CHECK FOR ODD COUNT
TFR Y, D	2 6	MOVE COUNT LSB TO B REGISTER; SET CARRY IF COUNT IS ODD; TO LOOP IF COUNT IS EVEN
LSRB	1 2	
BCC LOOP	2 3	
		ELSE GET ODD BYTE; BUMP POINTER; MOVE IT; BUMP POINTER; DECREMENT LOOP COUNT; QUIT COUNT IS ZERO
LDA ,X+	2 6	
STA ,U+	2 6	
LEAY -1, Y	2 5	
BEQ DONE	2 3	
LOOP LDD ,X++	2 8	LOOP: GET NEXT WORD; BUMP POINTER+2; MOVE IT; BUMP POINTER+2; DECREMENT LOOP COUNT BY TWO UNTIL COUNT IS ZERO
STD ,U++	2 8	
LEAY -2, Y	2 5	
BNE LOOP	2 3	
DONE EQU *	29	

Figure 7: 6502/MC6809 byte and cycles per byte ratios for figures 1 through 6.

Class of Move	Byte Ratio	Cycles/Byte Ratio
< = 256 bytes		
6502-Fig 1 / MC6809-Fig 2	11 / 15 = 0.73	14 / 15 = 0.93
6502-Fig 1 / MC6809-Fig 6	11 / 29 = 0.38	14 / 12 = 1.17
> 256 bytes		
6502-Fig 3 / MC6809-Fig 4	47 / 18 = 2.61	35 / 20 = 1.75
6502-Fig 3 / MC6809-Fig 5	47 / 18 = 2.61	35 / 12 = 2.92
6502-Fig 3 / MC6809-Fig 6	47 / 29 = 1.62	35 / 12 = 2.92

easily made into a subroutine, the extra byte cost might be lessened by sharing the code with other parts of a program. The 6502 code example lacks this versatility since it is limited to fixed 256 byte ranges.

The more complex memory move of more than 256 bytes is where the MC6809 really asserts itself. MC6809 versions were presented for a single byte move, an even-length-only double-byte move, and a general-purpose "any length" move. For "byte tight" applications, the MC6809 byte mover runs 1.75 times faster than the 6502, while the 6502 uses 2.6 times the bytes of the MC6809. While the MC6809 double-byte mover from figure 5 is restricted to even-byte moves only, it rips along at almost three times the rate of the 6502 with no more code than the single-byte version.

The MC6809 general-purpose double-byte mover (figure 6) maintains the blazing speed of figure 5 without being restricted to even-byte moves. The 6502 move uses 1.6 times the bytes of the MC6809 general purpose mover.

These results show clearly the degradation of speed and code size of the 6502 for memory moves across page boundaries. We feel that the MC6809 has also been easier to program. There has been no need to set up and manipulate indirect pointers with registers of only eight bits, as was necessary on the long 6502 memory move.

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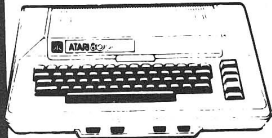
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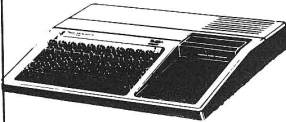
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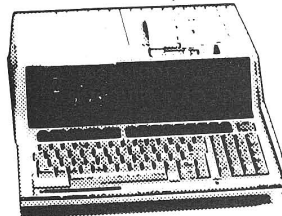
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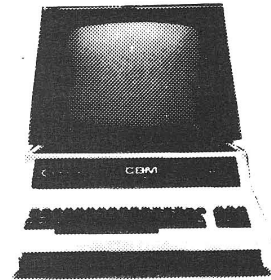
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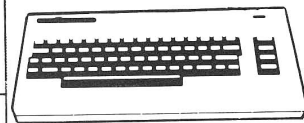
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By Loren Wright

### PET's Powerful Screen Editing — Are you getting the most from it?

When it comes to BASIC programming, most computers employ what I call a 'teletype' mentality. You type in the line number, followed by the line contents. Then you send all the characters you typed to the computer by pressing the RETURN key. Before you hit RETURN, you can correct errors by deleting back to the error, making the correction, and then retyping the rest of the line. If you have made the mistake of hitting RETURN before you notice the error, the only way to correct it is to start over. The characters you just typed in are still sitting there on the screen, but you can't do anything with them. The computer has forgotten all about what you typed. Sure, there's a copy in your BASIC program, and you can list the line to the screen, but you can't do anything with that either. Some of these computers allow some primitive editing — if you can remember the obscure control codes and are willing to copy characters back into memory. It is usually faster to retype your BASIC line.

The PET BASIC input works quite differently. Instead of keeping track of the stream of characters you're typing, the PET just puts them up on the screen. You can move the cursor anywhere you want, draw pictures, check your disk directory, or list another line. All that counts is where the cursor is when you hit RETURN. If it's on a line that begins with a number, then the system reads the line as a BASIC statement. If the line doesn't begin with a number and the line isn't a valid direct command, then the PET will respond with a ?SYNTAX ERROR.

This system offers a lot of advantages to the PET BASIC programmer. To correct an error in the line you're typing, all you have to do is move the cursor, make the correction, move the cursor back to the end of the line, and continue typing. If you want to correct a line you've already entered into the program, just list it to the screen (if it isn't already there), make the correction, and hit RETURN with the cursor anywhere on the line to enter the new version.

### Tricks of the Trade

It seems simple enough, doesn't it? If you have never tried to write a BASIC program on another computer, you probably take it all for granted. There are, however, a few traps you can fall into, and there are a few little tricks you can use to make the system work even better.

1. Clear the screen before you list lines you're going to edit. If you don't, garbage left over from your program run will appear on the same lines as your BASIC lines and those characters will be put into memory when you hit RETURN.
2. The cursor does not have to be at the end of the line when you hit RETURN. As soon as you have completed your change, you can hit RETURN.
3. If you're at the left end of a line and you want to be at the right end, the fastest way to get there is not to go forward, but rather to back up to the end of the previous line and move down one line. If you're at the right end and you want to be at the left, then the opposite holds true.
4. Don't forget the HOME key! If you're at the bottom of the screen, it's much faster to hit HOME than to move the cursor up all those lines.
5. Shifted RETURN is not the same as RETURN! It will move the cursor to the beginning of the next line, but it will not send the line to the PET for processing.
6. If you need to move a line to make room for others, just list it, change the number and hit RETURN. Remember, though, that the old copy is still there at the old number until you delete it or replace it. This technique is also particularly handy when you are writing a program that is very repetitive (e.g., a series of subroutines, where several lines are identical in each routine). Just type the line once, and for each copy, change the line number and hit RETURN.
7. If a listed line exceeds two lines, the overflow is not considered as part of the line when you try to re-enter it. This happens because you used abbreviations for BASIC keywords (like '?' for PRINT) when you originally entered the line. Using the keyword abbreviations is fine, but try to avoid using such long lines.
8. Be careful with BASIC lines that occupy only one screen line. Under some circumstances it is possible to get the next line listed on the screen entered as part of your current line. The cure is to list only one such line at a time.
9. Use the screen as a temporary storage device! This one takes some care. Let's say you have just typed in 30 lines, and you suddenly decide that only eight of them are good. You could delete each unwanted line by typing its number, but it is faster to list the lines you want to save, type NEW and RETURN. Then position the cursor on the first line, hit RETURN, and keep hitting RETURN until all the lines are restored. If any of them scroll off the screen before you re-enter them, they will have to be retyped.

Most of these tricks work fine for direct commands, too. For instance, if you misspell the file name in a LOAD command, just stop the search, move the cursor to the command line, make the change, and hit RETURN.

### Programmed Cursor Mode

Another powerful feature of the PET is its character-programmable cursor commands. Cursor moves can be included as special characters in a BASIC string so that when the string is printed, the cursor moves are executed. To get these characters into the string, the PET has something called "programmed cursor mode," where pressing a cursor key causes the appropriate special character to appear on the screen instead of the cursor move itself. The programmer loses control of the cursor while in programmed cursor mode (PCM), and if you don't know what's going on, it's easy to get

## PET VET (Continued)

frustrated. PCM is entered under only two circumstances:

1. When you type a double quote, you enter PCM; when you type another, you exit. The PET keeps track of the number of quotes in a line, but it can be fooled.
2. When you use the INSERT key, the PET counts the number of times you press it, and for that number of characters it is in PCM. The assumption is that most insertions will be within strings.

Quite often you want to be in PCM when the PET isn't, and *vice versa*. To get in or out, just type a quote and then delete it if you don't need it. The PET only recognizes when you type quotes, not when you delete them! If you've done an insertion, just type spaces for the number of characters you inserted and you will regain control of the cursor. The spaces can then be deleted.

In other instances, things get completely out of hand and you just want to start over. The answer is shift-

RETURN! It will bail you out of PCM and it will preserve the original version of the line you're editing.

It also helps to know what the cursor control characters look like when they're included in strings. This depends both on which model PET you have and on which character set you're in. A few experiments, and perhaps a little crib sheet taped to your PET will help.

### Editing Improvements

If you do a lot of BASIC programming even these powerful features may not be enough. Autonumber, renumber, delete functions, and repeating keys are probably the most useful enhancements. List scrolling and programmable function key capability are also useful. These functions are available in a number of commercial ROMs, such as Programmer's Toolkit, Disk-O-Pro, Command-O, POWER, EZAID, and others. Not all offer all of these editing features, but all include other capabilities.

### Fat 40, 8000 Series, and VIC

These recent Commodore machines incorporate repeating keys and an ES-

CAPE key to get out of programmed cursor mode. The 8000 series computers have additional special characters for window, delete line, insert line, scrolling and other commands. The VIC has special characters for color commands and its eight programmable function keys.

### Commodore's New Computers

With three new computers added to its existing line, Commodore will have an iron in just about every part of the microcomputer fire. The Ultimax (\$149.95) is a color-and-sound computer that hooks up to any home TV set. It will compete very favorably with the Sinclair ZX-81, Mattel Intellivision, and Atari VCS. The Ultimax will support joysticks, paddles, light pens, cartridges, and cassette storage. To achieve such a low price, Commodore has provided only a limited amount of RAM and a flat membrane keyboard.

The Commodore-64 (\$599) is designed to compete with the Atari 800 and Apple II with its full-size keyboard, 64K of memory, function keys, and sophisticated sound capabilities. Also announced was a 16K VIC — the SuperVIC.

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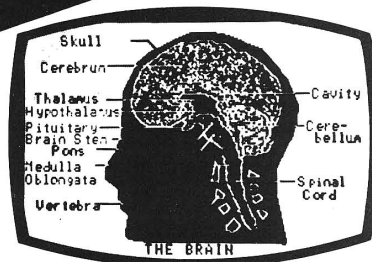


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## From Here to Atari

By James Capparell

*Editor's Note: This is the last "From Here to Atari" that will appear in MICRO. We thank Jim Capparell for his efforts and wish him success with his new Atari magazine, ANTIC. And we say to the Atari Community: send us your work! We are very interested in publishing Atari material.*

The "front jacks" on the Atari 400 and 800 are used for everything from game controller ports to printer and graphics ports. To get the most out of them it is necessary to understand something about the hardware. This month, I'll provide a description of the pin configuration of these jacks, the memory locations assigned to the jacks, and an example of how each pin may be individually configured as input or output.

The hardware controlling these jacks is a 6820 PIA (Peripheral Interface Adapter). This chip consists of two ports labeled "A" and "B". Port A controls Jacks 1 and 2. Jacks 3 and 4 (on your right) are controlled by Port B. The jacks are numbered left to right as you face the console. There is a numbering discrepancy: BASIC numbers them 0 to 3. The BASIC statement,

```
10?STICK(0),STICK(1),STICK(2),STICK(3)
```

will print the values read at Jack 1, Jack 2, Jack 3, and Jack 4.

Each port consists of three registers — the Control Register, the Data Direction Register (DDR), and the Data (buffer) Register (DR). The PIA is a 40-pin chip. Due to a limitation on available pins, the DDR and the DR share the same address. (See table 1.)

Bit 2 of the control registers determines whether the DDR or the DR is addressed. When set to 0, bit Z addresses the DDR, but when set to 1 the DR is addressed. The data register simply holds data. When the jacks are configured as input ports, the DR holds the data for the Atari to read.

When the jacks are configured as output ports, the DR holds data to be written to an external device. The DDR determines for the PIA which lines are input and which are output.

To configure Jack 1 as input and Jack 2 as output, it is necessary to tell the PIA the direction for each of the eight bits in Port A. To accomplish this, perform the following steps:

1. Set bit 2 of PACTL(\$D302) to 0. This allows us to address the DDR.
2. Write 00001111 = 15 to address \$D300 (note a 1 bit indicates the associated line is output).
3. Set bit 2 of PACTL to 1. This restores address \$D300 to the data register.

At this point, Jack 1 can be read normally with a STICK(0) statement. Jack 2 can't be read since it is configured as an output jack. Try the following:

```
10 POKE 54018,0 :REM Go talk to
Data Direction Register
20 POKE 54016,15 :REM Jack 1 is input,
Jack 2 is output
30 POKE 54018,4 :REM Reset to data
register
40 REM connect joystick to Jacks 1 and 2
50 ?STICK(0),STICK(1) :REM Print out
values from Jacks 1 and 2
60 GOTO 50 :REM Loop forever
70 REM Move Joysticks 1 and 2, only
Joystick 1 will register a change.
```

Whenever your system is turned on all jacks are configured as input. That is, the operating system writes a 0 to the Data Direction Registers in Ports A and B. The values returned at these jacks are always a 1 when there is no input — logical 1 is false. This helps explain why a 15 is read even when there is no

Table 1

I/O Address	O.S. Shadow Address
\$D300 (54016)	\$278 (632)
Port A data register or data direction register when bit 2 of PACTL is 0. This address corresponds with Jack 1 and Jack 2. BASIC statements STICK(0) and STICK(1) read this port.	
\$D301 (54017)	\$279 (633)
Port B data register or data direction register when bit 2 of PACTL is 0. This address corresponds with Jack 3 and Jack 4. BASIC statements STICK(2) and STICK(3) read this port.	
\$D302 (54018)	\$27A (634)
Port A control register. Insert a value of 4 (bit 2 = 1) and \$D300 becomes the Data Register.	
\$D303 (54019)	\$27B (635)
Port B control register. Insert a value of 4 (bit 2 = 1) and \$D301 becomes the Data Register.	
The shadow registers are updated at Stage 2 of Vertical blank processing — no more frequently than every 1/60 second. If your program requires more accurate data, read the associated hardware registers at addresses \$D300 and \$D301.	

## From Here To Atari *(Continued)*

input from a joystick. Look at the diagram in figure 1 for correspondences between bits in DDR and bits in data buffer.

When a jack is configured to input and the following BASIC statement is executed:

```
10 ?STICK(0):GOTO 10
```

the following values will be printed as the joystick is manipulated:

```
1111 (15) = stick neutral
1110 (14) = forward
1101 (13) = backward
1011 (12) = left
0111 (11) = right
```

Combinations (diagonal)

```
1010 (10) = forward/left
1001 (9) = backward/left
0101 (7) = backward/right
0110 (6) = forward/right
```

The pin configuration for each jack is as follows:

1	2	3	4	5
6	7	8	9	

Console (male)

Pin 1 = forward  
Pin 2 = backward  
Pin 3 = left  
Pin 4 = right

Pin 5 = pot (paddle control)  
Pin 6 = joystick trigger at \$D010-\$D013 (CTIA)  
Pin 7 = +5V  
Pin 8 = gnd  
Pin 9 = pot (paddle control)

These front jacks are versatile and easy to use. I've connected a Hewlett Packard Bar code reader to my 800. Others have used them for graphics printer interface and 10-key pad for business use as well.

**Joystick Data**

7	6	5	4	3	2	1	0
---	---	---	---	---	---	---	---

Jack 2            Jack 1  
 (stick 1)        (stick 0)

7	6	5	4	3	2	1	0
---	---	---	---	---	---	---	---

Data Direction Register

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When bit = 0 then switch pressed  
bit = 1 then switch not pressed

Bit    0, 4 = Forward  
      1, 5 = Backward  
      2, 6 = Left  
      3, 7 = Right

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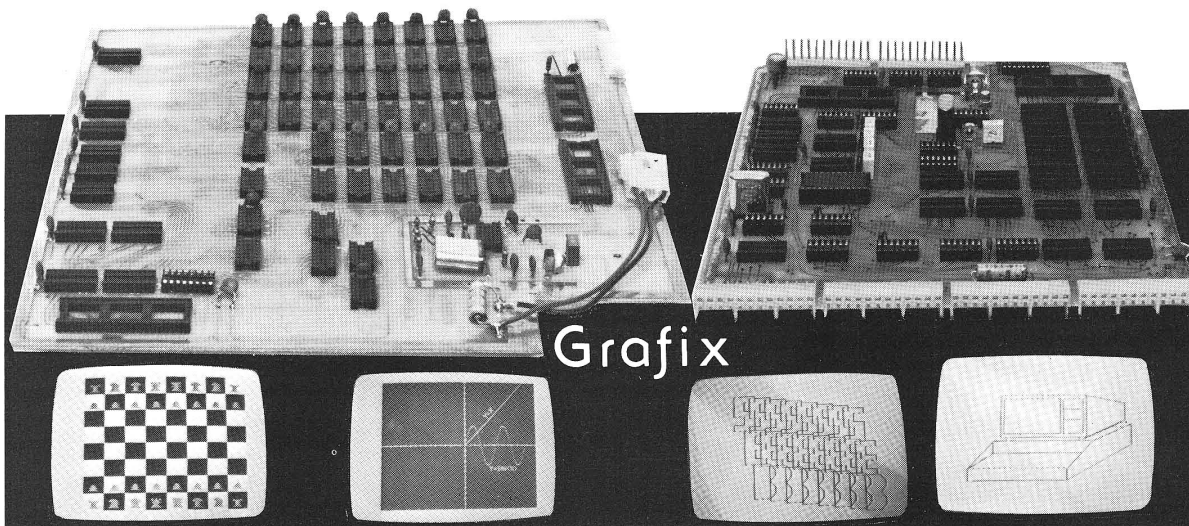
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## Reviews in Brief

Product Name: **Mittendorf High-Resolution Graphics Board**

Equip. req'd: OSI  
Price: \$40 bare board; \$185 kit  
Manufacturer: Mittendorf Engineering  
905 Villa Nueva Dr.  
Litchfield Park, AZ 85340

**Description:** A 6" x 6" circuit board which adds 256 x 256 black and white high-resolution graphics to OSI systems. The same kit works with the superbboard or 540 video board. The Mittendorf board contains 8K of 2114 memory which can be used for program storage when not using graphics.

**Pluses:** Combines with the present video signal to give hi-res graphics and the OSI character set on the same monitor. The graphics memory can be wired at one of several addresses.

**Minuses:** The Mittendorf board requires 16 connections into the OSI video circuits. The 540 version requires additional jumpers to all the bus lines. The superbboard version requires removal of the data buffers which prevents further use of the 40-pin expansion port. All 256 x 256 dots are not visible. Dots are lost to overscan in the same ratio that are lost from OSI's nominal "32 x 32" characters.

**Documentation:** Several sets of construction plans dependent on system, software to add graphics commands to BASIC, demonstration examples.

**Skill level required:** Experienced builder; modification of present video circuits required.

**Reviewer:** Earl D. Morris

Product Name: **Visiterm**  
Equip. req'd: Apple II or Apple II Plus and communications device: Apple Communications card, CCS card plus modem or D.C. Hayes Micromodem  
Price: \$149.95  
Manufacturer: Personal Software Inc.  
1330 Bordeaux Drive  
Sunnyvale, CA 94086  
(408) 745-7841  
Author: Tom Keith  
Copy Protection: Yes  
Language: 6502 Machine Language

**Description:** A communication package for interfacing the Apple with other computers, permitting the transfer and receipt of sequential text files.

**Pluses:** Visiterm uses one of two high-resolution character sets and the hi-res screen to provide the Apple user with a seventy-column display when communicating with other systems. This feature is particularly valuable when accessing a mainframe computer since up to eighty columns are often transmitted to the user. The character sets are programmable, permitting the user the valuable resource of redefining keys to permit the generation of mainframe-dependent control characters. One of the most technically

challenging aspects of using a micro as an intelligent terminal is the problem of required control keys such as the Break and X-on and X-off signals. The very extensive manual contains a thorough discussion of data communications. The main part of the manual contains almost 100 pages. The appendices, glossary, and detailed index contain almost as many pages. A print utility is provided that allows the user to obtain a hard copy of received data. The utility has many useful options which permit printer control and output formatting. A very powerful package with features useful for more than just communications.

**Minuses:** One limitation is that only sequential text files can be exchanged. However, stand-alone utility programs, outside of Visiterm, are provided to convert BASIC and binary files to and from text files. Visiterm does not provide the user with the ability to edit the data buffer exchanged. A separate text file editor may be needed by the user. (This is mentioned because at least one competing package does provide this feature.) An abbreviated summary of the Visiterm options would be helpful. For those familiar with VisiCalc II, also manufactured by Personal Software, a flow chart of commands is included which provides the user an excellent reference. It is sometimes difficult to locate the discussion of a particular topic. For example, it is possible to obtain a CATALOG of text files on a disk from within Visiterm. However, the section describing this is found under lesson Three, "File Transfer Mode." You may find it necessary to read most of the three lessons provided before you are comfortable using the package.

**Skill level required:** For the moderately sophisticated user, preferably with some understanding of communications problems.

**Reviewer:** David R. Morganstein

Product Name: **A2-3D1, A2-3D2 and A2-GE1 Graphics Package**  
Equip. req'd: 48K Apple II or Apple II with disk drive  
Price: \$119.85  
Manufacturer: SubLogic Communications Corp.  
713 Edgebrook Drive  
Champaign, IL

**Description:** Programs to help the user produce, project, and maneuver three-dimensional shapes on the two-dimensional screen medium. Contains impressive features for recording motion sequences and replaying them. Individual snapshots or slides of a motion sequence can also be recorded for later display. Provision is made for interfacing routines to Applesoft programs.

**Pluses:** Either eye or object movement can be commanded, thereby adding flexibility to sequence definition. Exceptional ease in interfacing to BASIC programs.

**Minuses:** Extensive memory and disk space is required. The included demo disk inadequately demonstrates the

*(Continued on next page)*

## Reviews in Brief *(Continued)*

package's considerable capabilities. The potential buyer should be aware of this and not underjudge the product.

**Documentation:** Superb documentation leads the user through a continuing example that eventually opens a 3-D garage door. Along the way, all capabilities are presented and an example of each is given. Surprisingly well-written in a style that lends itself to use as a tutorial or a reference.

**Skill level required:** Competent BASIC programmer with some exposure to assembly language.

**Reviewer:** Chris Williams

---

**Product Name:** 56K CMOS Static Memory Board  
**Equip. req'd:** OSI 48-pin bus  
**Price:** 4K \$200; 24K \$450; 56K \$850  
**Manufacturer:** Micro-Interface  
3111 So. Valley View Blvd.  
Suite I-101  
Las Vegas, Nevada 89102

**Description:** The Micro-Interface board puts 56K of memory, an expanded monitor ROM and a parallel printer port all into a single bus slot. The board enable can be set at each 2K address selection, allowing any combination of 6116 CMOS RAM and/or 2716 EPROM to populate any portion of the 56K memory space. The use of CMOS RAM reduces the power requirements for 48K to less than 1/2 amp, allowing memory expansion without a new power supply. Decoding is also provided for a 1.75K enhanced ROM monitor between \$F800 and \$FFFF. Micro-Interface sells several such monitors, or you can program your own into a 2716 EPROM.

**Pluses:** Very low power RAM rated for 2 MHz operation. Combines functions of several boards into one bus slot. Provision is made for multi-user or memory banking. The parallel port supports either a 6821 PIA or 6522 VIA. The board is available assembled with any amount of memory between 4K and 56K. Additional memory chips are easily installed.

**Minuses:** For 8/16/24K the Micro-Interface board is more expensive than the same memory assembled from D&N.

**Documentation:** Instructions for installing jumpers, memory addresses, chip types, jumper locations, and functions are printed on the circuit board.

**Reviewer:** Earl Morris

---

**Product Name:** Cer-Comp Color Computer Editor  
**Equip. req'd:** TRS-80C Color Computer  
with 16K memory  
**Price:** \$19.95  
**Manufacturer:** Cer-Comp  
5566 Ricochet Ave.  
Las Vegas, Nevada

**Description:** A screen editor based on line numbers; resides in R/W memory, distributed on cassette tape using the Color Computer format. The editor has 21 commands that modify text produced in a BASIC-like format. Two edit modes allow spaces or characters to be inserted or deleted from existing lines, and allow forward and reverse scrolling through existing text. Cursor control is either single space per keystroke (forward or back) or single keystroke to reach either end of a line. Block move and copy, search and replace, list to screen or printer with or without line numbers, load and save tapes, append a second tape to existing text, and some special commands for

BASIC files are available. In addition, line numbers can be removed from a file to save space, or added to files from other editors to allow editing.

**Pluses:** Low price, good versatility, easy to learn, does not require Extended BASIC. Works with machine-language monitors.

**Minuses:** Instructions and documentation lacking, no listing supplied. Although cursor control is adequate, a repeat key function for continuous cursor scroll would be advantageous.

**Skill level required:** Normal typing skills, ability to visualize final page format.

**Reviewer:** Ralph Tenny

---

**Product Name:** Color Computer Disk System  
**Equip. req'd:** TRS-80 Color Computer,  
16K w/Extended BASIC  
**Price:** \$600  
**Manufacturer:** Tandy Radio Shack  
P.O. Box 2625  
Fort Worth, TX 76113

**Description:** A 35-track, double-density disk operating system for the Color Computer. Capacity is 156,672 user-available bytes, and 68 maximum files, on a standard 5 1/4 inch soft-sectored diskette. The system includes a single drive, a disk controller ROM pak, and a connecting cable that allows two drives at a time on line. A four drive cable is optional. System utilities include BACKUP, COPY, and FORMAT. The operating system requires 2K of RAM and no disk space (except for directory tracks). Files are cataloged with an eight-character file name, and three-letter extension. VERIFY, LSET, RSET, MKN\$, and CVN\$ are typical commands available to the system which are used in other DOS systems.

**Pluses:** Because the operating system is on ROM, it requires very little extra memory from the machine. There is no DOS to learn, as disk commands are an extension of BASIC. As there is no DOS with the COLOR disk system, all disk commands can be executed from BASIC, inside or outside a program. The Microsoft disk BASIC includes the "WRITE" command, which allows easier formatting and creation of serial data files, and random access variable length files. The disk BASIC is simple, and easy to learn.

**Minuses:** Utilities are lacking in sophistication, compared to TRSDOS. Backups require pre-formatted destination disks, and there are no file protection capabilities (other than the write protect tab). BACKUP also copies all bytes on a disk, whether there is one small file, or a full disk. Auto start is not supported, and there are no DO files to provide a turn-key system. This could be partially offset by running a standard file upon power-up. This file could load any machine-language routines, and finally load the desired program from a MENU. The CHAIN command is not supported, although it is possible to load and run a program from inside another program. Another useful command that is missing is the ON ERROR GOTO statement.

**Documentation:** The owner's manual is written to the same high standards of the other two Color Computer manuals. Instructions pre-suppose no previous experience with disk systems or programming. The style is very readable, and some fine demonstration file programs are included. Missing is the usual TRS-80 programmers card.

**Skill level required:** Novice.

**Reviewer:** John Steiner

**MICRO**



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# TRS-80

# COLOR-80

# OSI

**GALAXIAN - 4K** - One of the fastest and finest arcade games ever written for the OSI, this one features rows of hard-hitting evasive dogfighting aliens thirsty for your blood. For those who loved (and tired of) Alien Invaders. Specify system - A bargain at \$9.95 OSI

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  - 2) Complete listings of two word processors for BASIC IN ROM machines.
  - 3) Moving the Directory off track 12.
  - 4) Listings for 20 game programs for the OSI.
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The easy way to speed in your programs. The tiny compiler lets you write and debug your program in Basic and then automatically compiles a Machine Code version that runs from 50-150 times faster. The tiny compiler generates relocatable, native, transportable machine code that can be run on any 6502 system.

It does have some limitations. It is memory hungry - 8K is the minimum sized system that can run the Compiler. It also handles only a limited subset of Basic - about 20 keywords including FOR, NEXT, IF THEN, GOSUB, GOTO, RETURN, END, STOP, USR(X), PEEK, POKE, -, =, \*, /, <, >, Variable names A-Z, and Integer Numbers from 0-64K.

TINY COMPILER is written in Basic. It can be modified and augmented by the user. It comes with a 20 page manual.

TINY COMPILER - \$19.95 on tape or disk OSI

### SUPERDISK II

This disk contains a new BEXEC\* that boots up with a numbered directory and which allows creation, deletion and renaming of files without calling other programs. It also contains a slight modification to BASIC to allow 14 character file names.

The disk contains a disk manager that contains a disk packer, a hex/dec calculator and several other utilities.

It also has a full screen editor (in machine code on C2P/C4) that makes corrections a snap. We'll also toss in renumbering and program search programs - and sell the whole thing for - SUPERDISK II \$29.95 (5 1/4") OSI

### BARE BOARDS FOR OSI C1P

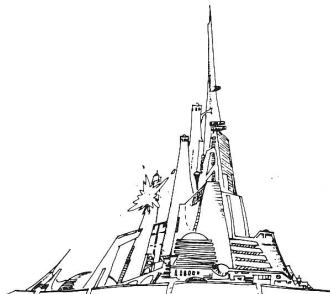
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COLOR-80

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# LISZT with Strings

by Leonard H. Anderson, Donald Cohen, Richard F. Searle

**LISZT turns your Applesoft program listing into an easy-to-understand structured format. The program is designed to be flexible and works with a variety of printers.**

## LISZT

requires:

Apple II with Applesoft  
Disk Drive  
Printer

Can you understand a program you wrote six months ago? Do you remember some of those special tricks imbedded in a concatenated line of code? The "LISZT" (Logical Interpreter Statement Zeugmatic Tabulator) can help you understand BASIC source code listings by structuring printouts in a clear, orderly form with a minimum of extra characters. Written for the Apple II Plus, it can be modified for other BASIC dialects.

Credit is due Mark Capella for the first listing program.<sup>1</sup> Since then, two others have been published.<sup>2,3</sup> Not completely satisfied, we decided to start fresh with the following rules:

1. Print results so they are easy to read.
2. Make the program adaptable to various printers.
3. Gather statements in strings for flexibility.
4. Separate REMs from printed code.
5. Omit the concatenation colon and "LET."
6. Split over-long print lines at a logical character.
7. Indent FOR-NEXT loops globally.
8. Indent IF-THEN statements locally.
9. Minimize disk operations.

The main program, LISZTER, was written in linear form to accommodate different printers and to allow easy deletion or addition of special features. This article is both a program description and a partial history of program development.

## Applesoft Source Code Structure

Source code structure rules the program. One line of Applesoft BASIC is shown in figure 1. Each line contains five overhead bytes: two for a pointer to the next line, two more for the number, and an end-of-line null (binary zero) byte. The last line number source code ends in three null bytes to indicate end-of-program.

All variable names, strings, and punctuation not a function are expressed as 7-bit ASCII with most-significant-bit (MSB) set false or zero. All function words (IF, NEXT, REM, etc.) are stored as one-byte "tokens" with MSB set true or high. There are 107 Applesoft tokens.<sup>4</sup>

## Starting the Program Organization

Figure 2 is the initial flow chart. Each program byte is examined, beginning with decimal memory location 2049. ("Standard" ROM Applesoft code begins here. It can be changed and

will vary for other BASICs.) String variables hold the line number in N\$, statement text in a "gather" string, G\$, and the "combination" printout string, C\$.

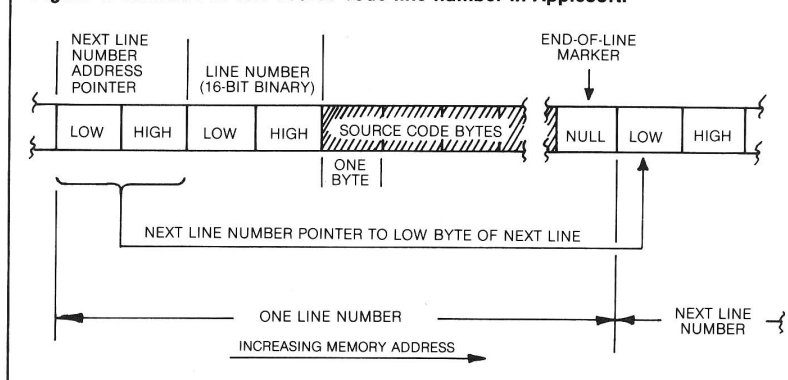
A remarks flag is set if a REM token is encountered. The first decision separates remarks by blank print lines but groups successive remarks without blank lines. Remarks are highlighted without appearing to be part of the main coding.

ASCII characters and token bytes are parsed next with tokens reconverted to the original function word. This section and the print line formatting section receive the most attention. A prime example is separating concatenated statements and allowing indication of over-long text lines.

## Holding Two BASIC Programs in Memory

Applesoft reserves two bytes in page zero (first 256 bytes) for the starting address. Start location is normally decimal 2049 for ROM BASIC, stored in locations 103 (low byte) and 104 (high byte). End-of-program in memory is in locations 175 (low) and 176 (high). Either can be changed from the keyboard or program in memory.

Figure 1: Structure of one source-code line number in Applesoft.



Apple's DOS allows the simulation of keyboard commands with an EXEC Text File. An EXEC file loads statements into the keyboard buffer. Each statement is then executed as if it were a keyboard command.

The program to be listed is loaded first. The EXEC file is called next by typing "EXEC LISZT." LISZT then changes normal program start address to the end of program plus two, loads and runs the LISZTER working program. Loading LISZTER will automatically set the new end-of-program address.

Although two programs are now in memory, Applesoft will only execute LISZTER as indicated by the starting address changed by EXEC file LISZT. Original start and end addresses are held in page zero scratchpad locations; LISZTER resets start and end from these scratch locations on completion of printout.

EXEC file LISZT is generated by the short program in listing 1. MAKE LISZT may be deleted after generating LISZT. LISZT EXECution commands are those indicated within quotes in MAKE LISZT line numbers 225 through 265.

LISZTER start location is set slightly higher than normally expected. This and the extra nulls will insure that the listed program can be RUN normally after LISZTER resets start and end addresses on printout completion. Normal source code ending must be three successive null bytes.

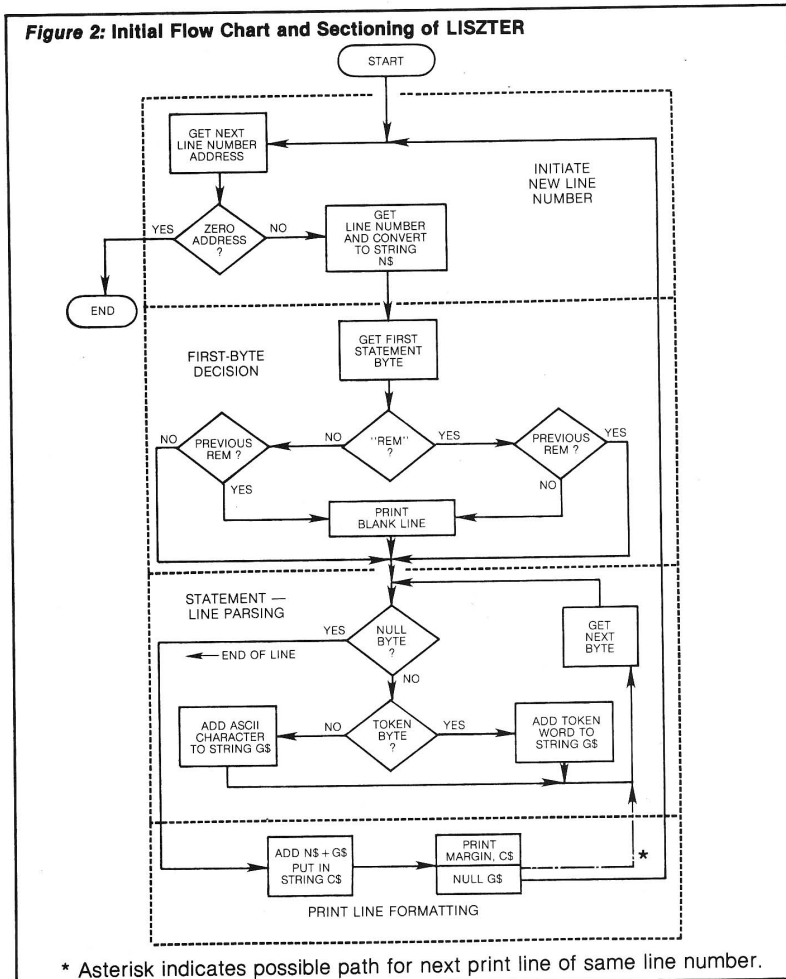
### Setting Up LISZTER

LISZTER begins execution at line number 82 by initializing the variables. Initializing will speed up execution, especially with string variables in Applesoft. Token array T\$ contains the 107 function words expressed as literal strings in the DATA statements. Direct expression as strings allows spaces to be added for clarity in gathering and converting the tokens.

The REM token word was changed to an asterisk. It is left as an isolated DATA declaration for those desiring another symbol or word. LET appears as a null string in line 88 to permit completion of the array; token parsing will skip over a LET.

Screen prompts in lines 94 to 100 are optional. Printed page length is normally 60 lines per page including the header. Indent spacing is normally four column spaces, fitting the REM asterisk with three following blanks.

Figure 2: Initial Flow Chart and Sectioning of LISZTER



\* Asterisk indicates possible path for next print line of same line number.

Listing 1: MAKE LISZT "EXEC" file generator printed with the LISZTER program in listing 2.

```

MAKE LISZT
LEONARD H. ANDERSON
PRINTOUT ON 20 AUGUST 1981
Page 1

200 * "MAKE LISZT" GENERATOR FOR "LISZT" EXEC FILE
205 * LEONARD H. ANDERSON 7/5/81
210 D$ = Chr$(4)
    C$ = Chr$(13)+D$
215 Print C*"OPEN LISZT"
220 Print C*"WRITE LISZT"
225 Print "POKE208,PEEK(103)"
    Print "POKE209,PEEK(104)"
    Print "POKE210,PEEK(175)"
    Print "POKE211,PEEK(176)"
230 Print "POKE104,PEEK(211)"
235 Print "IF PEEK(210)<254 THEN POKE103,(PEEK(210)+1)"
240 Print "IF PEEK(210)>253 THEN
    POKE103,(PEEK(210)-254);POKE104,(PEEK(211)+1)"
245 Print "POKE(PEEK(210)+PEEK(211)*256-2),0"
250 Print "POKE(PEEK(210)+PEEK(211)*256-1),0"
255 Print "POKE(PEEK(210)+PEEK(211)*256),0"
260 Print "POKE(PEEK(210)+PEEK(211)*256+1),0"
265 Print "POKE(PEEK(210)+PEEK(211)*256+2),0"
270 Print "RUN LISZTER"
275 Print D$"CLOSE"
280 End

End of Listing

```

Program Length = 642 Bytes, Total of 17 Line Numbers  
19 Total Non-Rem Statements, 2 Total Remarks



Line 104 assumes the printer interface located in peripheral slot 1. The "POKE 33,30" sets screen window width to 30 columns, necessary only for certain Apple I/O interfaces. Line 106 is the main printer control statement.

### Subroutines

"GET BYTE" simply advances program byte pointer P and fetches a decimal value of the byte in B. "BLANK LINE PRINT" is used mainly in REM separation. String S\$ is a single blank space and required by Centronics 737 printers; most other printers will accept a single PRINT without a variable.

"TEST PAGE" (lines 6 through 14) does several things: line count (LC) advances and test, header printing and a "continued" indicator print on the current page if another page is to be printed. Since concatenated statements are separated, some may be printed on the following page. Lines 13 and 14 place brackets around the line number and print that on the following page for clarity.

### Upper and Lower Case

The mixture of upper and lower case characters is due primarily to the case characters in program statements. We decided that program statements would appear better with the familiar function words in a mixture, non-token state-ments in normal upper-case only. The choice is up to the user.

Since none of us has direct lower-case control, an available utility program was used to "zap" the desired characters directly on the disk. You should do this on a copy file in disk; strange results occur if a token is accidentally changed!

### First-Byte Decision

In the section occupying lines 29 through 33 on listing 2 remarks are separated and grouped. A single, first-byte colon in Applesoft is equivalent to a REM; first-byte colons are changed to REMs since the asterisk-equivalent voids the original source code separation intent.

### Statement Line Parsing

Line 34 begins a number of decisions. A null program byte indicates the print line formatting routine at line

```

Listing 2
LISZTER "UNIVERSAL" VERSION
LEONARD H. ANDERSON
24 JULY 1981
Page 1

0 Goto B2
1 * "GET BYTE" SUBROUTINE
2 P = P+1
3 B = Peek(P)
4 D = 0
5 GOSUB 6
6 Print B$
7 Return
8 * "BLANK LINE PRINT" SUBROUTINE
9 D = 0
10 GOSUB 6
11 Print B$
12 Return
13 * "TEST PAGE" SUBROUTINE. NOTE: SINGLE CHARACTER SET
    PRINTERS SHOULD DELETE "GOSUB 11" & "GOSUB 12"
    THROUGHOUT, LINES 110 THRU 113.
14 LC = LC+1
15 IF LC <= 6 THEN
16   GOTO 11
17   RETURN
18 * NOT A NEW PAGE
19 "continued" indicator print on the cur-
20 rent page if another page is to be
21 printed. Since concatenated statements
22 are separated, some may be printed on
23 the following page. Lines 13 and 14
24 place brackets around the line number
25 and print that on the following page for
26 clarity.
27 "TEST PAGE" (lines 6 through 14)
28 does several things: line count (LC) ad-
29 vance and test, header printing and a
30 "continued" indicator print on the cur-
31 rent page if another page is to be
32 printed. Since concatenated statements
33 are separated, some may be printed on
34 the following page. Lines 13 and 14
35 place brackets around the line number
36 and print that on the following page for
37 clarity.
38 The mixture of upper and lower
39 case characters is due primarily to the
40 case characters in program statements. We
41 decided that program statements would
42 appear better with the familiar function
43 words in a mixture, non-token state-
44 ments in normal upper-case only. The
45 choice is up to the user.
46 Since none of us has direct lower-
47 case control, an available utility pro-
48 gram was used to "zap" the desired
49 characters directly on the disk. You
50 should do this on a copy file in disk;
51 strange results occur if a token is ac-
52 cidentally changed!
53 In the section occupying lines 29
54 through 33 on listing 2 remarks are
55 separated and grouped. A single, first-
56 byte colon in Applesoft is equivalent
57 to a REM; first-byte colons are changed
58 to REMs since the asterisk-equivalent
59 voids the original source code separa-
60 tion intent.
61 Line 34 begins a number of deci-
62 sions. A null program byte indicates
63 the print line formatting routine at line
64 (continued)

```

```

18 GOSUB 111
19 GOSUB 4
20 GOSUB 4
21 GOSUB 4
22 * END OF PROGRAM, PRINT NOTICE
23 IF D > 0 Goto 27
24 D = 256B+B
25 GOSUB 2
26 D = B
27 GOSUB 2
28 * INDICATES END.
29 * GET THE TWO-BYTE POINTER TO NEXT LINE NUMBER; NULL
    RETURN
30 K = F#(0)
31 K = F#(0)
32 C# = Rights((Left$(LB$, (6-K)) + Chr$(91) + N# + Chr$(93) + S#), B) +
    Rights(C#, (Len(C#) - B))
33 * STATEMENT CHARACTERS
34 * # IS NOW WITHOUT SPACES; BRACKET # AND ATTACH TO
    K = Len(N#)
35 N# = Str$(Val(N#))
36 * IDENTIFICATION ON NEXT PAGE
37 * PUT LINE NUMBER IN BRACKETS AS A STATEMENT
    RETURN
38 IF NOT D THEN
39   Print B$
40   K = F#(0)
41   Next
42   Print Left$(B$, E)
43   E = Int((LL - Len(H#(K))) / 2) + 1
44   For K = 1 To 4
45     H#(K) = "Page" + Str$(PC)
46   * SPLIT OVER TWO PRINT PAGES
47   * PRINT THE HEADER, BRACKET LINE NUMBER FOR STATEMENTS
48   * PUT LINE NUMBER IN BRACKETS AS A STATEMENT
49   * IDENTIFICATION ON NEXT PAGE
50   * STATEMENT CHARACTERS
51   * # IS NOW WITHOUT SPACES; BRACKET # AND ATTACH TO
52   K = Len(N#)
53   N# = Str$(Val(N#))
54   * IS NOW WITHOUT SPACES; BRACKET # AND ATTACH TO
55   STATEMENT CHARACTERS
56   C# = Rights((Left$(LB$, (6-K)) + Chr$(91) + N# + Chr$(93) + S#), B) +
57     Rights(C#, (Len(C#) - B))
58   K = F#(0)
59   Return
60 * END OF LISTING"

```

54. A decimal value between 1 and 127 is an ASCII character byte; any value above 127 is a token.

The double quote test at line 36 allows colons *within* quotes or remarks. Any other colons are treated as delimiter characters and tested at line 37. A delimiter forces a new print line but not a new line number as in the case of a null value byte.

Control characters are converted to upper case equivalents. Besides making control characters visible, conversion allows a printer to continue without suddenly switching to a new mode! We enclosed control characters in vertical bars because that print character has little use in normal printing.

Token byte values are changed to allow you to gather them from the T\$ array. A token value out of normal range is made into a distinctive word at line 40. A test-true here would indicate an error.

The REM flag set at line 43 is primarily for concatenated remarks. The remarks counter is optional and used only for end-of-listing statistics. REM spacing variable RS is set to one for indenting remarks. While remarks are highlighted, we also wanted their appearance out of the normal program flow.

The FOR flag sets up the start of global FOR-NEXT indenting. The FOR spacing counter is advanced in print line formatting to allow completion of the entire FOR statement. The NEXT test at line 48 removes one FOR indent space. This space is held at zero in case an intermediate (but legal) NEXT is used with the loop.

Conditional tests add an indent space on completion of a THEN. Anything following a THEN, even if only a line number, is considered a separate statement. An IF-GOTO is considered a single statement. The choice was arbitrary to reduce total code.

A LET token is ignored by choice. Omitting line 47 allows you to print a LET.

DATA flag (DF) is used solely in print formatting. When set, it allows splitting an over-long print line only on commas. This is useful when DATA declarations contain strings with spaces as in LISZTER itself.

#### Listing 2 (Continued)

```

19      *  OPTIONAL STATISTICS

20      GOSUB 4
      GOSUB 4
      GOSUB 6
      PRINT M$;"PROGRAM LENGTH = _
          ";(PEEK(211)-PEEK(209))*256+PEEK(210)-PEEK(208);" BYTES, _
          TOTAL OF ";TN;" LINE NUMBERS"

21      GOSUB 4
      GOSUB 6
      PRINT M$;(TS-TR);" TOTAL NON-REM STATEMENTS, ";TR;" TOTAL_
          REMARKS"
      GOSUB 4
      GOSUB 6
      PRINT M$;"END"

22      *  TURN OFF PRINTER, DISPLAY END PROMPT ON SCREEN

23      PR# 0
      POKE 33,40
      HOME
      VTab 12
      HTab 11
      INVERSE
      PRINT " END OF LISTING "
      NORMAL

24      *  RESET PAGE 0 POINTERS FOR THE LISTED PROGRAM

25      POKE 105,PEEK(210)
      POKE 106,PEEK(211)
      POKE 107,PEEK(210)
      POKE 108,PEEK(211)
      POKE 109,PEEK(210)
      POKE 110,PEEK(211)
      POKE 111,PEEK(115)
      POKE 112,PEEK(116)
      POKE 103,PEEK(208)
      POKE 104,PEEK(209)
      POKE 175,PEEK(210)
      POKE 176,PEEK(211)
      END

26      *  MAKE THE LINE NUMBER STRING

27      TN = TN+1
      GOSUB 2
      D = B
      GOSUB 2
      K = B*256+D
      D = LEN(STR$(K))
      N$ = RIGHT$(LEFT$(LB$(7-D))+STR$(K)+"  ",B)

28      *  BEGIN LINE PARSING WITH FIRST-BYTE DECISION

29      TS = TS+1
      D = 0
      GOSUB 2
      IF B = 58 THEN
          B = 178
          *  CONVERT "SIMPLE REM" (A ":" FIRST-BYTE) TO ORDINARY
              "REM"

30      IF B = 178 AND NOT RF THEN
          GOSUB 4
          GOTO 34
          *  "REM" FLAGS ARE SET AFTER SEPARATION OF TOKENS;
              REM-GROUPS SEPARATED BY BLANK PRINT LINES.

31      IF B = 178 AND RF GOTO 34
          *  BYPASS RF RESET

32      IF RF THEN
          RF = 0
          GOSUB 4

33      *  RE-ENTRY POINT FOR NEXT BYTE IN STATEMENT DECISION FLOW

34      IF B = 0 GOTO 54
          *  FORCE A NEW LINE ON THE END-OF-LINE NULL MARKER

35      IF B>127 THEN
          B = B-127
          GOTO 41
          *  BYTE IS A TOKEN; REMAINDER ARE CHARACTERS
  
```

(continued)

**Listing** (Continued)

```
36 If B = 34 Then
    QF = -QF
    * TOGGLE QUOTE FLAG FOR COLON-PRINT TEST IN NEXT LINE

37 If B = 58 And Not RF And QF<1 Then
    TS = TS+1
    Goto 54
    * OMIT THE CONCATENATION ":" AND FORCE A NEW LINE, ELSE
    PRINT THE COLON AS A CHARACTER

38 If B<32 Then
    B = B+64
    G$ = G$+Chr$(124)+Chr$(B)
    B = 124
    * PRINT CONTROL CHARACTERS AS UPPER-CASE BETWEEN
    VERTICAL BARS; INDICATOR OF CONTROL CHARACTER
    OPTIONAL.

39 G$ = G$+Chr$(B)
    Gosub 2
    Goto 34

40 * INDICATE UNUSED TOKENS AND CONTINUE

41 If B>107 Then
    G$ = G$+" ?! "
    Gosub 2
    Goto 34

42 * ACCEPTABLE TOKENS...

43 If B = 51 Then
    TR = TR+1
    RF = 1
    RB = 1
    * SET BOTH FLAGS AND TOTAL-COUNT ON "REM"

44 If B = 2 Then
    FF = 1
    * A "FOR" IS STARTED

45 If B = 69 Then
    CF = 1
    G$ = G$+T$(B)
    Goto 54
    * FORCE A NEW LINE AFTER PRINTING A "THEN"

46 If B = 4 Then
    DF = 1
    * "DATA" STATEMENT BEGUN; WILL AFFECT INDENTING LATER

47 If B = 43 Then
    Gosub 2
    Goto 34
    * IGNORE A "LET" (IT IS A NULL STRING IN DATA STATEMENT
    LINE #88)

48 If B = 3 Then
    FS = FS-1
    If FS<0 Then
        FS = 0
    * "NEXT" TOKEN REMOVES A "FOR" LOOP INDENT

49 G$ = G$+T$(B)
    Gosub 2
    Goto 34

50 * ADD EXTRA INDENT FOR EACH SPLIT LINE, LIMITING FOR
    LINE-UP OF "REM" AND "DATA" PRINT-OUTS

51 SF = 0
    RS = RS+1
    If RS>2 Then
        RS = 2

52 If DF And RS>1 Then
    RS = 1

53 * GET TOTAL INDENT SPACES FOR PRINT LINE PLUS LOW-LIMIT FOR
    SPLIT-POINT ("E")

54 K = IM*(FS+CS+RS)
    E = K+13
    If K>0 Then
        G$ = Left$(BB$,K)+G$
```

(continued)

## Print Line Formatting

The next part of the program sets up indent spaces and splits over-long print lines on a selected character. Splitting is done on ASCII characters since gather string G\$ contains only ASCII values on entrance at line 54.

FOR, REM, and IF spacing counters are added at line 54, multiplied by IM (default value of four), and inserted ahead of G\$. Temporary variable D is an indicator to insert the line number on the first statement. G\$ is set into C\$, then tested for length at line 59. If the C\$ string length is too long, it is split with the right side remainder replacing the former contents of G\$.

Splitting has two priorities. The first priority split occurs at the right-most available space, if it is not a DATA statement. The second priority is an arithmetic operator character (ASCII, not token) or comma; DATA statements split only on commas. While the second priority choice seems arbitrary, it is convenient in terms of ASCII values.

Splitting character search is right to left, beginning with the last available print line column determined by LL. Left limit is determined by temporary variable E (line 54). The original program had an undesired zero left limit; a few print lines were endless blanks!

Another undesired condition occurred with spaces in long strings or PRINTs going beyond the right limit. There was no way to determine if a space existed in the printout. This is solved by lines 74 and 75 adding an underline at the right-most space of the first line, or left-most space of the next line.

## Final Print and Cleanup

Every new line calls the TEST PAGE subroutine. This determines if a new page is called for and, if so, prints the "continued" reminder at the bottom, form-feeds, then prints a header on the next page.

Deciding on a one-statement-per-line format gave us the possibility of one or more unnumbered statements on the next page. Holding the readability rule, we decided on placing the next-page line number in brackets (seldom used in Applesoft) while holding the number print justification. Lines 13 and 14 take care of this. An early version used two colons between the



number and statement but conflicted with Backus-Naur notation.

Uncompleted split lines jump to line 51 for extra indents. A remark allows one extra indent count to line up the remark second line with first line text. The REM symbol used here takes four columns or one default indent space. The DATA declaration single indent (line 52) seemed to be most readable.

Separate flag and counter variables on FOR and IF statements allow for concatenation in one line number of source code and the global or local indenting in printout. Local indenting of conditionals is reset on a new line number but global indenting of FOR loops is decremented only on a NEXT token at line 45.

A new source code line number is begun only when the program byte contains the end-of-line null.

### Ending it All

Applesoft indicates the end of a listing by three successive nulls. This would appear as a zero line number — a second zero line number, since LISZTER begins with line number zero. This second zero line number falls through the IF in line 16 to begin optional statistical printouts at lines 18, 20, and 21.

Line 23 disables all Apple peripherals by "PR#0", resets screen width to normal by "POKE 33,40", and indicates a finish on the screen. The print command at line 106 allowed the screen to be active at all times even though lower case characters appear as nonsense on a standard Apple.

The POKes in line 25 reset the start and end pointers to their original values prior to the EXEC file command. Variable and array space pointers are also reset permitting the user to RUN the program after LISZTING.

### Optional Starting Prompts

The "RUN 23" notice in line 94 should remain until the user is very familiar with LISZT. It is the only way to restore start and end pointers after a RESET. Address locations in line 95 are optional, useful only with very long programs.

Page length, left margin, and indent spacing are useful only if different paper is used. If available, different vertical printer spacing could be added to

### Listing 2 (Continued)

```

55 * ADD LINE NUMBER OR EQUIVALENT-SPACE BLANK
56 If Not D Then
   C$ = N$+B$
57 If D Then
   C$ = LB$+B$
58 * TEST FOR LONG LINE, SPLIT IF NECESSARY
59 K = Len(C$)-LL
   If K<1 Goto 73
   * NOT A SPLIT LINE
60 B$ = Right$(C$,K)
   C$ = Left$(C$,LL)
   SF = 1
   If DF Goto 65
61 * START SPLIT WITH A SPACE FIRST IF NOT "DATA"
62 D = LL
63 If Mid$(C$,D,1) = B$ Goto 71
64 D = D-1
   If D>E Goto 63
65 D = LL
   * SPLIT NEXT AT ARITHMETIC OPERATOR OR COMMA
66 K = Asc(Mid$(C$,D,1))
   If K<42 Or K>47 Goto 69
67 If DF And K = 44 Goto 71
   * "DATA" STATEMENTS SPLIT ONLY ON COMMAS
68 If Not DF And K<>46 Goto 71
   * OTHER STATEMENTS SPLIT BY ALL BUT PERIOD
69 D = D-1
   If D>E Goto 66
70 Goto 73
   * FALL-THROUGH INDICATES END-OF-PRINT-LINE SPLIT
71 K = LL-D
   If K>0 Then
   B$ = Right$(C$,K)+B$
   C$ = Left$(C$,D)
72 * TEST PAGE LINE-COUNT, INSERT SPACES AS ALLOWED, THEN
   PRINT AT LINE #76. NOTE: SINGLE CHARACTER SET PRINTERS
   SHOULD USE ONLY "PRINT M$,C$" BEFORE "K = FRE(0)" IN LINE
   #76.
73 Gosub 6
   K = Len(C$)
   If SF = 0 Or K<2 Or RF Then
   76
74 If Mid$(C$,K,1) = B$ Then
   C$ = Left$(C$, (K-1))+Chr$(95)
   * PUT A TRAILING UNDERLINE IN PLACE OF THE LAST SPACE
   AS A MARKER FOR THE LEFT-HAND STRING
75 If Len(B$)>2 And Left$(B$,1) = B$ Then
   B$ = Chr$(95)+Right$(B$, (Len(B$)-1))
   * PUT A LEADING UNDERLINE IN PLACE OF THE FIRST SPACE
   OF RIGHT-HAND STRING AS A MARKER
76 Gosub 111
   K = Len(C$)
   Print M$;Left$(C$,B$)
   Gosub 112
   Print Right$(C$, (K-B$))
   K = FRE(0)
   If SF Then
   D = 1
   Goto 51
   * PRINT REST OF A SPLIT LINE
77 DF = -1
   RS = 0
   DF = 0
   If FF Then
   FS = FS+1
   FF = 0
78 D = 0
   If CF Then
   CS = CS+1
   CF = 0

```

(continued)

the page length prompt at line 98. A variable left margin requires the BB\$ string to be slightly longer than one-half print line width.

We recommend that you retain the inverse video reminder at line 102. Concentration on program development makes us forget the right buttons to push at crucial moments!

### Final Thoughts

A "REM-less" version of LISZTER is about 3.9K long and will run in 5.5K of free memory. Disk operations are not required after the initial EXEC LISZT command.

Hesitation in execution occurs only in parsing long character lines. LISZTER's line 76 takes about 20 seconds to gather, split, and begin printing. The 256-byte string maximum has not yet been reached, including one LISZTING over 30 print pages.

Lack of concatenation character does not seem to hamper reading. Those familiar with the interpreter syntax will know it is always there. Statement separation is easier to understand and is improved further with indenting.

*Thanks are due to Cliff Bruhn, Dennis Kaloi, Sterling Tate, Wes Ten, and Bob Keene of Candid Computers for their trial runs, comments, and suggestions.*

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### Listing 2 (Continued)

```

79 SF = 0
   G$ = ""
   If B = 0 Then
       CS = 0
       Goto 16
       * GET ANOTHER PRINT LINE IF NOT E-O-L NULL, ELSE FALL
       THROUGH AND GET ANOTHER LINE NUMBER
80 Gosub 2
   D = 1
   Goto 34

81 * INITIALIZATION OF VARIABLES
82 Dim T$(107),H$(4)
83 * INITIAL VARIABLE SETTING HAS AN 80-CHARACTER WIDE PRINT
   LINE AND 60-LINE PAGE LENGTH (INCLUDING HEADER, EXCLUDING
   'CONTINUED' INDICATOR); CHANGE LL AND LP AS DESIRED FOR
   OTHER FORMAT SIZE.
84 * THE "P=2048" IN LINE #85 ASSUMES A NORMAL APPLESOFT ROM
   START AT DECIMAL ADDRESS 2049. CHANGE FOR APPLESOFT IN
   RAM.

85 P = 2048
   B = 0
   RS = 0
   CS = 0
   FS = 0
   RF = 0
   CF = 0
   FF = 0
   DF = 0
   SF = 0
   GF = -1
   LL = 80
   LP = 60
   IM = 4
   E = 0
   TN = 0
   TS = 0
   TR = 0
   S$ = " "
86 C$ = ""
   N$ = ""
   G$ = ""
   M$ = ""
   H$(0) = ""
   LB$ = " "
   BB$ = " "

87 Data "End","For ","Next ","Data ","Input ","Del ","Dim ","Read ",
   "Gr","Text","Pr# ","In# ","Call ","Plot ","HLin ","VLin ","
   "HGr2","HGr","HColor = ","HPlot ","Draw ","XDraw ","HTab ",
   "Home","Rot = "
88 Data "Scale = ","ShLoad","Trace","NoTrace","Normal","Inverse",
   "Flash","Color = ","Pop","VTab ","Hmem : ","Lomem : ",
   "OnErr ","Resume","Recall ","Store ","Speed = ",""," Goto ",
   "Run","If ","Restore","& "," Gosub ","Return"
89 Data "*"
   * ^ CHANGE "REM" TOKEN WORD INDICATOR AS DESIRED
90 Data "Stop","On ","Wait ","Load ","Save ","Def ","Poke ","Print ",
   "Cont","List ","Clear","Get ","New","Tab("," To ","Fn ",
   "Spc("," Then "," At ","Not ","Step ","+","-","*"
91 Data "/" ,"^"," And "," Or ",">"," = ","<","Sgn","Int","Abs","Usr",
   "Fre","Scrn(","Pd1","Pos","Sqr","Rnd","Log","Exp","Cos","Sin",
   "Tan","ArcTan","Peek","Len","Str$","Val","Asc","Chr$","Left$",
   "Right$","Mid$"
92 For K = 1 To 107
   Read T$(K)
Next
93 * SCREEN PROMPTS AND ALTERNATE LISTING CONSTANTS
94 Home
   VTab 3
   Flash
   Print " RUN 23 ";
   Normal
   Print " RESTORES ORIGINAL AFTER RESET"
   * 'RUN 23' RESTORES POINTERS FOR PROGRAM START AND END TO
   ORIGINAL VALUES AND RESETS SCREEN

```

(continued)

Listing 2 (Continued)

```

95 Print
Print "START OF PROGRAM LISTED: ";Peek(209)*256+Peek(208)
Print " END OF PROGRAM LISTED: ";Peek(211)*256+Peek(210)
Print " END OF 'LISZTER': ";Peek(176)*256+Peek(175)

96 * ABOVE IS OPTIONAL, CHECKS TO SEE IF THE 'LISZT' EXEC-FILE
IS OPERATING PROPERLY

97 Print
Input "PROGRAM NAME: ";H$(1)
Input " PROGRAMMER: ";H$(2)
Input " DATE: ";H$(3)
Print

98 Print
Print "PAGE LENGTH IS 60 LINES, WANT OTHER?"
Get H$(0)
If H$(0) = "Y" Then
Input " PAGE LENGTH: ";LP
If LP>62 Goto 98
* LIMIT TO 11" LENGTH AND HEADER START-POSITION; CAN
CHANGE WITH SMALLER-SPACING PRINTERS.

99 Print
Print "NO LEFT MARGIN, WANT ONE ?"
Get H$(0)
If H$(0) = "Y" Then
Input " MARGIN SPACES: ";K
If K>0 And K<49 Then
M$ = Left$(BB$,K)
LL = LL-K
* MARGIN & LINE-LENGTH UNTOUCHED ON WRONG INPUT,
REMAINS AT DEFAULT VALUE

100 Print
Print "INDENT SPACING = 4, WANT OTHER ?"
Get H$(0)
If H$(0) = "Y" Then
Input " SPACING: ";IM
If IM<0 Or IM>12 Goto 100

101 * REMINDER FOR PRINTER SET-UP
102 Home
Inverse
Print " SET PAPER TO TOP OF FORM "
Print " THEN "
Print " TURN ON PRINTER "
Normal
Print
Get H$(0)

103 * SET SCREEN WIDTH, TURN ON PROPER PORT

104 Home
Poke 33,30
Pr# 1

105 * SET-UP FOR EPSON MX-80 PRINTER WITH ORANGE MICRO
'GRAPPLER' OR CENTRONICS-COMPATIBLE PARALLEL INTERFACE
CARD. CCS CARD MUST ADD 'CHR$(9)"K"' TO REMOVE EXTRA
LINE FEED.

106 Print Chr$(9)"B2N"Chr$(9)"I"

107 * RESERVED LINE FOR OPTIONAL PRINTER CONTROL
108 * CHR$(9) = "CONTROL-I"

109 LC = 6
PC = 1
Gosub 11
Goto 16

110 * MX-80 ITALICS/STANDARD CHARACTER SET SWITCHING
SUBROUTINES (APPLIES ONLY TO "GRAFTRAX"-AUGMENTED
PRINTERS)

111 Print Chr$(27)"5";
Return
* ESC-5 IS STANDARD SET

112 Gosub 111
If RF Then
Print Chr$(27)"4";
* ESC-4 IS ITALICS SET USED FOR "REM"S

113 Return

```

(continued)

Problems You May Encounter with LISZT with Strings

1. A colon ending a line causes a stop and 'error at line 76' display. The best solution is to use a line editor program or keyboard to correct the program line to remove the extraneous byte. Usually appears to be a 'forgotten' removal during program editing.
2. A double colon starting a line causes LISZTER to think the first colon is a REM, but the second colon causes reversion to gathering tokens and characters in the usual manner. Using an italics set on the printer will make this line look like a REM splat, but has both upper and lower case contents. Best solution is to edit out the extra colons.
3. A statement ending nested FOR loops such as "NEXT J,K,L" executes in Apple-soft as if they were three separate NEXT statements. Since LISZTER will only recognize one NEXT token, all following lines will retain the FOR-NEXT indent(s) for the remainder of printout.

We don't have a simple solution for this — yet. Changing the program to "NEXT J:NEXT K:NEXT L" will add only two bytes and bring the left margin back to normal. The two added bytes are the NEXT tokens; concatenation colons take the place of the commas.

4. On any mid-printout deliberate stop, such as RESET, you must key in RUN 23 to restore the program start and end pointers. Failure to do so may attach LISZTER to the program being listed.

---

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Leonard H. Anderson is a hardware and systems engineer, who uses his Apple II for number crunching (when not playing games). He is also a contract writer and currently an Associate Editor with *Ham Radio Magazine*. Address correspondence to 10048 Lanark Street, Sun Valley, California 91352.

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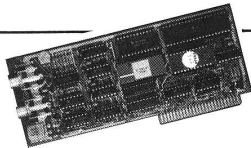
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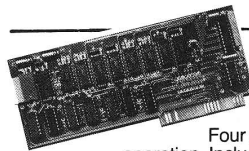
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# Apple Graphics for Okidata Microline 80

by Charles F. Taylor, Jr.

**Programs are given, in Apple/UCSD Pascal and 6502 assembly language, to dump the Apple high-resolution graphics screen(s) to an Okidata Microline 80 printer. This article should also be of interest to owners of the Epson MX-80 printer because graphics on the two printers are implemented similarly.**

These Apple Graphics routines require:

Apple  
Okidata Microline 80, 82A,  
or 83A  
Epson MX-80

Pascal version requires:

Apple Pascal system

When I purchased my Okidata Microline 80 dot matrix impact printer, I was attracted to its relatively low price, the 200,000,000-character print head warranty, and the flexible form handling (friction and pin feed). I really didn't consider its graphics, which were advertised as "TRS-80-compatible."

After I'd had the printer for a while, I decided to take another look at its graphics capabilities. The basic graphical unit for the Microline 80 is the graphics character. Each graphics character may be thought of as a 3-row by 2-column matrix, as depicted in figure 1.

The individual elements of the graphics character are numbered 1-6 as in figure 1. Each element of the character may be "on" (black) or "off" (white), which means that there are 2 to the 6th power, or 64, possible distinct graphics characters. An element that is "on" is represented by what appears (under magnification) to be a 3 by 3 matrix of dots. The total graphics character, then, is a 9-row by

6-column matrix. This is achieved with a 7-pin print head by making two passes for every line which contains a graphics character, advancing the paper slightly between passes.

With the printer set for 16.5 characters per inch on an 8-inch line, the horizontal resolution is 0.030 inches (0.77 millimeters). At eight lines per inch, the vertical resolution is 0.042 inches (1.06 millimeters). In other words, the smallest "dot" that can be printed is an element of a graphics character which is a rectangle 0.030 inches wide by 0.042 inches high.

Each graphics character is sent to the printer as a single byte with the high-order bit (bit 8) set (1). Bit 7 may be either 0 or 1. Bits 1 through 6 are set (1) or clear (0) as the correspondingly numbered element of the graphics character is "on" or "off." (See figure 1 again.)

Software could be written to utilize these graphics characters directly. This would include, as a minimum, routines to set and clear individual elements of graphics characters and to draw straight lines between any two points. Because Applesoft BASIC and Apple/UCSD Pascal each provide these graphics primitives for use with the Apple high-resolution screen, a better approach is to develop a utility program to dump, point by point, the contents of the hi-res screen to the printer. This was the approach I took, first in Pascal, then in 6502 assembly language. (The latter version can be called from BASIC programs.)

The basic unit of Apple hi-res graphics is of course the "pixel" or dot. The hi-res screen is organized as a 192-row by 280-column matrix of individually addressable pixels. The display is bit-mapped; that is, there exists a mapping between each pixel on the screen and a bit somewhere in memory.

There were three principal problems to be resolved in designing the

program: the first problem was how to address the bit representation of each pixel in order to determine whether it is on or off. The second problem was to decide whether to print the screen image horizontally or vertically on the printer. Finally, a means had to be found to map six pixels to each graphics character.

## Pascal Solution

The solution in Pascal is presented first because it is simpler. This is because of the existence of the SCREENBIT function, which is provided as part of the TURTLEGRAPHICS unit. SCREENBIT(x,y) is a Boolean function which returns the value TRUE if pixel

Figure 1: Microline 80 Graphics Character

1	2
3	4
5	6

Figure 2: Model of High Resolution Screen (6 x 6)

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

(x,y) is on (not black), and FALSE if it is off (black). This makes the first problem cited above almost trivial.

Since only a maximum of 132 characters can be printed on a line (16.5 characters per inch times 8 inches), and each character is two elements wide, the maximum number of pixels which can be presented on a printed line is 264. Because the Apple hi-res screen is 280 pixels wide, two choices are possible: (1) print the screen image vertically on the printer, 192 elements across and 280 down; or, (2) print the screen image horizontally, but print only 264 of the 280 columns. The former choice was made for the Pascal version and the latter for the 6502 assembly language version.

The Pascal program is shown in listing 1. The main program queries the user as to whether to print all or a specified portion of the screen. Procedure SETUP handles the details of turning on the printer and selecting the

proper print size and vertical spacing. Procedure TURNOFF turns the printer off again. The real work is done in the procedure called SCREENDUMP.

How the algorithm works can best be illustrated by example. Assume that the Apple hi-res screen consists of a 6-row by 6-column grid as shown in figure 2, and that an arbitrary pattern has been plotted on it. An "\*" is used to indicate which grid elements are "on." In Pascal (as opposed to BASIC) the origin is at the lower left corner of the grid, so the numbers along the left side refer to the row of y-coordinates. The numbers along the right side will not be needed until later.

The Pascal program will reduce this grid to two lines of three graphics characters each. The first line will represent columns (x-coordinates) 0, 1, and 2 of the grid and the second line columns 3, 4, and 5. Remember that the image on the printer will be rotated

Graphics Characters	Screen Grids
Bit 1	(0,0)
2	(0,1)
3	(1,0)
4	(1,1)
5	(2,0)
6	(2,1)

90 degrees, so that columns on the screen correspond to rows on the printer and *vice versa*.

The first graphics character of the first line will represent rows (y-coordinates) 0 and 1 of the columns 0, 1, and 2. We may imagine the grid of figure 1 superimposed on the grid of

```

Listing 1
PROGRAM PRINTSCREEN;

  (*S***)
  (* DUMPS ENTIRE PASCAL SCREEN *)
  (* TO OKIDATA MICROLINE 80 *)
  USES TURTLEGRAPHICS;

  VAR XMIN, XMAX, YMIN, YMAX : INTEGER;

  PROCEDURE SCREENDUMP(XMIN, XMAX, YMIN, YMAX : INTEGER);

    (* DUMPS PASCAL GRAPHICS TO *)
    (* OKIDATA MICROLINE 80 *)

    VAR H, I, J, K : INTEGER;
        LINE : ARRAY [1..96] OF CHAR;
        BIT : ARRAY [1..6] OF 0..1;
        OKI : TEXT;

    PROCEDURE SETUP;
    BEGIN
      (* OPEN PRINTER FILE *)
      REWRITE (OKI, 'PRINTER');
      (* SET CENTRONICS CARD FOR 132 COLS *)
      WRITELN (OKI, CHR(9), '132N');
      (* SET PRINTER FOR 16.5 CPI & 8 LPI *)
      WRITELN (OKI, CHR(29), CHR(27), '8', CHR(27), 'B');
    END; (* SETUP *)

    PROCEDURE TURNOFF;
    BEGIN
      (* RESETS OKIDATA *)

      WRITELN (OKI, CHR(30), CHR(27), 'B', CHR(27), 'A');
    END; (* TURNOFF *)

    FUNCTION GCHAR : CHAR;
    BEGIN
      (* RETURNS GRAPHICS CHARACTER *)
      (* DEFINED BY BIT ARRAY *)

      VAR NR : 0..255;
          POWER, I : INTEGER;

      BEGIN
        POWER := 1;
        NR := 128;
        FOR I := 1 TO 6 DO
          BEGIN
            NR := NR + POWER*BIT[I];
            POWER := 2*POWER;
          END;
      END;
    END;

    BEGIN
      FOR K := 1 TO 96 DO
        LINE[K] := CHR(128);
        I := XMIN;
        REPEAT
          J := YMIN;
          K := 1 + YMIN DIV 2;
          REPEAT
            FOR H := 1 TO 6 DO BIT[H] := 0;
            IF SCREENBIT(I, J) THEN BIT[1] := 1;
            IF SCREENBIT(I, J+1) THEN BIT[2] := 1;
            IF SCREENBIT(I+1, J) THEN BIT[3] := 1;
            IF SCREENBIT(I+1, J+1) THEN BIT[4] := 1;
            IF SCREENBIT(I+2, J) THEN BIT[5] := 1;
            IF SCREENBIT(I+2, J+1) THEN BIT[6] := 1;
            LINE[K] := GCHAR;
            K := K + 1;
            J := J + 2;
          UNTIL J+1 > YMAX;
          FOR K := 1 TO 96 DO
            BEGIN
              WRITE (OKI, LINE[K]);
              LINE[K] := CHR(128);
            END;
            WRITELN(OKI);
            I := I + 3;
          UNTIL I+2 > XMAX;
        TURNOFF;
      END; (* SCREENDUMP *)

  BEGIN (* MAIN PROGRAM *)
    REPEAT
      WRITE ('FIRST COLUMN TO PRINT (0..279):');
      READLN(XMIN);
    UNTIL (XMIN) = 0 AND (XMIN) <= 279;
    REPEAT
      WRITE ('LAST COLUMN TO PRINT (XMIN..279):');
      READLN(XMAX);
    UNTIL (XMAX) = XMIN AND (XMAX) <= 279;
    REPEAT
      WRITE ('FIRST ROW TO PRINT (0..191):');
      READLN(YMIN);
    UNTIL (YMIN) = 0 AND (YMIN) <= 191;
    REPEAT
      WRITE ('LAST ROW TO PRINT (YMIN..191):');
      READLN(YMAX);
    UNTIL (YMAX) = YMIN AND (YMAX) <= 191;
    SCREENDUMP(XMIN, XMAX, YMIN, YMAX);
  END.

```

```

Listing 1 (Continued)
  GCHAR := CHR(NR)
  END; (* GCHAR *)

  BEGIN (* PROCEDURE SCREENDUMP *)
    SETUP;
    FOR K := 1 TO 96 DO
      LINE[K] := CHR(128);
      I := XMIN;
      REPEAT
        J := YMIN;
        K := 1 + YMIN DIV 2;
        REPEAT
          FOR H := 1 TO 6 DO BIT[H] := 0;
          IF SCREENBIT(I, J) THEN BIT[1] := 1;
          IF SCREENBIT(I, J+1) THEN BIT[2] := 1;
          IF SCREENBIT(I+1, J) THEN BIT[3] := 1;
          IF SCREENBIT(I+1, J+1) THEN BIT[4] := 1;
          IF SCREENBIT(I+2, J) THEN BIT[5] := 1;
          IF SCREENBIT(I+2, J+1) THEN BIT[6] := 1;
          LINE[K] := GCHAR;
          K := K + 1;
          J := J + 2;
        UNTIL J+1 > YMAX;
        FOR K := 1 TO 96 DO
          BEGIN
            WRITE (OKI, LINE[K]);
            LINE[K] := CHR(128);
          END;
          WRITELN(OKI);
          I := I + 3;
        UNTIL I+2 > XMAX;
      TURNOFF;
    END; (* SCREENDUMP *)

  BEGIN (* MAIN PROGRAM *)
    REPEAT
      WRITE ('FIRST COLUMN TO PRINT (0..279):');
      READLN(XMIN);
    UNTIL (XMIN) = 0 AND (XMIN) <= 279;
    REPEAT
      WRITE ('LAST COLUMN TO PRINT (XMIN..279):');
      READLN(XMAX);
    UNTIL (XMAX) = XMIN AND (XMAX) <= 279;
    REPEAT
      WRITE ('FIRST ROW TO PRINT (0..191):');
      READLN(YMIN);
    UNTIL (YMIN) = 0 AND (YMIN) <= 191;
    REPEAT
      WRITE ('LAST ROW TO PRINT (YMIN..191):');
      READLN(YMAX);
    UNTIL (YMAX) = YMIN AND (YMAX) <= 191;
    SCREENDUMP(XMIN, XMAX, YMIN, YMAX);
  END.

```

figure 2, with figure 1 rotated 90 degrees (counter-clockwise). Thus bits of the graphics characters correspond to screen grids as shown in table 1. In this case bits 3, 4, 5, and 6 will be 0 and bits 1 and 2 will be 1. Bit 7 will (arbitrarily) be 0, and bit 8 will be 1, as discussed earlier. The resulting graphics character is, therefore, binary 10000011 (\$83 or decimal 131).

The next graphics character of the line will be constructed from grid elements (0,2), (1,2), (2,2), (0,3), (1,3), and (2,3), which correspond to, respectively, bits 1, 3, 5, 2, 4, and 6. In this case bits 1, 2, and 6 will be 1 and bits 3, 4, and 5 will be 0. The resulting graphics character is binary 10100011 (\$A3, or decimal 163). The third and final graphics character of the line will be binary 10000111, (\$87, or decimal 135).

At this point the program has constructed the first full line of graphics characters. Using the CHR function, the computed decimal values have been converted to their character equivalents and are stored in the array LINE. Now that LINE is full, it is sent to the printer, one character at a time, and is followed by the usual carriage return and line feed (WRITELN).

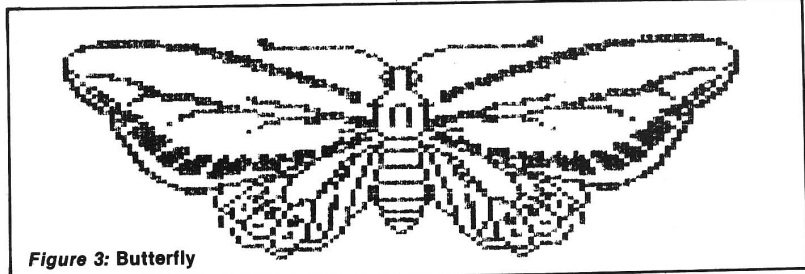


Figure 3: Butterfly

The program then constructs the next line of graphics characters from columns 3, 4, and 5 of the screen grid. These characters will be, in decimal notation, 152, 129, and 128, respectively.

The procedure described above is carried out by the procedure SCREEN-DUMP. The function GCHAR uses simple arithmetic to convert the binary representation of the character to decimal. Then it uses CHR to convert the decimal value to a character. Experienced Pascal programmers may notice that I could have accomplished the binary-to-character conversion directly using a free-union variant record. That technique would have been faster and more efficient, but less clear. Readers who wish to pursue this topic should refer to an article by David

Casseres of Apple Computer Inc., which appeared in the October 1981 issue of *BYTE* magazine.

Figure 3 is an example of output produced by this program. The butterfly image was created on the screen by a demonstration program furnished with the Apple Pascal system and then printed on the Microline 80 by this program.

### Assembly Language Solution

The most difficult part of the 6502 assembly language solution was to develop an algorithm to step through memory, addressing of each pixel's bit representation in the proper sequence. (Recall that this was done for us in Pascal by SCREENBIT.) The task is complicated by the fact that, for various reasons, Apple chose to represent the hi-res screen in memory in what appears to be a rather peculiar sequence. The mapping used is documented in the *Apple II Reference Manual* and was the subject of a 1978 article in *MICRO* (7:43) by Andrew H. Eliason. Rather than reiterate the details here, I have chosen to present a short Applesoft BASIC program (listing 2) which prints out the beginning address (in decimal and in hex) of each of the 192 rows of hi-res screen 1. (To get the corresponding values for screen 2, change line 100.) The 280 pixels of each row are represented by seven bits of each of the 40 bytes beginning at the location given. The program prints a screen, then prompts the user to press the space bar before running another screen.

As mentioned above, I decided to represent the screen horizontally on the printer in this version (which considerably simplifies the arithmetic). This means that only 264 columns of the hi-res screen could be printed. The first 264 were arbitrarily selected.

The 6502 assembly language program is shown as listing 3. Instructions for its use are contained in the program's introductory comments. The printer interface I used was the Apple

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\$15 Disk, Applesoft (32K, ROM or Language Card).

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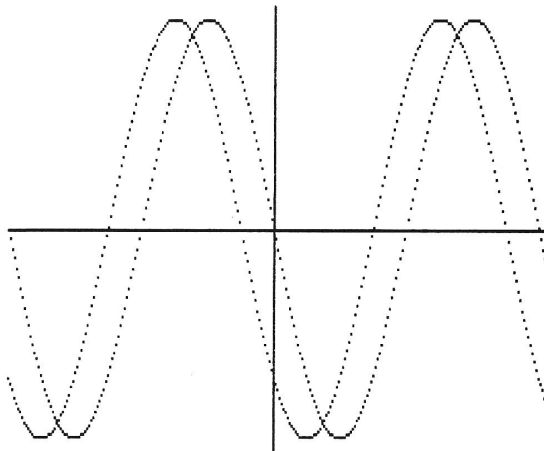
\*Apple II is a registered trademark of the Apple Computer Co.



### Listing 2

```
10 REM PROGRAM TO DEMONSTRATE
20 REM THE SEQUENCE OF STORAGE
30 REM LOCATIONS USED BY THE
40 REM APPLE HI-RES SCREEN
50 REM
60 REM BY C.F. TAYLOR, JR.
70 REM JULY 24, 1981
80 REM
90 HOME
95 DIGIT$ = "0123456789ABCDEF"
100 B0 = 8192: REM FOR SCREEN 1
110 SLIN = 0: REM SCREEN LINE NR
120 FOR I = 1 TO 3
130 B1 = B0
140 FOR J = 1 TO 8
150 CLIN = B1
160 FOR K = 1 TO 8
170 GOSUB 500: REM CONVERT TO HEX
180 PRINT SLIN, CLIN, HL$
190 SLIN = SLIN + 1
200 CLIN = CLIN + 1024
210 IF SLIN - INT (SLIN / 23) * 23 ( ) 0 THEN GOTO 240
220 PRINT "PRESS (SPACE) TO CONTINUE":
230 GET A$: PRINT
240 NEXT K
250 B1 = B1 + 128
260 NEXT J
270 B0 = B0 + 40
280 NEXT I
290 END
500 X = CLIN: REM SUBROUTINE CONVERT TO HEX
510 HL$ = ""
520 HL$ = MID$(DIGIT$, X - INT (X / 16) * 16 + 1, 1) + HL$
530 X = INT (X / 16)
540 IF X ( ) 0 THEN GOTO 520
550 HL$ = "$" + HL$
560 RETURN
```

Figure 4: Sine Curves



Centronics Parallel Interface; some modifications will likely be required for use with other interface cards. What is critical is that bit 8 must be controllable (high for graphics, low for text). Some interfaces may not use bit 8 at all, or may force it low. The Epson interface board has bit 8 wired to ground, but a jumper is provided for changing this. If you do modify the setting of this jumper, however, you will have to make some other provision for forcing bit 8 low for text. My recommendation is to replace the jumper

with a single-pole, double-throw switch. This is, in effect, what I have done to my Apple Centronics Interface card.

How the assembly language program works can also be illustrated by example. Refer again to figure 2. This time we will use the row numbers (y-coordinates) along the right edge, recalling that BASIC refers to the upper left corner as (0,0). This time rows 0, 1, and 2 will be used to construct the first line of graphics characters and rows 3, 4, and 5 the second line.

The first graphics character will therefore represent columns 0 and 1 of rows 0, 1, and 2. We may imagine the grid of figure 1 superimposed on the grid of figure 2, but this time without rotation. Thus bits 1-6 of the graphics character will represent, respectively, the screen grid positions (0,0), (1,0), (0,1), (1,1), (0,2), and (1,2). Bits 1, 3, 4, and 5 will be 1 and bits 2 and 6 will be 0. As before, bit 7 will be 0 and bit 8 will be 1. Therefore, the first graphics character is binary 10011101 (\$9D, or decimal 157).

For the second graphics character, bits 1-6 correspond, respectively, to coordinates (2,0), (3,0), (2,1), (3,1), (2,2), and (3,2). Bit 5 is 1 and bits 1, 2, 3, 4, and 6 are 0. This translates to binary 10010000 (\$90, or decimal 144). The third and last graphics character of the first line is binary 10000000 (\$80, or decimal 128). The decimal values of the three graphics characters of the second line are 149, 130, and 164.

The algorithm illustrated in the BASIC program of listing 2 is used to find the beginning of each of three consecutive rows of the screen in memory. The bytes representing the pixels of these lines are then transferred to working buffers. (Only 38 bytes out of 40 are used because only 264 out of 280 columns are plotted.) The subroutines DUMP and DUMPY then extract the appropriate bits from the buffers and rotate them into a page zero location called CHAR. From there each is sent to the printer.

Figure 4 shows a typical plot of two out-of-phase sine curves. More sophisticated plots (3-D, etc.) are of course possible; anything you can put on the screen, you can print! The one limitation is color since the printer only prints black and white!

Execution time for the assembly language version is typically about six minutes. The Pascal version takes about 2.5 times as long to print a full screen.

Although the programs presented here were reasonably involved to write, they are simple to use. Best of all, they transform a fairly unsophisticated graphics capability on an inexpensive printer into a powerful graphics tool, rivaling printers costing several times as much.

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**Listing 3**

```

0010      ;HI-RES SCREEN DUMP
0020      ;APPLE II PLUS 70
0030      ;OKIDATA MICROLINE 80 VIA
0040      ;APPLE CENTRONICS PARALLEL INTERFACE
0050      ;
0060      ;WRITTEN BY C. F. TAYLOR, JR.
0070      ;24 JULY 1981
0080      ;
0090      ;INSTRUCTIONS:
0100      ;
0110      ; SET HIMEM: 37760 BEFORE LOADING
0120      ; CALL 37888 FOR HI-RES PAGE 1
0130      ; CALL 37904 FOR HI-RES PAGE 2
0140      .BA $5400
0150      .DS
0160      .DE $638      ;LOCATIONS USED
0170      .DE $688      ;PRINTER INTERFACE
0180      .DE $468      ;ROM
0190      .DE $588
0200      .DE $03EA      ;DOS RE-ENTRY POINT
0210      .DE $06      ;PAGE 0 LOCATIONS
0220      .DE $08
0230      .DE $E3
0240      .DE $C102      ;PRINTER DRIVER
0250      ;
0260      ;ENTRY POINT FOR HI-RES PAGE 1
0270      ;
9400- A9 20 0280 PAGE1 LDA #$20      ;INITIALIZE POINTERS
9402- 8D 97 95 0290 STA BASE+1
9405- 8D 99 95 0300 STA SAVBAS+1
9408- A9 40 0310 LDA #$40
940A- 8D 9D 95 0320 STA CURLIM+1
940D- 4C 1D 94 0330 JMP START
0340      ;
0350      ;ENTRY POINT FOR HI-RES PAGE 2
0360      ;
9410- A9 40 0370 PAGE2 LDA #$40      ;INITIALIZE POINTERS
9412- 8D 97 95 0380 STA BASE+1
9415- 8D 99 95 0390 STA SAVBAS+1
9418- A9 60 0400 LDA #$60
941A- 8D 9D 95 0410 STA CURLIM+1
0420      ;
941D- A9 00 0430 START LDA #$00      ;COMMON POINTER VALUES
941F- 8D 96 95 0440 STA BASE
9422- 8D 98 95 0450 STA SAVBAS
9425- 8D 9B 95 0460 STA SLIN
9428- 8D 9C 95 0470 STA CURLIM
942B- 20 9D 94 0480 JSR SETUP      ;INITIALIZE PRINTER
942E- A9 02 0490 LDA #2      ;INITIALIZE BUFFER LINE NR
9430- 8D 9A 95 0500 STA LINE
0510      ;
9433- AD 96 95 0520 LOOPA LDA BASE      ;CLIN := BASE
9436- 85 06 0530 STA *CLIN
9438- AD 97 95 0540 LDA BASE+1
943B- 85 07 0550 STA *CLIN+1
0560      ;
943D- 20 C4 94 0570 LOOPB JSR BUFLIN      ;INCREMENT BUFFER LINE NR
9440- EE 9B 95 0580 INC SLIN      ;AND SCREEN LINE NR
9443- A0 25 0590 LDY #37      ;TRANSFER LINE TO BUFFER
9445- B1 06 0600 B1 LDA (CLIN),Y
9447- 91 08 0610 STA (BUFF),Y
9449- 88 0620 DEY
944A- 10 F9 0630 BPL B1
944C- AD 9A 95 0640 LDA LINE      ;TIME TO DUMP BUFFER?
944F- C9 02 0650 CMP #2
9451- D0 03 0660 BNE CONT
9453- 20 0A 95 0670 JSR DUMP
9456- A5 07 0680 CONT LDA *CLIN+1

```

**Listing 3 (Continued)**

```

9458- 18 0690 CLC
9459- 69 04 0700 ADC #4      ;INCREMENT MEMORY LOCATION
945B- 85 07 0710 STA *CLIN+1
945D- CD 9D 95 0720 CMP CURLIM+1 ;TIME TO ADJUST BASE?
9460- 90 DB 0730 BCC LOOPB      ;NO
9462- AD 9B 95 0740 LDA SLIN      ;SCREEN LINE NR
9465- C9 40 0750 CMP #64      ;READY TO SHIFT?
9467- F0 06 0760 BEQ SC0      ;YES
9469- C9 80 0770 CMP #128
946B- F0 02 0780 BEQ SC0      ;YES
946D- D0 15 0790 BNE SC1      ;NO
946F- AD 96 95 0800 SC0 LDA SAVBAS
9472- 18 0810 CLC
9473- 69 28 0820 ADC #28      ;SHIFT BASE
9475- 8D 98 95 0830 STA SAVBAS
9478- 8D 96 95 0840 STA BASE
947B- AD 99 95 0850 LDA SAVBAS+1
947E- 8D 97 95 0860 STA BASE+1
9481- 4C 33 94 0870 JMP LOOPA
9484- C9 C0 0880 SC1 CMP #192      ;DONE?
9486- F0 14 0890 BEQ EXIT      ;YES
9488- 18 0900 CLC      ;ADJUST BASE
9489- AD 96 95 0910 LDA BASE
948C- 69 80 0920 ADC #80
948E- 8D 96 95 0930 STA BASE
9491- AD 97 95 0940 LDA BASE+1
9494- 69 00 0950 ADC #0      ;ADD IN CARRY
9496- 8D 97 95 0960 STA BASE+1
9499- 4C 33 94 0970 JMP LOOPA
949C- 60 0980 EXIT RTS      ;DONE
0990      ;
1000      ;SUBROUTINES FOLLOW
1010      ;
1020      ;FIRST SETUP DRIVER
949D- A2 C1 1030 LDX #C1      ;FOR SLOT 1
949F- A9 09 1040 LDA #09      ;INITIALIZE DRIVER
94A1- 9D B8 06 1050 STA FLAGS,X ;VIDE0 OFF
94A4- A9 FF 1060 LDA #FF
94A6- 9D B8 04 1070 STA PMDTH,X ;PRINT WIDTH
94A9- 9D 38 06 1080 STA ESCHR,X ;ESCAPE CHAR
94AC- A9 00 1090 LDA #0
94AE- 9D B8 05 1100 STA MODE,X ;CLEAR 'AFTER ESC' MODE
94B1- 20 EA 03 1110 JSR DOS      ;REPLACE WITH 3 NOP'S
1120      ;FOR CASSETTE SYSTEM
;NOW SETUP PRINTER
94BA- A9 1D 1150 LDA #1D      ;SET 16.5 CPI ON PRINTER
94B6- 20 02 C1 1160 JSR DRIVER
94B9- A9 1B 1170 LDA #1B      ;SET 8 LINES
94BB- 20 02 C1 1180 JSR DRIVER ;PER INCH
94BE- A9 38 1190 LDA #38      ;VERTICAL SPACING
94C0- 20 02 C1 1200 JSR DRIVER ;ON PRINTER
94C3- 60 1210 RTS
1220      ;
94C4- EE 9A 95 1230 BUFLIN INC LINE
94C7- AD 9A 95 1240 LDA LINE
94CA- C9 03 1250 CMP #3
94CC- D0 0E 1260 BNE BL1
94CE- A9 81 1270 LDA #L,LINE0 ;SET BUFFER LINE 0
94D0- 85 08 1280 STA *BUFF
94D2- A9 93 1290 LDA #H,LINE0
94D4- 85 09 1300 STA *BUFF+1
94D6- A9 00 1310 LDA #0
94D8- 8D 9A 95 1320 STA LINE
94DB- 60 1330 RTS
94DC- C9 01 1340 BL1 CMP #1      ;SET BUFFER LINE 1
94DE- D0 09 1350 BNE BL2
94E0- A9 A7 1360 LDA #L,LINE1
94E2- 85 08 1370 STA *BUFF

```

Listing 3 (Continued)

```

94E4- A9 93 1380 LDA #H,LINE1
94E5- B5 09 1390 STA *BUFF+1
94E6- 60 1400 RTS
94E9- A9 CD 1410 BL2 LDA #L,LINE2 ;SET BUFFER LINE 2
94EB- 85 08 1420 STA *BUFF
94ED- A9 93 1430 LDA #H,LINE2
94EF- 85 09 1440 STA *BUFF+1
94F1- 60 1450 RTS
;
94F2- AD 9B 95 1470 SCRLIN LDA SLIN ;CHECK FOR SHIFT OF BASE
94F5- C9 40 1480 CMP #64
94F7- D0 10 1490 BNE NX1
94F9- C9 80 1500 CMP #128
94FB- D0 0C 1510 BNE NX1
94FD- AD 9B 95 1520 LDA SAVBAS
9500- 18 1530 CLC
9501- 69 28 1540 ADC #*28
9503- 8D 9B 95 1550 STA SAVBAS
9506- 8D 9B 95 1560 STA BASE
9509- 60 1570 NX1 RTS
;
950A- A2 00 1590 DUMP LDX #0 ;DUMP BUFFERS TO PRINTER
950C- A9 00 1600 DUMP1 LDA #0
950E- 85 E3 1610 STA *CHAR
9510- A0 02 1620 LDY #2
9512- 20 37 95 1630 JSR DUMPY ;Y+1 CHARS TO PRINTER
9515- 20 68 95 1640 JSR TRANS ;TRANSITION TO NEXT BYTE
9518- E8 1650 INX
9519- A0 02 1660 LDY #2
951B- 20 37 95 1670 JSR DUMPY ;REST OF BYTE
951E- E8 1680 INX
951F- E0 24 1690 CPX #36 ;DONE?
9521- 30 E9 1700 BMI DUMP1
9523- A0 02 1710 LDY #2 ;FINISH COLS 127-132
9525- 20 37 95 1720 JSR DUMPY
9528- 20 68 95 1730 JSR TRANS
952B- E8 1740 INX
952C- A0 01 1750 LDY #1
952E- 20 37 95 1760 JSR DUMPY
9531- A9 0D 1770 LDA #*0D ;CARRIAGE RETURN
9533- 20 02 C1 1780 JSR DRIVER
9536- 60 1790 RTS
;
9537- 7E 81 93 1810 DUMPY ROR LINE0, X
953A- 66 E3 1820 ROR *CHAR ;BIT 1
953C- 7E 81 93 1830 ROR LINE0, X
953F- 66 E3 1840 ROR *CHAR ;BIT 2
9541- 7E A7 93 1850 ROR LINE1, X
9544- 66 E3 1860 ROR *CHAR ;BIT 3
9546- 7E A7 93 1870 ROR LINE1, X
9549- 66 E3 1880 ROR *CHAR ;BIT 4
954B- 7E CD 93 1890 ROR LINE2, X
954E- 66 E3 1900 ROR *CHAR ;BIT 5
9550- 7E CD 93 1910 ROR LINE2, X
9553- 66 E3 1920 ROR *CHAR ;BIT 6
9555- 18 1930 CLC
9556- 66 E3 1940 ROR *CHAR ;BIT 7 = 0
9558- 38 1950 SEC
9559- 66 E3 1960 ROR *CHAR ;BIT 8 = 1
955B- A5 E3 1970 LDA *CHAR
955D- 20 02 C1 1980 JSR DRIVER ;PRINT
9560- A9 00 1990 LDA #0
9562- 85 E3 2000 STA *CHAR
9564- 88 2010 DEY
9565- 10 D0 2020 BPL DUMPY
9567- 60 2030 RTS
9568- 7E 81 93 2040 TRANS ROR LINE0, X ;FINISH BYTE
;AND START NEXT
2050

```

Listing 3 (Continued)

```

956B- 66 E3 2060 ROR *CHAR
956D- 7E 82 93 2070 ROR LINE0+1, X
9570- 66 E3 2080 ROR *CHAR
9572- 7E A7 93 2090 ROR LINE1, X
9575- 66 E3 2100 ROR *CHAR
9577- 7E A8 93 2110 ROR LINE1+1, X
957A- 66 E3 2120 ROR *CHAR
957C- 7E CD 93 2130 ROR LINE2, X
957F- 66 E3 2140 ROR *CHAR
9581- 7E CE 93 2150 ROR LINE2+1, X
9584- 66 E3 2160 ROR *CHAR
9586- 18 2170 CLC
9587- 66 E3 2180 ROR *CHAR ;BIT 7 = 0
9589- 38 2190 SEC
958A- 66 E3 2200 ROR *CHAR ;BIT 8 = 1
958C- A5 E3 2210 LDA *CHAR
958E- 20 02 C1 2220 JSR DRIVER ;SEND TO PRINTER
9591- A9 00 2230 LDA #0
9593- 85 E3 2240 STA *CHAR
9595- 60 2250 RTS
9596- 2260 BASE .DS 2
9598- 2270 SAVBAS .DS 2
959A- 2280 LINE .DS 1
959B- 2290 SLIN .DS 1
959C- 2300 CURLIM .DS 2
;BA #9381
2310
9381- 2320 LINE0 .DS 38
93A7- 2330 LINE1 .DS 38
93CD- 2340 LINE2 .DS 38
;EN
2350

```

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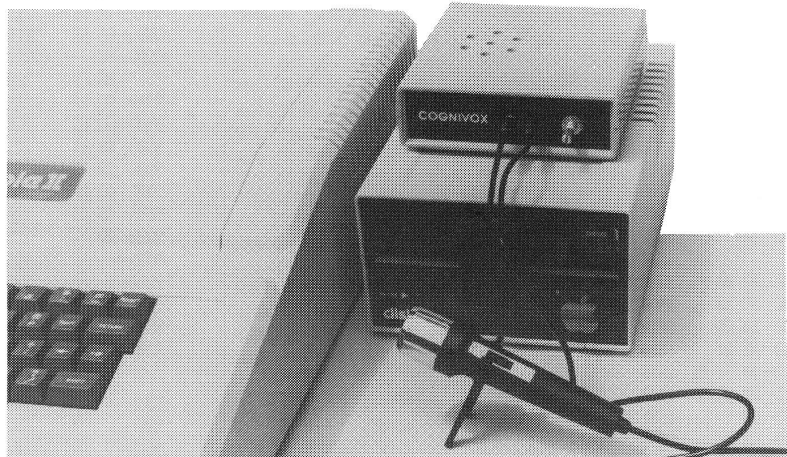
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- Silence gap between words:** 150 ms minimum.
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## Microbes and Updates

*Jim Sherman of Huntsville, AL, called in with these corrections to "Saucer Launch" by Mike Dougherty (42:53):*

On page 59 the listing is out of order. Lines 108E through 1092 belong at the bottom of the page (after line 108C). On page 60, line 10D2 should read: F0 06 BEQ NOXP.

*Here are a few corrections to the RUNZMENU article by Frank Shyjka (45:67):*

On page 68 in the far right column, the third line of BCDF should read:

85 39 20 51 A8 A9 **8C** 8D 6D  
BA8D should read:

D2 D5 CE DA CD C5 CE D5 **BF**

*Erken Heinzjosef from West Germany wrote in with this update:*

In MICRO 43 you published a Call Routine for the Superboard. Although it is very good, I have found a simpler way. My routine is only nine bytes long but it has a disadvantage: you cannot use hex addresses. But you can use

labels! See listing 1 for the machine-language routine and listing 2 for the equivalent BASIC load. The syntax must be

Z (or any alpha) =  
USR (any argument) 65030

or

Z (or any alpha) =  
USR (any argument) SC

The label "SCREEN CLEAR" gives syntax error as BASIC thinks it should be SQR.

65030 = hex FE06 = Screen clear in the C 1 S Monitor ROM from Aardvark. If you use labels, don't forget to define the label:

```
10 SC = 65030
20 WARMSTART = 0
30 X = USR(X) SC
40 X = USR(X) WARMSTART
```

You have to set the USR Vector at first by POKE 11,64: POKE 12,2. My BASIC load does it, but after a BREAK you have to reset the vector.

### Listing 1

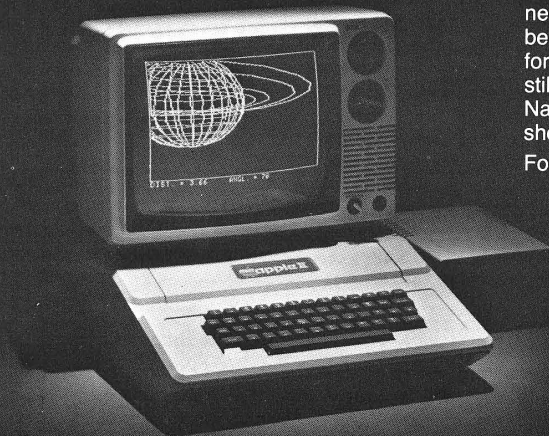
```
10 0000 ;CALL-ROUTINE FOR SUPERBOARD
20 0000 ;
30 0000 ;H. J. Erken, West Germany
40 0000 ;
50 0000 ;
60 0000 ;Addresses can be decimal values or labels
70 0000 ;
80 0000 ;To use, first set up the USR Vector by
90 0000 ;POKE 11,64:POKE12,2
100 0000 ;
110 0000 ;
120 0240 * = $0240
130 0240 ;
140 0240 20ADAA JSR #AAD ;Evaluate any expression
150 0243 2008B4 JSR #B408 ;Convert floating to fix
160 0246 6C1100 JMP ($11) ;Hex value of expression is
170 0249 ;stored in $11/$12
```

### Listing 2

```
10 REM CALL FOR SUPERBOARD
20 REM H.J. ERKEN, WEST GERMANY
30 REM
40 FOR X = 576 TO 584
50 READ A: POKE X,A: NEXT
60 POKE 11,64: POKE 12,2: REM INIT OF USR FUNCTION
70 NEW
80 DATA 32, 173, 170, 32, 8, 180, 108, 17, 0
```

MICRO™

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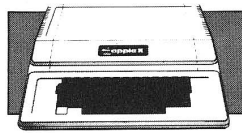
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# MICRO<sup>TM</sup>

## The Single Life

By Brad Rinehart

In my previous columns I have explained various HDE Disk BASIC features. This month I will cover some of the most unusual commands, as well as file handling techniques.

HDE Disk BASIC's more powerful commands include INSTR (in string), VARPTR (variable pointer), EXEC, MERGE, GET!, PUT!, PRINT USING, MKI\$, MKS\$, CVI, and CVS.

The INSTR command returns the position of a search string within a target string. The syntax for the command is

```
VAR1 = INSTR ( VAR2, "STRING1",  
"STRING2" )
```

VAR2 is the character position within the target string where you begin searching. STRING1 is the target string and STRING2 is the key. VAR2, or the starting character position, is optional. If you omit it the search starts at the beginning of the target string. After you evaluate the function, VAR1 will contain the character position within the target string where the key was found. For example, if you have the string "THIS IS A TEST", and the key "IS", the statement

```
X = INSTR ("THIS IS A TEST", "IS")
```

will return the variable X with the value 3. You may have expected X to equal 6. However, the word 'THIS' contains an 'IS' in it. The statement

```
X = INSTR (4, "THIS IS A TEST", "IS")
```

will return X with the value 6. This time, we specified the fourth character as the starting point for the search.

The INSTR command also acts as the argument for an IF-THEN-ELSE statement.

```
IF INSTR("THIS IS A TEST", "IS")  
THEN GOSUB 1000 : ELSE PRINT "NO"
```

will cause a GOSUB to line 1000. The statement following the ELSE will not

be executed. However, if you change this statement to

```
IF INSTR(7, "THIS IS A TEST", "IS")  
THEN GOSUB 1000 : ELSE PRINT "NO"
```

control will pass to the ELSE statement and the word 'NO' will be printed to the screen.

The VARPTR command returns the memory address (in decimal) of:

1. The exponent of the variable A,
2. The least significant byte of the two-byte integer A%,
3. The byte defining the length of the string A\$.

To use this information, you must understand how BASIC stores variable data in memory. Numeric variables such as A and A% are stored in five-byte and two-byte locations, respectively. VARPTR will return the address of the beginning of this memory location sequence. In the case of string variables, a three-byte descriptor defines the string. The first byte is the length of the string in memory, and the second and third bytes are the address pointer to the string.

VARPTR may also be used to determine whether or not a variable exists. For example, if you study the statement

```
X = VARPTR (A$(1))
```

you will see that X will be returned with the value zero if the variable does not exist. Frequently, I need to know if an array has already been dimensioned. Without VARPTR, the only recourse is to redefine it and trap the error with an ON ERROR GOTO statement. I avoid ON ERROR GOTO statements; they make it too easy to build hidden 'BUGS' into a program.

The EXEC and MERGE commands each accept input from the disk as though it were entered from the keyboard. Either command accepts input from a SEQUENTIAL DATA file or a LIST# (ASCII) file.

The MERGE command enters program lines from the disk file as opposed to entering them from the keyboard.

This feature is useful when standard subroutines are to be used in several programs. For example, you may have a particular subroutine that is used to address the cursor on your terminal. Rather than manually entering the program lines each time you want to build a new program, the subroutine may first be entered from the keyboard, then LIST#ed out to a file called CURSR. Then whenever you want to use the subroutine within a program you simply enter MERGE "CURSR". This command, entered from the keyboard, will open the CURSR file and insert the lines into the program. You can save quite a bit of development time here!

The EXEC command will EXECute the command lines as they are read from the file. But with an EXEC file, the commands must be legal direct commands, such as PRINT, A=1, OPEN, CLOSE, PUT, and GET. Examples of commands that are not legal direct commands are INPUT and PRINT USING. Therefore, they may be used in files that are to be MERGED, but not in files that are to be EXECed.

The EXEC command is useful for repetitive tasks. For example, when you have several programs you want to list to the printer, you can create an EXEC file that will initialize the output device, load the first file, list it, load the next file, list it, and so on. This can all be done without any human intervention. Remember, any sequence of commands you enter repetitively from the keyboard may be put into an EXEC file and reused.

The EXEC command also accepts input from a string variable. This feature lets you build a command in the variable A\$, and then execute and EXEC A\$ command. Any string variable may be used. However, your commands may be no longer than 250 bytes. Of course, if several commands are to be EXECed, they could be constructed in a string array and executed in a FOR-NEXT loop as in:

```
FOR X = 1 TO 5  
EXEC A$(X)  
NEXT
```

(Continued on next page)

## The Single Life *(continued)*

You might use this feature when you execute routines that are to be invisible to the user.

### Some Printing Conventions

HDE has implemented a command, 'CALL', for directing output to peripherals such as printers and modems. The syntax for the command is CALL "DEVICE NAME", where the DEVICE NAME is a three character name associated with a binary or machine-language program stored on the system disk.

To use the CALL command you must either write or purchase the device driver program. This device driver is then SAVED to the system disk (drive 0 to 1). The CALL command will load and initialize the driver. With the driver initialized, output may be directed to the screen, the device, or both. To output to the device, commands such as PRINT, LIST, FIND, and LIB are followed by an exclamation point (!), as in PRINT!, LIST!, FIND!, and LIB!. To output to the screen, even while the device is enabled, eliminate the exclamation point. To disable the device, use the command CALL0 (call zero). Once the device is disabled, output from statements such as PRINT! will be directed to the screen. To change the output device from a printer to a modem, just execute another CALL with the proper device name as the argument, as in CALL "MOD".

You may want to write a driver that accepts input from a modem or another terminal. Then when you want to pass control to that device, just initialize it with the CALL command.

PRINT USING may be used to manipulate string data. If you consider that A\$="FRED", B\$="SMITH", then the statement

```
PRINT USING "PAY TO !! %    %";
A$";B$
```

will print PAY TO F. SMITH to the terminal. To dispatch this to an output device, use the statement:

```
PRINT! USING "PAY TO !! %    %";
A$";B$
```

The exclamation point after the PRINT command directs the output to the external device that was initialized with the CALL command.

PRINT USING allows seven different types of format identifiers for dealing with numbers. The pound sign is used exclusively for defining the field width of a number. The PRINT USING command in conjunction with the pound sign causes number fields to be right-justified. For example, if you wish to print a column of numbers beginning at position 50 on the page, you could use the command:

```
PRINT TAB(50); USING "#####, #"; N
```

The use of the comma in the field specifier will cause a comma to be output every three places in the number. Your printout might look like:

```
123,456
   232
  1,508
```

If decimal positions are to be defined, simply use the command

```
PRINT TAB(50); USING "#####, #. ###"; N
```

and the column will be right-justified, rounded to two decimal places, and zero-filled on the right.

```
123,456.25
   232.00
  1,508.07
```

### File-Handling Techniques

Along with these unique commands, I want to introduce some of HDE Disk BASIC's file-handling techniques. There are three types of data files: SNAPSHOT, SEQUENTIAL, and RANDOM access. In addition, you have the ability to create an ASCII file of the program listing using the LIST# (list pound sign) command.

The main difference between the different types of data files is the way the data is stored on the disk and the techniques used to access it. First of all, the snapshot data file is, as its name implies, a snapshot of all the data in memory. If you can picture being able to grab the data in memory, compress it into one block, and then write it to the disk, you can understand the operation of this file. It is most useful when saving analytical data. For example, if

you are accumulating data and monitoring the results of laboratory tests, but need something recorded quickly, the command SAVED "TEST1" (meaning "save data") will, in a matter of seconds, write the contents of every variable to the disk file TEST1. To reload the information for later analysis, simply execute the command LOAD "TEST1" and memory will be restored to its previous contents.

With the RANDOM access file you can randomly access records within the file *without* reading or writing any other part of the file. This provides quick access to any record in the file.

The SEQUENTIAL data files are useful for data such as tax tables, rate tables, etc. Sequential files are best used when data fields or records are of varying lengths. Normally this type of data is manipulated in memory then written to the disk file when the user has completed working with it. The disadvantage of sequential file use is that to read the last record in the file, you must read the entire file. The same is true when changing one record in the file: you must read the file, make the change, and rewrite the entire file. But sequential files are usually more compact than RANDOM files.

To use sequential files properly, you must understand the structure of the file. First, records within the file may be terminated by a carriage return character (\$0D), a comma, or, when dealing with numerical fields, a space. The end of the file is signified by an end-of-file, or EOF mark. If you could look into the disk, you might find any of the following structures in a sequential file:

```
THIS IS RECORD 1$0D THIS IS
RECORD 2$0DEOF 22 33 44 $0D 11 66
55 $0D 13 $0D 99 21 $0DEOF 22, 33,
- 44$0D 11, 66, 55$0D 13$0D
99, - 21$0DEOF "THIS IS RECORD
1"$0D"THIS IS RECORD 2","THIS IS
RECORD 3"$0DEOF
```

The first two files were created using the PRINT# command, the second two using the WRITE# commands.

---

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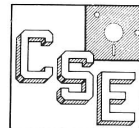
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## EXCITING NEWS FOR COLOR COMPUTER USERS

### FLEX, OS-9 and the Radio Shack Disk System ALL on the SAME Color Computer

Would you believe that you can run FLEX, OS-9 and Radio Shack disk software on the same Color Computer, and all you have to do is change the disk? That's right, just change the disk. If you have a 32K Color Computer with the Radio Shack disk system, all you need to do is make a trivial modification to access the hidden 32K, as described in the Feb. issue of COLOR COMPUTER NEWS and the April issue of '88' Micro. You can get FLEX from us right now. OS-9 will be ready by summer. Please note that this will only work with the Radio Shack disk system and 32K/64K memory chips that RS calls 32K. Maybe they put 64K's in yours, too. If you don't have a copy of the article, send a legal size SASE (40¢ stamps) and we'll send it to you.

Using this system to run FLEX and OS-9 has many advantages. First, it gives you 48K from zero right up to FLEX. This means that ALL FLEX compatible software will run with NO MODIFICATIONS and NO PATCHES! There are no memory conflicts because we moved the screen up above FLEX, which leaves the lower 48K free for user programs.

What you end up with is 48K for user programs, 8K for FLEX and another 8K above FLEX for the screens and stuff. We have a multi screen format so you can page backward to see what scrolled by and a Hi-Res screen that will enable us to have 24 lines by 42 character display is on the way. That's better than an Apple!

We also implemented a full function keyboard, with a control key and escape key. All ASCII codes can now be generated from the Color Computer keyboard!

We also added some bells and whistles to Radio Shack's Disk system when you're running FLEX or OS-9. We are supporting single or double sided, single or double density, 35, 40 and 80 track drives. If you use double sided drives, the maximum is three drives because we use the drive 3 select for side select. When you are running the Radio Shack disk, it will work with the double sided drives but it will only use one side and only 35 tracks. Using 80 track RAM is okay, but will not be compatible with standard Radio Shack software. You can also set each drive's stepping rate and drive type. (SS or DS -SD or DD)

In case you don't understand how this works, I'll give you a brief explanation. The Color Computer was designed so that the roms in the system could be turned off under software control. In a normal Color Computer this would only make it go away. However, if you put a program in memory to do something first (like boot in FLEX or OS-9), when you turn off the roms, you will have a full 64K RAM System with which to run your program (FLEX or OS-9). When the roms are turned off, it is as if you had removed them from the computer. They are gone!

Now, we need the other half of the 64K ram chips to work, and this seems to be the case most of the time, as the article states. Of course, you could also put 64K chips in.

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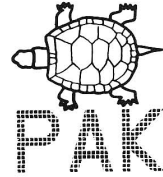
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# Commodore and MICRO

by Loren Wright

Commodore has been a dominant force in the microcomputer world since the Personal Electronic Transactor (or PET) was introduced in 1977. The first PETs admittedly had their problems. The small keyboard, a holdover from Commodore's calculator background, gave the PET a toy-like appearance. There was no resident machine language monitor — a tape version had to be loaded into RAM each time. There were also a few problems, of varying annoyance, in the operating system. Documentation had to be obtained from users' groups, since Commodore would not, and perhaps could not, provide very much.

In the U.S., the PET came out in the face of stiff competition from Apple and Radio Shack. The Apple attracted many people with its high-resolution color and full-size keyboard, while Radio Shack, with its nationwide network of stores and well-organized marketing effort, drew even more attention. To compound their problems, Commodore attempted to sell the PET only directly or through its Mr. Calculator stores, and there were delivery delays of many months.

The PET, as many other computer shoppers recognized, offered a system complete with CRT display, cassette mass-storage, and fully implemented BASIC for a price less than comparable systems from either Apple or Radio Shack. In the rest of the world, where Commodore was organizationally better equipped to compete, the PET became (and still is) the number one microcomputer.

The company corrected most of the problems with a new operating system. Unfortunately, this was done without much consideration for those who had already invested a lot of time and money developing commercial software for the old operating system. Many people abandoned ship at this point, but most adjusted and are still loyal PET owners. Since then, there has

been yet another operating system introduced, but this time the changes were far less radical, and Commodore cooperated considerably more in the transition.

To understate the situation, Commodore has been unpredictable in its approach to the market. When the 80-column business machine and the VIC were announced, there were widespread fears that the company would abandon PET owners in favor of the more lucrative entertainment and business markets. So far, those fears have not been justified. It is clear now, particularly with the announcement of several new computers, that Commodore wants to compete in all microcomputer markets. The new line-up will apparently include the Ultimax, the VIC, the SuperVIC, the PET, the 8016/8032, the color 8032, the Commodore-64, the SuperPET, and the 8096. Each of these is aimed at a particular segment of the market.

If its new advertising campaign is any indication, Commodore intends to provide the best value for any microcomputing need. The company plans to accomplish this not by inventing radically new computers, but rather by producing variations on its PET and VIC themes to compete over the full range of the market. To quote Jack Tramiel, the man behind Commodore, "We will become the Japanese!" — meaning that they will offer a lower-priced alternative. Whether Commodore can actually accomplish its goals is still uncertain.

MICRO has been covering the PET since its inception. Much of our job in the early days was to provide the information not provided by Commodore, and to help PET owners get around the bugs in their systems. Things have progressed much further than that now. The PET system is virtually bug-free and good documentation is available not only from Commodore, but from a

number of other sources. We will continue to publish articles of special interest to PET users, but you will find many of our other articles valuable as well. More articles written for other computers will be accessible to PET users, and we will continue to expand your horizons with material on new programming techniques, languages, and applications.

This issue's feature article "Growing Knowledge Trees," by David Heise, introduces artificial intelligence to MICRO readers. While it is written especially for the PET, I recommend that all MICRO readers try to see this program in operation. It should provide some ideas for your own artificial intelligence programs.

"Menu and Tape Timer," by Dale DePriest is a sequel to last month's "A Real Tape Operating System." In that article he discussed the good and bad features of the PET's tape system and presented some techniques to get the most from that system. This month's programs will help you turn your cassette collection into a well-organized file retrieval system. Although a disk drive is faster and more convenient, the PET's cassette system, with a few refinements, can offer a considerably less expensive alternative, which is still very satisfactory.

Louis Sander's "PET Memory Protector" is a simple circuit that is inserted between one of your PET's static RAM chips and its socket. Depending on where it is installed, PMP protects 1K or more of RAM from BASIC, LOADs and resets. The reset button, which is part of the circuit, can be used for either a cold or a warm reset.

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```

100 GOSUB 180
105 PRINT USING CS, A, BS
130 INPUT "TIME": DS
131 INPUT "DAY": ES
160 IFB - C THEN 105
180 FOR X = IT09
183 PRINT Y(X):NEXT
184 RETURN
200 I = X/19
READY
RENUMBER 110, 10, 105-184
READY
LIST
100 GOSUB 150
110 PRINT USING CS, A, BS
120 INPUT "TIME": DS
130 INPUT "DAY": ES
140 IFB - C THEN 110
150 FOR X = IT09
160 PRINT Y(X):NEXT
170 RETURN
200 I = X/19
READY

```

```

MERGE D1 "BUY NOW"
SEARCHING FOR BUY NOW*
LOADING
READY
RENUMBER 100, 10
READY
FIND BS
110 PRINT USING AS, ES, BS - CS - DS
280 ES = "NOW IS THE TIME"
READY

```

```

580 BA = BA - 1
590 RA = 123 * 5X / 92 + BA * 10
600 IF BA = 143 THEN 580
610 RETURN
620 CS = "PROFIT $#, #### DAILY"
630 PRINT USING CS, PI
640 DS = "LOSS $#, #### DAILY"
650 PRINT USING DS, LI
RUN
PROFIT $1, 238.61 DAILY
LOSS $ 0.00 DAILY
READY

```

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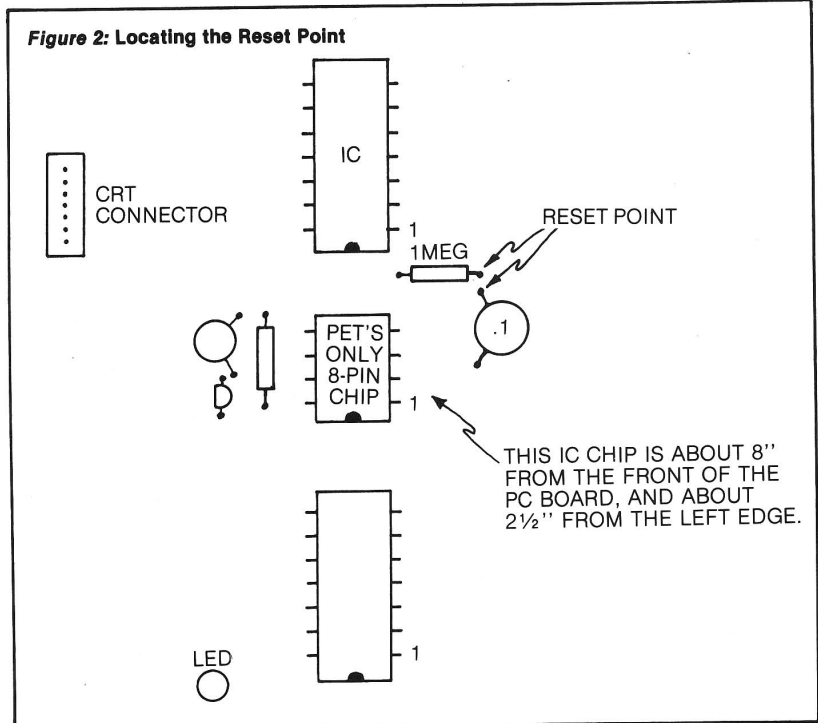
$\overline{SEL}$  pin will be held high by the voltage from  $R_2$ . So the read/write process into  $IC_x$  will fail, and PET will conclude that  $IC_x$  and all memory above it does not exist. Because  $IC_x$  is paired with another chip that is not disabled by  $S_1$ , the reset will have modified the lowest single byte in  $IC_x$ , but will not have affected any higher memory locations. The BYTES FREE message will include only those memory locations below  $IC_x$ .  $S_1$  can be released as soon as the BYTES FREE message appears, and at that time  $IC_x$  will be fully functional, but BASIC will not know that it is there. In other words,  $IC_x$  and above will constitute a fully protected area of memory.

If  $S_1$  is released before the timer finishes its cycle,  $IC_x$  will be properly connected when PET attempts to access it. The reset process will proceed normally, writing over any information in  $IC_x$  and above, and including those locations in the BYTES FREE message.  $IC_x$  and above will not be protected memory. In either case, as soon as  $S_1$  is released,  $C_1$  will discharge through  $R_1$ , to be ready for the next reset.

## Construction

If you are not an experienced electronics builder, you shouldn't try this project on your own, since a miswired PMP could mean disaster to your PET. For the builder with any experience, PMP construction is straightforward, except for breaking the  $\overline{SEL}$  line to  $IC_x$ . For the 6550,  $\overline{SEL}$  is pin 18, and +5 is pin 17. For the 2114,  $\overline{SEL}$  is pin 8 and +5 is pin 18. Make up a "PMP connector" from two wire-wrap IC sockets. Plug the sockets together, piggyback-style, and cut the pin carrying the  $\overline{SEL}$  lead from one socket to the other. If you want to do a more professional job, use one wire-wrap socket and the plastic base from another, cutting one of the pins. Either way, solder your  $S_{1b}$  leads to the severed ends, and glue everything together so it can't move. Solder  $R_2$  to the appropriate pins of the upper socket, and you're in business. (You need wire-wrap-type sockets for this work, because the solder-tab-type pins are too short to work with, unless you're used to microsurgery.)

We advise the prospective builder to be persistent in his search for parts, since  $S_1$  and the IC sockets are not common items. They are manufactured by the thousands for industrial use, but your local Radio Shack doesn't carry them.



## Installation

The first step in installation is to unplug your PET. Then find a way to mount  $S_1$  permanently. You can either drill a hole in your PET, or drill a  $1/2'' \times 3''$  strip of heavy sheet metal to accept  $S_1$ . Then mount it to the cover hold-down bracket on PET's right side, using two additional holes drilled through your piece of sheet metal. If  $S_1$  is properly chosen, it will easily fit in the  $1/2''$  space between PET's cover and base, making a very attractive and unobtrusive installation.

Next, connect the wire from  $S_{1a}$  to the reset point. Here you can solder a wire directly to PET's circuit board, or you can use a tiny test clip to connect it to a component lead. The reset point is easy to find by locating the 555 timer chip, which is the only eight-pin IC in the PET. It's on the far left side of the printed circuit board, about eight inches from the front edge. The reset point is accessible either at pin 2 of the 555, or at the resistor or capacitor lead wire shown in figure 2. (By the way, this is the same point used by the reset buttons on old ROM PETs.)

Finally, locate  $IC_x$  and put the PMP connector between it and its socket. At the very front of the main printed circuit board are two identical rows of eight IC chips in sockets; this is PET's RAM. Each 1K of memory is made up

of one IC in the front row, plus its partner in the second row. Half a byte is stored in each chip, for 1024 memory locations in each pair.

If your memory chips have 18 pins each, they are 2114's, and the IC's making up the lowest memory locations are to the far left. The highest memory locations are to the right. To protect 1K of memory, the PMP plugs into either one of the rightmost chips. With 2114's the PMP can be plugged into any RAM socket, protecting any number of 1K memory blocks.

If your memory chips have 22 pins, they are 6550's, and things work differently. The low memory locations are to the right in this case, and the high ones are to the left. Your PMP will only work properly in the highest 1K (the leftmost socket), or the highest 4K (number 4 from the left).

To locate  $IC_x$ , first determine how much memory you want PMP to protect. If it's 1K, then  $IC_x$  is the rightmost or leftmost IC in the front row. If you want to protect 2K of memory,  $IC_x$  is the chip just next to that one, and so on, at the rate of 1K per chip. For test purposes, you will need to protect 1K, so initially use the end chip in the front row. Use the left chip for 6550's, or the right chip for 2114's. (In every case, the corresponding chip in the second row could be used, with identical effect.)

We've arbitrarily chosen the front row chips because they're easier to get to.)

Before removing IC<sub>x</sub>, note the U-shaped depression on its top at one end. That is an orientation mark, and when it faces you, with the IC pins pointed downward, pin 1 is the closest pin to you on the right. See figure 2 for examples. Take careful note of IC<sub>x</sub>'s orientation, so that you'll be able to insert the PMP connector and IC<sub>x</sub> in the proper direction.

When you've done this, gently pry IC<sub>x</sub> from its socket, using a small screwdriver inserted from the front. Use standard static protection techniques: keep yourself grounded, and lay the naked IC, pins downward, on a piece of foil or conductive foam. Now insert the PMP connector into the vacant socket, being extremely careful to preserve proper orientation. Using static protection techniques, and once again paying careful attention to orientation, insert IC<sub>x</sub> into the PMP connector, and you're ready to test your PMP.

**Test and Operation**

Visually inspect the installation to make sure there are no broken wires or short circuits. Make sure that the PMP is plugged into the correct socket, and that all its pins are making contact. (Look closely, as bent pins are common, and easy to miss.) Make the same check on the IC chip, where it plugs into the PMP. Finally, double check the orientation of the IC and the PMP; if either one is in backwards, correct it immediately.

When you're certain that everything is as it should be, turn on the power to your PET. You should get the normal BYTES FREE message (7167 bytes on the 8K PET). Now load a machine-language program (MLP) of some sort into the top part of the top 1K of memory. Ideally, it should extend to the very last free byte. Be sure your program doesn't use the very first byte of the top 1K, since that byte will be modified by the reset routine. Run your MLP to make sure that it works.

Now activate S<sub>1</sub>, and keep it activated until the BYTES FREE message appears once again. If all has gone well, that message will have appeared about one second after you first activated S<sub>1</sub>, and will indicate 1024 fewer bytes than normal. Next, LOAD and RUN a BASIC program that uses several string variables. Run your MLP once again. If both programs work properly, PMP has protected upper memory from being written into by BASIC.

**Parts List**

- C<sub>1</sub> — 0.68 F, 50 wv
- R<sub>1</sub> — 1000 ohm, ¼ watt
- R<sub>2</sub> — 10K ohm, ¼ watt
- S<sub>1</sub> — DPDT momentary toggle or pushbutton switch

Two 18-pin or 22-pin wire-wrap-type IC sockets (pin configuration depends on your RAM type)

Hookup wire

Glue (Devcon clear epoxy or similar)

Optional ½" x 3" piece of heavy sheet metal (for switch mounting bracket)

Total parts cost should be \$10-\$12 for top-quality, name-brand parts.

For the final test, momentarily activate S<sub>1</sub>, this time being sure to release it before the BYTES FREE message appears. If you get a normal BYTES FREE message, and if both programs are gone from memory, your PMP is working correctly. Congratulations on a job well done!

Now here's the full story on clearing and protecting memory in your PMP-equipped machine.

1. POWER ON clears all memory, overwriting it with characters dictated by your ROM set.
2. Using either cassette drive to LOAD, SAVE, or VERIFY clears the associated cassette buffer, replacing what was there with data from the tape header. The unused cassette buffer is not affected.
3. Momentarily depressing S<sub>1</sub> and releasing it before the BYTES FREE message appears clears all memory *except* the cassette buffers, and gives a normal BYTES FREE message. The cleared memory is overwritten with characters dictated by your ROM set.
4. Holding S<sub>1</sub> until the reduced BYTES FREE message appears clears all memory *except* the two cassette buffers and the memory above the first protected byte. That first byte will be altered by the reset process, but is protected afterward. Anything previously existing above that byte will be unaffected by the reset, and will

be protected from being written into by BASIC. It can be PEEKed and POKEd, but that is all.

That's the full story on the PET Memory Protector. We've found it to be a very handy device for protecting high memory, and we hope that you will, too. If you'd like to have a fully assembled and tested PMP, we've made some up that we'll send you for \$20 each. Just send your name, address, and RAM type to: Louis F. Sander at 153 Mayer Drive, Pittsburgh, PA 15237.

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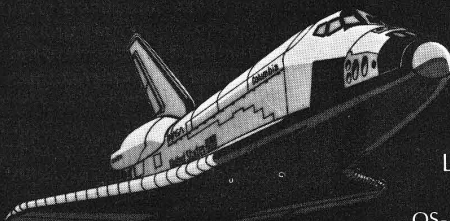
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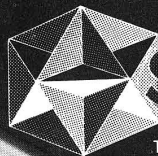
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# Growing Knowledge Trees

by David R. Heise

**Knowledge can be represented in tree diagrams that are stored and analyzed by computers. This PET program finds out what people know about a topic, analyzes answers, and shows users the organized results.**

**"Knowledge Trees" requires:**

- 16K or 32K PET
- 3.0 Operating System
- Printer and disk drive are supported, but optional. Notes are provided for 1.0 and 4.0 conversion.

A computer needs to be knowledgeable if it is to help you classify plants, diagnose illnesses, or identify beliefs that hold down productivity. But how do you make a computer knowledgeable? How do you teach a computer what an expert knows? How do you represent knowledge?

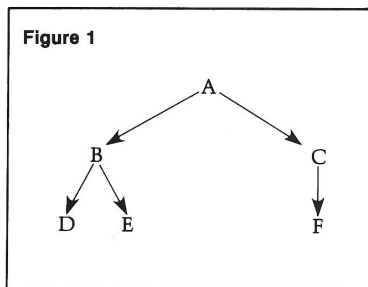
Research on these questions has been performed in computer science specialties like data base management and artificial intelligence, and also in social sciences like anthropology, sociology, and cognitive psychology. Data base management systems and psychological research demonstrate that some kinds of knowledge can be stored as associative networks with pointers linking items to related items. As a sociologist, I've shown that measurements about actors and behaviors can be used mathematically to generate information about social events. Artificial intelligence research and contemporary anthropology often represent knowledge as hierarchical trees of relationships.

This article discusses the tree concept for knowledge representation and presents a program that turns a Commodore microcomputer into a machine

for gathering hierarchical knowledge from people and reducing it to its simplest form. The program illustrates how to pass multiple parameters to an assembly-language subroutine via the USR function in BASIC. It shows you how to create a BASIC subroutine that can call itself recursively, and demonstrates a method for automatically loading and protecting assembled code, along with a BASIC program. Assembled routines are provided for carrying out operations on trees.

**Data Structures**

Hierarchical knowledge can be represented in a tree diagram, which is a type of directed graph. See figure 1.



Letters A through F represent *nodes* in the graph. These are the entities involved in hierarchical relationships. For example, the nodes could be A = living creature, B = mammal, C = bird, D = dog, E = cat, and F = robin.

The arrows are called the *edges* of the graph. All of the arrows on a graph represent a certain relationship. For example, in figure 1, each arrow could represent the relation "is a kind of." Thus, reading backward along an arrow, we see that B is a kind of A. Different arrows show which entities are related to other entities. In general, the node at the top of an arrow is a *superordinate* of the node at the bottom of the arrow. The node at the bottom of an arrow is a *subordinate* of the node at the top.

Relations in a tree diagram are *transitive*. This means that a relationship between two entities can be inferred when they are connected by a chain of arrows rather than by a direct arrow. For example, in figure 1, D (a dog), is a kind of B (mammal), and B (a mammal) is a kind of A (living creature). Therefore we can infer "a dog is a kind of living creature" even though there is no direct arrow from A to D. Many kinds of relationships are transitive. For example, time ordering is transitive: if event B occurs after A, and C occurs after B, then C occurs after A. "Is part of" also is transitive: if B is part of A, and C is part of B, then C is part of A. Some relations seem transitive but are not, like the relation "has." Jane may have a husband, and her husband may have a bald head. We would not want to conclude that Jane has a bald head.

Tree diagrams can be represented in matrix form. Figure 2 shows the matrix for the diagram in figure 1. Letters along the top of the matrix show nodes as originating sources for arrows. Letters along the side of the matrix show nodes as destination points for arrows. A zero in a cell indicates that no arrow connects the column node to the row node. A one indicates that an arrow goes from the originating node (column label) to the destination node (row label).

**Figure 2**

	A	B	C	D	E	F
A	<u>0</u>	0	0	0	0	0
B	1	<u>0</u>	0	0	0	0
C	1	0	<u>0</u>	0	0	0
D	0	1	0	<u>0</u>	0	0
E	0	1	0	0	<u>0</u>	0
F	0	0	1	0	0	<u>0</u>

The major diagonal is emphasized with underlining in figure 2. In a matrix that represents a hierarchical

tree, the major diagonal is always filled with zeros, and nodes can be ordered such that all entries above the major diagonal are zero. A *topographical ordering* of nodes has the node at the top of the graph first (A). Nodes that are directly connected to this node come next (e.g., C and B), then nodes directly connected to these follow (e.g., F, E, D), and so on, until all nodes are listed. A topographical ordering orders the nodes as they are encountered when going from the top of the tree diagram to the bottom. If nodes are listed in topographical order for the matrix representation, then all cells above the major diagonal contain zeros.

A tree diagram can be stored inside a computer in various ways. We could store the matrix representation, but this wastes space on zeros above the main diagonal. Instead we will use the *edge list* representation. This approach stores a tree, including verbal labels for the nodes, in two lists — name and edge — as shown in figure 3.

**Figure 3**

**Name List**

- (1) a living creature
- (2) a mammal
- (3) a bird
- (4) a dog
- (5) a cat
- (6) a robin

**Edge List**

- 1,2
- 1,3
- 2,4
- 2,5
- 3,6

The name list is simply a list of node labels with index numbers implied. Each entry in the edge list corresponds to an arrow on the tree diagram, and the entry consists of two numbers. The first is the index number for the arrow's originating node. The second is the index number for the destination node. The edge list has as many entries as there are arrows on the diagram. Their order is not important.

In the program presented here, index numbers are interpreted as ASCII values and converted to characters. Thereby the edge list can be maintained as a character string, taking advantage of dynamic string allocation in CBM BASIC; we do not have to set aside space for the edge list, whose size is unpredictable beforehand. By adding

64 to each index number before converting to a character, we get ASCII values for letters of the alphabet. For example, the edge list in figure 3 could be represented as the following string:

'ABACBDBECF'

This string contains all the information represented in figures 1 and 2. Marking the string off into pairs of letters precisely defines each arrow in the tree diagram.

We now have a neat, concise way of representing hierarchical knowledge in a CBM microcomputer. Artificial intelligence research usually employs a list representation that calls for a LISP language interpreter, but that would not be as convenient as this approach that works in BASIC.

**Elicitation**

The next step is to input knowledge from humans into computers. Storing knowledge within programs is not an efficient approach because too many people do not know how to program. Rather, the computer should elicit and store people's knowledge:

- accommodating to a user's interest in a certain kind of relation,
- talking with the user about a given topic,
- helping the user recall topical elements (nodes),
- helping the user to define relations among elements (edges).

Ideally the computer would deal with any kind of relation for making trees and would talk in accordance with rules of grammar and discourse. These kinds of flexibilities are costly in terms of program space, so we compromise. The program here offers three kinds of relationships for analyses, and presents only a limited number of queries.

Requirements for eliciting nodes and edges are more critical. To represent a person's knowledge about a topic, we must get as close as possible to an exhaustive listing of concepts (nodes). Furthermore, we must meticulously examine every possible relationship to assure that all real ones are included.

This program uses several tactics to help a person recall entities in the domain being considered. At the begin-

ning of a session, and periodically thereafter, a general elicitation question is presented, in the form: "What is an entity in the domain being considered?" The user is reminded of all the entities that have been entered already. Once some entities have been specified, these are used to stimulate recall of more entities, using questions like: "What other entities are related to entity X in the domain being considered?" Ultimately, every recorded entity is used as a stimulus for obtaining more entities. Additionally, the user occasionally is asked to name an entity that differentiates some entities from others, in a query like: "X, Y, and Z are entities in the domain of interest; what entity might be implied by two of these?" While no methodology guarantees exhaustive recall of all entities, these techniques do promote extensive recall.

Definition of a new entity's relations is complex because a number of conditions have to be fulfilled in building a tree. These conditions are:

1. As we consider a new entity, we have to allow that it could be subordinate to any existing entity, and/or superordinate to any entity except the top one (which defines the domain of interest). That is, a new node might be positioned anywhere in the tree diagram except above the top node. In principle, this means that for every existing entity except the topmost one, the computer has to ask the user whether the new entity is a superordinate and/or subordinate. Fortunately, principles of logic and transitivity permit economies.
2. The complexity of hierarchical knowledge requires allowing any entity to have multiple subordinates or multiple superordinates.
3. Finally, proper tree structure calls for deleting any relations that can be inferred from transitivity.

The program assumes that a new entity is subordinate to the top node — it is in the domain of interest. Then a series of yes-no questions is asked to determine which existing entities are superordinates or subordinates of the new entity. Each query is of the form: "Does X (an existing entity) imply Y (the new entity)?" "Does Y imply X?"

The entities that are superordinate to the new entity are determined first. Querying works from the top of the tree downward, the procedure considers existing entities in topological order.



Let's say an existing entity is not superordinate to the new entity. Then subordinates of that existing entity are not superordinate to the new entity because of the transitivity principle.

Once a new entity's superordinates are known, more questions are asked to find its subordinates. The procedure employs two logical principles that follow from transitivity. First, if a new entity, Y, is not subordinate to an existing entity, X, then the new entity cannot be superordinate to any of X's subordinates. For example, since a sparrow is not a kind of mammal, various kinds of mammals cannot possibly be kinds of sparrows. Thus, no queries need to be presented regarding subordinates of entities which are not superordinate to the new entity. To find all of a new entity's subordinates, we only need to ask about the subordinates of entities for which the new entity is itself a subordinate.

Second, once we discover that the new entity is superordinate to an existing entity, we know that it is superordinate to all of that entity's subordinates. We do not want to represent those relations directly since they are derivable.

"Knowledge Trees" is written for the PET's 'upgrade' or 3.0 operating system. Notes have been provided to modify it to run on 1.0 and 4.0 systems. With the changes indicated, the program should work on 1.0 PETs. However, to run properly on 4.0 PETs, changes to the machine language portion of the program, beyond those indicated for PET ROM routines, will be necessary.

The problem is in the infamous 'garbage collection' routine. To speed up garbage collection (the process of removing old copies of dynamic strings), the 4.0 ROMs store a back pointer after the actual string characters in high memory. The garbage collection routine checks these back pointers to be sure they point to valid string descriptors in low memory. Bad strings are wiped out. The "Knowledge Trees" machine language routines do not accommodate these back pointers, and as a result, the system is likely to crash when a garbage collection takes place. MICRO will publish a fix for this problem in a future issue.

The transitivity principle eliminates queries about many possible relations, thereby substantially reducing the labor in establishing a new entity's position in the tree diagram. However, the potential for multiple subordinates and multiple superordinates requires that we ask many questions that might seem unnecessary.

To illustrate, suppose that "house pet" is added to the tree represented in figure 3 (abbreviated in figure 1). A house pet is a living creature, but

queries establish that a house pet is not necessarily either a mammal or a bird. We then search for subordinates of house pet among the subordinates of living creature. Mammals are not all house pets, so mammal is not subordinate to house pet. Nevertheless, to avoid error, we must continue searching among the subordinates of mammal. It happens that dogs are a kind of house pet. Thus, in the new tree diagram, dog will be subordinate to both mammal and house pet; dog has two superordinates. Similarly, cat also

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is a subordinate of house pet. Having found these subordinates of house pet, we still must continue searching for other subordinates among the other subordinates of living creature. Searching through the bird subgraph yields no more subordinates in this example, but it would if we had canary as an entity.

Once all required queries have been answered, the program positions the new node by linking it to all of its immediate superordinates and all of its immediate subordinates. This is done by adding appropriate entries to the edge-list. If a superordinate and a subordinate of the new entity were originally connected by an arrow in the tree diagram, that relationship is deleted since it now can be derived using the transitivity principle.

### Illustrative Analyses

One program option permits the analysis of the kinds of people at a scene. This elicitation provides a way to study people's subjective notions of social structure. The results can be related to issues of role identification, role conflict, and definitions of situations.

When the program has been loaded, the user is instructed on how to use the computer's keyboard. The user is given the instructions in exhibit 1 to read, and a sheet like exhibit 2 showing available commands.

The progression of questions and answers during the first part of a session might be as shown in exhibit 3. You might find a different structure if you did it yourself.

Choosing option 2 in answer to the first question would lead to the elicitation of happenings in an event. For example, analyzing what happens when we dine out might give the final results shown in exhibit 4. This elicitation could precede critical path analyses in order to define all the events that have to be considered. It also is an empirical approach to constructing "frames" for artificial intelligence research.

### The BASIC Program

#### Input

The STOP key is disabled while the program is running (lines 340-350). A special input routine (lines 640-780) uses a shaded cursor to keep the program from ending if the user hits RETURN without making an entry. However, you can still break from a run

by typing SPACE, then RETURN. The STOP key's function is turned on and off again during the input routine, so STOP is available if you break out of the program for programming purposes.

In the introductory part of the program (lines 370-510), a menu allows the user to choose one of three kinds of analysis.

1. *Analysis of a social scene.* This option elicits social roles and orders them by the "kind of" relation.

Specifically, relations among roles are defined by asking "Is an X always a Y?" The name of the scene (the top node) and one role are elicited as part of the opening procedure (lines 880-1010).

2. *Analysis of an event.* Particular happenings are elicited, and then ordered in terms of their temporal priority: "Is X over before Y?" The definitional subroutine (lines 1030-1160) also gets the name of the general event (top node) and one specific happening.

#### Exhibit 1: Instructions

You can look at people in different ways. For example, the President of the United States is the President, a politician, a man, an adult, a husband, a father, and other things, too. Everyone can be seen in several ways.

How you see people depends a lot on where you see them. You might think of someone on the street as a pedestrian. The same person inside a store would be a customer or a browser or an employee. One idea about a person can lead to another. For example, teachers always are adults, so if people are talking about a teacher, you automatically know they are talking about an adult.

In this session with the microcomputer, you will name the scene you want to analyze. Thereafter the computer will ask you what kinds of people are found there, and how one type relates to another.

The machine begins by asking questions like, "Is a child always an adult?" But the computer learns what you tell it, so later questions are more interesting. In fact, you have to think carefully to answer some of them.

After you've named different types of people, the computer will analyze your answers and present the results in a chart. The chart has a row and a column for each type. Dots show which types are special cases of other types. For example, if professor and teacher were on the chart, a dot might appear in the professor row and the teacher column indicating that a professor is a kind of teacher.

Two dots in one column show what people have in common. For example, teacher and secretary might both have dots in an adult column, indicating that teachers and secretaries have adulthood as a bond between them. Two dots on one row suggest how a person might get confused in the situation. For example, professor might have a dot under teacher and another under researcher, indicating that sometimes a professor might feel torn between acting as a teacher and acting as a researcher.

Answer the first question by typing number 1 and pressing the RETURN key to analyze types of people.

The second question asks what kind of scene you want to analyze. Answer by typing a singular noun, like FAMILY, SCHOOL, or PARTY. Then press RETURN.

The next questions ask for types of persons you might find at the scene. Use just one or two words to name each type. Use nouns rather than adjectives — e.g., DUMMY rather than DUMB. Use singular rather than plural — e.g., TEACHER rather than TEACHERS. Type each name and press RETURN. If you misspell a word, you can correct it with the change command the next time you are asked to enter something.

Pretty soon the computer starts asking yes-no questions like, "Is a teacher always an adult?" Answer by typing Y or N. Answer yes-no questions for the ideal or general case. If you make a mistake while answering a yes-no question, continue answering Y until the yes-no questions are over. Then delete the entry with the change command so you can re-enter it correctly.

After the first few questions, the chart may appear automatically just before you name another type. When you are through looking at the chart, press the RETURN key, and the questions will start again. You also can get the chart by entering # instead of a name.

Enter \$ to skip a question, if you cannot think of a good answer. (The \$ option does not apply when answering yes-no questions.)

3. *Analysis of an entity.* Components of an entity and their incorporation relationships are elicited, using the relational question "Does X definitely have Y?" The name of the entity and of one of its parts are acquired while defining this option (lines 1180-1310).

Wordings of the various elicitation questions are adjusted for each option. You can change the wordings by changing the definitions of the string variables W3\$, W4\$, and W5\$ (e.g., in lines 980-1000).

After these preliminaries, the program drops into a loop which continually cycles through all of the existing nodes in the graph (lines 530-620). The loop has no termination: the program ends when you press SPACE RETURN or turn off the machine.

The subroutine eliciting new entries (lines 1430-1840) ordinarily presents one of the existing entries as a stimulus, asking a question like: "What else might X relate to in the entity?" Existing entries that relate are

listed as a reminder: "Aside from Y, Z?" The new entry is accepted, preceded by "a" or "an" (if that is appropriate), added to the name list, and another subroutine is called to place the new node in the tree.

Instead of entering a word in response to the elicitation question, the user can enter any of the program commands to correct, display, analyze, or save the data.

The main program loop calls a second elicitation subroutine (lines 2730-3010) that checks whether a node has more than two immediate subordinates. If so, another elicitation question is presented, such as: "Here are some parts of a W: X, Y, Z. What is a more general term for some of these?" The user may skip the question. If an answer is provided, it is treated in the same way that new entries ordinarily are handled.

The subroutine to establish a new node's position in the tree structure is the longest in the program (lines 1860-2710). First it clears some short-term memory for storing yes-no answers. Next it determines which existing nodes are superordinate to the new node. Then, working among the subordinates of these superordinates, it searches for existing nodes that are subordinate to the new node. The edge list is modified to reflect the new node's position.

An error-correction subroutine (lines 3680-4570) allows two kinds of changes to be made in the data. An entry in the name list can be changed to a different spelling (lines 3800-3850). Or a node can be deleted entirely from the graph (lines 3870-4570). In the latter case, the program checks whether subordinates are also to be deleted and, if so, deletes them first using the subroutine recursively. Recursion is achieved by defining a push-down 'stack' containing the nodes to be deleted, and letting the procedure work until the stack is empty. Deletion involves removing edges from the edge list and changing other edges in order to close up the graph over the deleted node. Deletion also involves removing the node from the name list and adjusting index numbers.

**Output**

A subroutine to display the matrix representation of the tree (lines 3130-3660) writes to screen or to printer. The lower triangle of the matrix is presented. Entry names, truncated to 13 characters, are listed in topological

**Exhibit 2: Commands**

\$	Skip to next question without answering this one.
#	Look at the chart.
#H	Print the chart on paper (requires a printer hooked up to the computer).
!NAME	Change an entry that was entered as NAME. The program will instruct you on how to change the name, or delete the entry entirely.
@	Analyze commonalities of two or more entries. The program will tell you what more general term covers all of the chosen entries, and in what way each chosen entry is a special case of the more general term.
." FILE NAME	Save all of the data on tape so that they can be read in again later.
\" FILE NAME	Save all data on disk.
T	As an answer to program's first question, this causes the program to read data from tape.
D	As an answer to program's first question, this causes the program to read data from disk.

**Exhibit 3: Sample Run**

This program allows you to analyze the organization of:

1. people at a scene
2. actions in an event
3. the parts of an entity

Which analysis do you want to do? 1  
 What's a word naming the scene you're going to analyze? FAMILY  
 What's one kind of actor you might find at a family scene? FATHER  
 Who is an actor at a family scene — aside from a father? MOTHER  
 Is a mother always a father? N  
 Is a father always a mother? N  
 Answer \$ to skip:  
 What else might a father be at a family scene? HUSBAND

**Exhibit 3 (continued)**

Is a husband always a father? N  
 Is a husband always a mother? N  
 Is a father always a husband? Y  
 Is a mother always a husband? N  
 The final results of this analysis might look as follows when the matrix representation is printed.

**AT A FAMILY SCENE**

ADULT	X <
CHILD	X + <
MALE	X + + <
FEMALE	X + + + <
HUSBAND	+ X + X + <
WIFE	+ X + + X + <
SON	+ + X X + + + <
DAUGHTER	+ + X + X + + + <
FATHER	+ + + + X + + + + <
MOTHER	+ + + + + X + + + + <
BROTHER	+ + + + + + X + + + + <
SISTER	+ + + + + + + X + + + + <

**Exhibit 4: Sample Printout**

<b>WHILE DINING OUT</b>	
LEAVING RESTA	X <
PAYING BILL	+ X <
LEAVING TABLE	+ + X <
LEAVING TIP	+ + + X <
WAITING FOR B	+ + + + X <
EATING FOOD	+ + + + + X <
GETTING FOOD	+ + + + + + X <
SITTING AT TA	+ + + + + + + X <
WAITING FOR P	+ + + + + + + X + <
GIVING ORDER	+ + + + + + + + X <
READING MENU	+ + + + + + + + + X <
WAITING FOR M	+ + + + + + + + + + X <
FINDING TABLE	+ + + + + + + + + + X + <
ENTERING REST	+ + + + + + + + + + + X X <
<b>WHILE DINING OUT</b>	
LEAVING RESTAURANT	
PAYING BILL	
LEAVING TABLE	
LEAVING TIP	
WAITING FOR BILL	
EATING FOOD	
GETTING FOOD	
SITTING AT TABLE	
WAITING FOR FOOD	
GIVING ORDER	
READING MENU	
WAITING FOR MENU	
FINDING TABLE	
ENTERING RESTAURANT	



order along the lefthand border (the full names are listed separately at the bottom when a hard copy is printed). Cells with zeros are left blank; cells with ones are marked graphically. Screen displays are limited to trees with less than 23 nodes; printed output covers the maximum size tree that the program handles — 63 nodes. The screen display is invoked randomly about one-third of the time after new entries are made (line 1830).

Common superordinates of two or more entries are found by another subroutine (lines 5070-5600). This procedure also indicates the immediate subordinates of the common superordinate. These subordinates lead down to each of the originally specified nodes — an analysis not easily done by inspection of the matrix. The algorithm involves concatenating all the up-graphs of the focus nodes, creating a dummy subordinate node of the focus nodes, and subtracting the up-graph of the dummy from the concatenated graphs (repeatedly if there are more than two focus nodes). The topologically lowest node of the remainder represents a commonality of the focus nodes. A search is made to find the immediate subordinates of the common

node that are linked to focus nodes. When multiple common nodes exist, they all are presented in turn. The dummy node is deleted before the subroutine ends.

The routine to save a knowledge base on tape or disk (lines 4590-4810) creates a file name from the label given as part of the save command, plus the name of the top node in the graph, as follows: LABEL.NODE1. The file contains the type of analysis as specified for the program's first question, the number of nodes, the node names, the number of edges, and the list of edges. The file can be read later by another routine (lines 4830-5050), called by typing T or D in answer to the first program question (data are listed as they are read into the program). Writing and reading are done with tape unit #1 or disk unit #0. A disk must be properly initialized before the program is run.

**Utilities**

Articles are appended to the front of entries for readability (lines 1330-1410). This routine inserts a nonprinting character with 'a' to make the appendage uniform in length, simplifying removal whenever necessary. Articles are not

added to event entries (option 2 in the program).

A subroutine (lines 800-860) presents the frequent query about relationships (e.g., "Is an X always a Y?"). The routine gets the answer and returns. A separate routine (lines 3030-3110) is used to add a name to the name list.

**Loader Program**

A separate loading program is shown in listing 2. This should be saved as the first program on a tape or disk. When it is loaded and RUN, it automatically loads the assembly language subroutines, guards the memory allocated to them, and then loads the main BASIC program and starts it running. On tape, the programs must be saved in the following order: loader (named anything); the file of assembly language subroutines, named CODE; main BASIC program, named TREES. These same file names must be implemented in order to use the loader program with a disk.

**Entering the BASIC Code**

A Glossary of special symbols used in the program listings is given at the *(Continued on page 74)*

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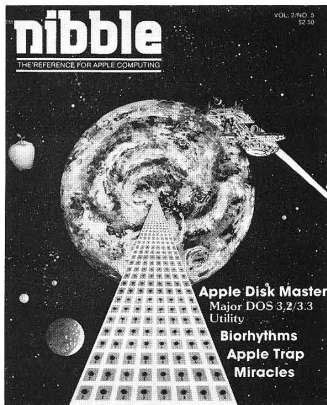
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(Continued from page 72)

end of the main program (lines 5620-5700).

REMARKS must be ignored when entering the main BASIC program into a 16K PET because all of the lines in listing 1 take up 18K. REMARKS could be included when using a 32K PET, but then the assembly language subroutine would have to be relocated.

## 6502 Assembly-Language Routine

A number of analytic functions are coded in 6502 assembly language for the sake of speed. The code is presented in listing 3, which begins with definitions of zero-page cells and the ROM subroutines used. These locations refer to Operating System 3.0 on the PET. Notes are included, where appropriate, for conversion to O.S. 1.0 and 4.0.

The short routine at lines 370-460 (called before the BASIC program is loaded) points the USR function to the code and protects the code from BASIC. The overall logic of the procedure can be seen in the executive program (lines 510-560).

A number of parameters have to be established every time the routine is called (lines 610-1630). The number of nodes is determined by finding the name list and counting the number of entries in it. The routine looks for a specific array, so the name list *must* be NM\$( ). Next the routine finds the location and the length of the edge list, which *must* be named L\$(0). The name list and the edge list — and later two graphs named GR\$(0) and BR\$(0) — are found using a separate subroutine (lines 1100-1630). If an array is not found, a pointer is set to the word "array" among the PET's canned messages, and control is transferred to the standard error routine in ROM.

Three parameters are passed from BASIC when the USR function is invoked: the starting node from which to begin tracing a subgraph, a code indicating whether to trace upwards (0) or downwards (2), and a code indicating whether the list of encountered nodes should (1) or should not (0) contain the same element if the trace goes through it repeatedly. The no-repeat option usually is used in this application. The three numbers are combined into a single argument for USR; the starting node is added to the two code values, each multiplied by 256. The USR function transfers this number to FACC — the BASIC accumulator — in five-byte floating point format. After the number

has been converted to two-byte integer format (using the ROM routine, FLPINT), the parameters are recovered. The low byte of the argument equals the specified starting node. The high byte of the argument is ANDed with one to recover the Repeat code. The low byte is ANDed with two to recover the Up-Down code.

Lines 1670-2280 create a topological list of node index numbers, using the second tape cassette buffer as a work space. The list is not returned directly; it is used to order nodes encountered while tracing a subgraph. The procedure follows an algorithm presented by Gotlieb and Gotlieb (1978). If a loop is encountered in the graph, then the routine aborts and prints "complex error."

The routine in lines 2330-3050 makes a list of all the nodes in a graph that are reachable, either in an upward direction or a downward direction, from the specified starting node. The index numbers are converted to characters and stored in a string named GR\$(0), which must be dimensioned in the BASIC program. The length of GR\$(0) is returned as the value of the USR function.

The GR\$(0) list is put into topological order by lines 3090-3350. If the starting node is specified as one, with direction down, then GR\$(0) will return with a topological listing of all nodes in the graph.

The final part of the procedure, lines 3390-3760, removes elements in the GR\$(0) list from another list of elements, BR\$(0). This array must be dimensioned in the BASIC program. If none of the members of GR\$(0) is in BR\$(0), then BR\$(0) remains unchanged. If elements of GR\$(0) are in BR\$(0), then they are removed, making BR\$(0) shorter. BR\$(0) must always be defined with a space following it (e.g., see line 2070 of the BASIC program).

Every USR call performs all of these functions, even if some of them are not used.

## Entering the Code

The procedure has been assembled for placement at the top of RAM in a 16K computer, and the same positioning can be used with a 32K machine. The positioning can be changed to the top of 32K RAM by changing every hex memory address in the \$3000 range so that it begins with seven instead of three. Enter the code with the CBM monitor, display the relevant cells with the M command, and overwrite the contents following listing 3. Use the following monitor command to save to disk.

```
.S "0:CODE",08,3DA8,3FF0
```

Use the following command to save on tape.

```
.S "CODE",01,3DA8,3FF0
```

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David Heise is Professor of Sociology at Indiana University. He recently edited "Microcomputers in Social Research" (Sage Publications, 1981). His books include *Causal Analysis and Understanding Events*. He has created commercial microcomputer programs for word processing and statistical analysis, and he has published a number of programs for PET computers. Contact Mr. Heise at the Department of Sociology, Indiana University, Bloomington, IN 47405.

### Listing 2: Loader Program

```
100 : REM: LOADER PROGRAM
110 :
120 : REM: ROUTINE TO LOAD THE ASSEMBLED CODE, THEN THE MAIN PROGRAM.
130 DV$=" ,8":CU$="000000"
140 REM DV$="":CU$=CU$+"00":REM ADD THIS LINE TO LOAD FROM TAPE.
150 : REM: SET GRAPHICS MODE.
160 POKE 59468,12
170 : REM: STORE 4 CARR. RETURNS IN INPUT BUFFER,
    (USE 525 AND 527-530 FOR 1.0)
180 POKE 158,4:POKE 623,13:POKE 624,13:POKE 625,13:POKE 626,13
190 : REM: SET UP SCREEN TO INVOKE THE SUBROUTINE FILE -- 'CODE',
200 PRINT "LOAD" CHR$(34) "CODE" CHR$(34):PRINTCU$:"SYS 15784"
210 : REM: THEN LOAD PROGRAM 'MAIN'.
220 PRINT "LOAD" CHR$(34) "MAIN" CHR$(34):DV$
230 PRINT CU$ "RUNG":;END
```



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Tree Analysis (Continued)

```

1470 PRINT
1480 : REM: USE A SPECIAL QUESTION IF USING THE TOP NODE FOR ELICITATION.
1490 IF IP=1 THEN PRINT W3NM$(1):GOTO 1540
1500 : REM: OTHERWISE PRINT THE STANDARD STEM
1510 PRINT "WHAT ELSE MIGHT
1520 PRINT RIGHT$(NM$(IP),LEN(NM$(IP))-1)W4NM$(1)
1530 : REM: SHOWING PRESENT LINKS, IF ANY.
1540 IO=LEN(L$(0)):FOR I=1 TO IO STEP 2
1550 IF FN(L(I))=IP OR (FN(L(I+1))=IP AND FN(L(I)<>1) THEN I=IO:NEXT I:GOTO 1570
1560 NEXT I
1570 PRINT "--ASIDE FROM
1580 BR$(0)="":DI=2:LL=USR(IP+DOWN)
1590 FOR J=1 TO LL
1600 IF FN(J)>1 AND FN(J)<>IP THEN PRINT " NM$(FN(J))
1610 NEXT J
1620 IF DI THEN DI=0:LL=USR(IP+UP):GOTO 1590
1630 : REM: GET USER'S INPUT.
1640 GOSUB 670:A$=LEFT$(WD$,1)
1650 : REM: ALLOW SKIPPING.
1660 IF A$=" " THEN RETURN
1670 : REM: ACCEPT A PRINT-GRID COMMAND.
1680 IF A$="*" THEN GOSUB 3160:GOTO 1450
1690 : REM: ACCEPT REVERSE COMMAND.
1700 IF A$=":" THEN GOSUB 3700:GOTO 1450
1710 IF A$="." THEN GOSUB 3700:GOTO 1450
1720 IF A$="," OR A$="\' THEN GOSUB 4620:GOTO 1450
1730 : REM: ACCEPT SAVE COMMAND.
1740 IF A$="@" THEN 5090:GOTO 1450
1750 : REM: THIS IS AN ENTRY!
1760 : REM: ADD AN ARTICLE TO THE WORD.
1770 GOSUB 1340
1780 : REM: ADD THE NODE TO NM$.
1790 H=LL+GOSUB 3060:IF H=1 THEN PRINT "<R>ALREADY EXISTS":GOTO 1450
1800 : REM: FIND THE NODE'S LINKAGES.
1810 GOSUB 1880
1820 : REM: GIVE AUTOMATIC PRESENTATION OF THE GRID OCCASIONALLY.
1830 IF RND(1)<.3 THEN WD$="*":GOSUB 3160
1840 RETURN
1850 : REM: SUBROUTINE TO POSITION NEW NODE IN TREE.
1860 : REM: CLEAR SPACE FOR REMEMBERING YES-NO ANSWERS.
1870 FOR I=1 TO 65:ODX(I)=0:NEXT I
1880 : REM: GET A DOWN GRAPH FROM THE ORIGIN, WITHOUT REPEATS.
1890 BR$(0)="":LO=USR(1+DOWN)
1910 : REM: IS NEW NODE SUBORDINATE TO AN EXISTING NODE?
1920 FOR IB=1 TO LO
1930 : REM: STOP IF BEYOND THE LENGTH OF CURRENT GR$.
1940 IF IB>LEN(BR$(0)) THEN IB=LO:GOTO 2140
1950 : REM: AND SKIP THE QUESTION FOR THE ORIGIN.
1960 IF FN(IB)=1 THEN NEXT IB
1970 : REM: IF QUESTION WAS ASKED FOR THIS NODE, RECALL THE ANSWER.
1980 IF ODX(FN(IB))<>0 THEN A$=CHR$(ODX(FN(IB))):GOTO 2040
2000 W1$=NM$(ZZ):W2$=NM$(FN(IB)):GOSUB 810
2010 : REM: (REMEMBER THE ANSWER.)
2020 ODX(FN(IB))=ASC(A$)
2030 : REM: IF NEW NODE IS NOT SUBORDINATE TO A NODE,
2040 IF A$<>"N" THEN NEXT IB:GOTO 2140
2050 : REM: THEN REMOVE THAT NODE AND ITS SUBORDINATES FROM THE DOWN GRAPH.
2060 BR$(0)=BYSETTING BR$ EQUAL TO A DUPLICATE OF BR$,
2070 BR$(0)=LEFT$(BR$(0)+",",LEN(BR$(0)))
2080 LL=USR(FN(IB)+DOWN)
2090 : REM: REMOVING UNWANTED NODES FROM BR$,
2100 : REM: THEN SETTING BR$ EQUAL TO BR$.
2110 GR$(0)=LEFT$(BR$(0),LEN(BR$(0)))
2120 : REM: RELOOK AT THE REVISED GR$.
2130 NEXT IB
2140 : REM: CLEAR SPACE FOR REMEMBERING YES-NO ANSWERS.
2150 : REM:

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Tree Analysis (Continued)

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2160 FOR I=1 TO 65:ODX(I)=0:NEXT I
2170 : REM: CREATE A DUPLICATE OF THE CURRENT PRIMARY GRAPH.
2180 GR$=LEFT$(GR$(0),LEN(GR$(0)))
2190 : REM: WORK BACKWARD IN THE PRIMARY GRAPH UNTIL ALL NODES ARE DELETED.
2200 IB=LEN(GR$(0)):IF IB=0 THEN RETURN
2210 : REM: MAKE A LINK IN EDGE LIST FROM THIS NODE TO NEW NODE.
2220 L$(0)=L$(0)+RIGHT$(GR$(0),1)+CHR$(ZZ+64)
2230 : REM: GET THE DOWN-GRAPH FROM NODE IB.
2240 BI=FN(IB)
2250 BR$(0)="":LL=USR(BI+DOWN)
2260 FOR BB=1 TO LL
2270 FOR BB=1 TO LL
2280 : REM: UNTIL ALL ARE CONSIDERED.
2290 IF BB>LEN(GR$(0)) THEN NEXT BB:GOTO 2690
2300 : REM: SKIP THE NEW NODE OR NODE IB.
2310 IF FN(BB)=ZZ OR FN(BB)=BI THEN NEXT BB:GOTO 2690
2320 : REM: IF QUESTION WAS ASKED FOR THIS NODE, RECALL ANSWER.
2330 K=ODX(FN(BB)):IF K>>0 THEN A$=CHR$(K):GOTO 2390
2340 : REM: OTHERWISE ASK IF THIS NODE IS SUBORDINATE TO THE NEW NODE.
2350 W1$=NM$(FN(BB)):W2$=NM$(ZZ):GOSUB 810
2360 : REM: (REMEMBER THE ANSWER.)
2370 ODX(FN(BB))=ASC(A$)
2380 : REM: WHEN THIS NODE, BB, IS SUBORDINATE TO NEW NODE, ZZ,
2390 IF A$="N" THEN NEXT BB:GOTO 2690
2400 : REM: SEE IF BB NODE IS DIRECTLY CONNECTED TO IB NODE.
2410 A$=LEFT$(GR$(0),1)+MID$(GR$(0),BB,1)
2420 FOR BC=1 TO LEN(L$(0)) STEP 2
2430 B$=MID$(L$(0),BC,2)
2440 : REM: IF IT IS NOT, THEN ADD EDGE FROM NEW NODE TO BB NODE
2450 IF A$=B$ THEN 2510
2460 NEXT BC
2470 : REM: (PROVIDING IT'S NOT ALREADY PRESENT).
2480 IF K>ASC("Y") THEN L$(0)=L$(0)+CHR$(ZZ+64)+MID$(GR$(0),BB,1)
2490 GOTO 2610
2500 : REM: IF IT IS, SUBSTITUTE EDGE ZZ-BB FOR OLD EDGE IB-BB
2510 C$=CHR$(ZZ+64)+MID$(L$(0),BC+1,1)
2520 : REM: (PROVIDING IT'S NOT ALREADY THERE).
2530 FOR IO=1 TO LEN(L$(0)) STEP 2:IF MID$(L$(0),IO,2)=C$ THEN C$=""
2540 NEXT IO
2550 A$="":IF BC>1 THEN A$=LEFT$(L$(0),BC-1)
2560 B$="":IF BC<LEN(L$(0))-2 THEN B$=RIGHT$(L$(0),LEN(L$(0))-BC-1)
2570 : REM: (CLOSE THE BC LOOP.)
2580 BC=LEN(L$(0)):NEXT BC
2590 L$(0)=A$+C$+B$
2600 : REM: REMOVE BB AND ITS SUBORDINATE NODES FROM THE IB DOWN-GRAPH,
2610 BR$(0)=LEFT$(GR$(0),LEN(GR$(0)))
2620 LL=USR(FN(BB)+DOWN)
2630 GR$(0)=LEFT$(BR$(0),LEN(BR$(0)))
2640 : REM: AND RELOOK AT IT.
2650 BB=BB-1
2660 NEXT BB
2670 : REM: IF ALL SUBORDINATES OF IB ARE DONE. RETURN TO PRIMARY GRAPH.
2680 : REM: REMOVE NODES UPWARD FROM IB.
2690 BR$(0)=LEFT$(GR$+"",LEN(GR$(0))):LL=USR(BI+UP)
2700 : REM: AND CONTINUE.
2710 GR$(0)=LEFT$(BR$(0),LEN(BR$(0))):GOTO 2180
2720 : REM: SUBROUTINE TO ELICIT GROUPING WORD.
2730 : REM: WHEN CURRENT NODE HAS 3+ IMMEDIATE SUBORDINATES,
2740 : REM: FOR I=1 TO LEN(L$(0)) STEP 2:IF CHR$(IP+64)=MID$(L$(0),I,1) THEN J=J+1
2750 NEXT I:IF J<3 THEN RETURN
2760 : REM: PRINT ELICITATION STIMULUS, ADJUSTING FOR KIND OF ANALYSIS.
2770 IP=3:W1$="":ON TA GOTO 2790,2810,2830
2790 PRINT:PRINT "HERE ARE KINDS OF ":IF IP=1 THEN W1$="PARTICIPANTS":I=0
2800 GOTO 2840
2810 PRINT:PRINT "HERE ARE ASPECTS OF ":IF IP=1 THEN W1$="WHAT HAPPENS":I=0
2820 GOTO 2840
2830 PRINT:PRINT "HERE ARE SOME PARTS":W1$=" OF ":IF IP=1 THEN W1$="OF":I=0

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Tree Analysis (Continued)

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2840 PRINT W1$RIGHT$(NM$(IP),LEN(NM$(IP))-1)";
2850 : REM: PRINT IMMEDIATE SUBORDINATES OF NODE IP.
2860 FOR I=1 TO LEN(L$(0)) STEP 2
2870 IF CHR$(IP+64)=MID$(L$(0),I,1) THEN PRINT " NM$(FNL(I+1))
2880 NEXT I
2890 : REM: PRINT ELICITATION QUESTION AND GET ANSWER.
2900 PRINT:PRINT " WHAT IS A MORE GENERAL TERM FOR
2910 PRINT " SOME OF THESE (<R>*<R>: SKIP)":GOSUB 670
2920 : REM: PERMIT SKIP.
2930 IF WD$=" $" THEN RETURN
2940 : REM: ACCEPT PRINT-GRID COMMAND.
2950 IF LEFT$(WD$,1)="#" THEN GOSUB 3160:GOTO 2750
2960 : REM: ADD AN ARTICLE TO NEW WORD, ENTER IN NM$, AND LINK IT INTO TREE.
2970 GOSUB 1340:H=IL:GOSUB 3060:IF H=IL THEN PRINT"<R>ALREADY EXISTS":GOTO2750
2980 GOSUB 1880
2990 : REM: SHOW GRID.
3000 GOSUB 3160
3010 RETURN
3020 : REM: SUBROUTINE TO ADD A WORD TO THE LIST OF WORDS, NM$.
3030 : REM: IF WORD ALREADY IS IN NM$
3040 : REM: THEN CLOSE LOOP AND RETURN.
3050 FOR JJ=2 TO IL
3060 IF WD$=LEFT$(NM$(JJ),LEN(WD$)) THEN ZZ=JJ:JJ=IL:NEXT JJ:RETURN
3080 NEXT JJ
3090 : REM: OTHERWISE ADD THE WORD TO NM$.
3100 ZZ=JJ:IL=JJ:NM$(JJ)=WD$
3110 RETURN
3120 :
3130 : REM: SUBROUTINE TO DISPLAY RESULTS ON GRID.
3140 : REM: ANSWER 'RH' GIVES HARD COPY.
3150 : REM: SET DEVICE # FOR SCREEN OR PRINTER.
3160 DV=3:IF MID$(WD$,2,1)="#" THEN DV=4
3170 : REM: SCREEN OUTPUT LIMITED TO 22 NODES.
3180 IF DV=3 AND MS>0 AND IL>22 THEN RETURN
3190 : REM: IF ON THE 23RD NODE, PRINT ONE-TIME MESSAGE.
3200 MS$="TOO MANY ENTRIES TO DISPLAY GRID ON
3210 IF MS=0 AND IL>23 THEN PRINT MS$:MS=1:RETURN
3220 : REM: SET GRAPHIC CHARACTERS FOR SCREEN OR PRINTER.
3230 LNS=CHR$(219):MK$=CHR$(209):DG$=CHR$(95)
3240 IF DV=4 THEN LNS$="":MK$="X":DG$="<
3250 : REM: OPEN PRINTING FILE.
3260 OPEN 1,DV
3270 : REM: CLEAR SCREEN AND PRINT HEADER.
3280 PRINT "<S>";
3290 PRINT#1,MID$(NM$(1),2):PRINT#1
3300 : REM: SEARCH DOWN TO GET ORDERED LIST OF NODES (GR$) WITHOUT REPEATS.
3310 BR$(0)="":LL=USR(1+DOWN)
3320 : REM: FOR EACH WORD IN TOPOLOGICAL ORDER,
3330 FOR IO=2 TO IL
3340 : REM: REMOVE ARTICLE,
3350 W1$=MID$(NM$(FNG(IO)),5)
3360 : REM: AND TRUNCATE IF TOO LONG.
3370 W1$=MID$(W1$,1,13)
3380 : REM: THEN PRINT ON NEXT ROW, FOLLOWED BY SPACES TO EDGE OF GRID.
3390 PRINT#1:PRINT#1,LEFT$(W1$+SP$,15);
3400 : REM: GENERATE GRID CHARACTERS.
3410 FOR JO=1 TO IO-1:ODX(JO)=ASC(LN$):NEXT JO:ODX(IO)=ASC(DG$)
3420 : REM: SET SPACING INDEX.
3430 JL=1
3440 : REM: GO THROUGH RECEIVER NODES IN EDGE-LIST TO FIND THIS NODE.
3450 FOR JO=2 TO LEN(L$(0)) STEP 2
3460 IF MID$(L$(0),JO,1)<>MID$(GR$(0),IO,1) THEN NEXT JO:GOTO 3550
3470 : REM: NOW FIND SENDER-NODE'S TOPOLOGICAL ORDER,
3480 FOR JU=1 TO LL
3490 IF MID$(L$(0),JO-1,1)<>MID$(GR$(0),JU,1) THEN NEXT JJ
3500 : REM: INSERT A LINK MARK IN THE GRID LINE,
3510 ODX(JU)=ASC(MK$)
3520 : REM: AND CLOSE LOOPS.

```

Tree Analysis (Continued)

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3530 JJ=LL:NEXT JJ,JO
3540 : REM: WHEN LINE IS FINISHED, PRINT IT.
3550 FOR JO=1 TO IO:PRINT#1,CHR$(ODX(JO));NEXT JO
3560 : REM: CONTINUE THROUGH ALL LINES.
3570 NEXT IO
3580 : REM: IF DOING HARD COPY, PRINT OUT NAMES.
3590 IF DV=4 THEN PRINT#1:FOR IO=1 TO IL:PRINT#1,NM$(FNG(IO)):NEXT IO
3600 : REM: CLOSE THE PRINT FILE, AND PRINT A MESSAGE.
3610 CLOSE 1
3620 PRINT"<S>:PRINT "<R>TYPE RETURN":PRINT "<R>TO CONTINUE
3630 : REM: WAIT FOR USER RESPONSE.
3640 GET #0:IF AS$="" THEN 3640
3650 : REM: CLEAR SCREEN AND RETURN TO ELICITATION.
3660 PRINT "<S>";RETURN
3670 :
3680 : REM: SUBROUTINE TO REVISE A NODE.
3690 : REM: REMOVE : FROM FRONT OF WORD, ADD ARTICLE, AND FIND IN NM$ LIST.
3700 WD$=RIGHT$(WD$,LEN(WD$)-1):K=IL:GOSUB 1340:GOSUB 3060
3710 : REM: ABORT IF WORD WAS NOT IN NM$ LIST.
3720 IF K<IL THEN NM$(IL)="" :IL=IL-1:PRINT "<R>NOT FOUND":RETURN
3725 PRINT "<S>FOUND":PRINT "<R>NM$(ZZ)
3730 : REM: PRINT MENU.
3740 PRINT "YOU CAN <R><R>HANGE THE NAME,
3750 PRINT " OR <R><R>DELETE THE WORD ENTIRELY,
3760 PRINT "<R>ENTER <R><R> OR <R><R>, OR <R><R>.
3770 GET #0:IF AS$="" OR AS$="C" AND AS$="E" THEN 3770
3780 : REM: GO TO SUBROUTINE FOR DELETION.
3790 IF AS$="D" THEN RETURN
3800 : REM: DO NAME CHANGE.
3810 PRINT "<R>NEW NAME FOR <R>:RIGHT$(NM$(ZZ),LEN(NM$(ZZ))-3)
3820 PRINT "<R>";GOSUB 670
3830 : REM: ADD ARTICLE AND REPLACE.
3840 GOSUB 1340:NM$(ZZ)=WD$
3850 RETURN
3860 :
3870 : REM: SUBROUTINE TO DELETE A NODE.
3880 : REM: PUT NODE TO BE REMOVED ON 'STACK'.
3890 ODX(0)=1:ODX(1)=ZZ
3900 : REM: GET LAST NODE, X, ON STACK.
3910 X=ODX(ODX(0))
3920 : REM: DEFINE ITS DOWN-GRAPH,
3930 BR$(0)="":LL=USR(X+DOWN)
3940 : REM: WITHOUT THE X NODE.
3950 GR$(0)=RIGHT$(GR$(0),L0-1)
3960 : REM: SAVE GR$.
3970 GG$=LEFT$(GR$(0),LEN(GR$(0)))
3972 : REM: WHEN X HAS SUBORDINATES,
3974 IF LEN(GR$(0))=0 THEN 4270
3980 : REM: CONSIDER THE FIRST OF THEM.
3990 J=FNG(1)
4000 : REM: ASK IF NODE J IS TO BE KEPT.
4010 PRINT:PRINT "RETAIN <R>RIGHT$(NM$(J),LEN(NM$(J))-4)"<R>? ":GOSUB 830
4020 : REM: IF NOT, DELETE J RECURSIVELY, THEN START OVER ON X.
4030 IF AS$="N" THEN ODX(0)=ODX(0)+1:ODX(0)=J:GOSUB 3910:GOTO 3910
4040 : REM: IF "YES, GET UP-GRAPH FROM J WITH REPEAT.
4043 BR$(0)="":LL=USR(UP+256)
4044 : REM: DELETE EDGE FROM X TO J.
4050 AS$=CHR$(X+64)+CHR$(J+64)
4060 K=LEN(L$(0))
4070 FOR I=1 TO K STEP 2
4080 B$=MID$(L$(0),I,2)
4090 IF AS$<>B$ THEN NEXT I:GOTO 4210
4100 AS$="":IF I>1 THEN AS$=LEFT$(L$(0),I-1)
4110 B$="":IF I<-1 THEN B$=RIGHT$(L$(0),K-I-1)
4120 L$(0)=AS$+B$
4130 I=K:NEXT I
4140 : REM: AND USE UP-LINKS OF X TO DEFINE UP-LINKS OF J.

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Tree Analysis (Continued)

```

2840 PRINT W1$RIGHT$(NM$(IP),LEN(NM$(IP))-1)";
2850 : REM: PRINT IMMEDIATE SUBORDINATES OF NODE IP.
2860 FOR I=1 TO LEN(L$(0)) STEP 2
2870 IF CHR$(IP+64)=MID$(L$(0),I,1) THEN PRINT " NM$(FNL(I+1))
2880 NEXT I
2890 : REM: PRINT ELICITATION QUESTION AND GET ANSWER.
2900 PRINT:PRINT " WHAT IS A MORE GENERAL TERM FOR
2910 PRINT " SOME OF THESE (<R>=<R>: SKIP)":GOSUB 670
2920 : REM: PERMIT SKIP.
2930 IF WD$=" $" THEN RETURN
2940 : REM: ACCEPT PRINT-GRID COMMAND.
2950 IF LEFT$(WD$,1)="#" THEN GOSUB 3160:GOTO 2750
2960 : REM: ADD AN ARTICLE TO NEW WORD, ENTER IN NM$, AND LINK IT INTO TREE.
2970 GOSUB 1340:H=L:GOSUB 3060:IF H=L THEN PRINT"<R>ALREADY EXISTS":GOTO2750
2980 GOSUB 1880
2990 : REM: SHOW GRID.
3000 GOSUB 3160
3010 RETURN
3020 : REM: SUBROUTINE TO ADD A WORD TO THE LIST OF WORDS, NM$.
3040 : REM: IF WORD ALREADY IS IN NM$
3050 : REM: THEN CLOSE LOOP AND RETURN.
3060 FOR JJ=2 TO IL
3070 IF WD$=LEFT$(NM$(JJ),LEN(WD$)) THEN ZZ=JJ:JJ=IL:NEXT JJ:RETURN
3080 NEXT JJ
3090 : REM: OTHERWISE ADD THE WORD TO NM$.
3100 ZZ=JJ:IL=JJ:NM$(JJ)=WD$
3110 RETURN
3120 :
3130 : REM: SUBROUTINE TO DISPLAY RESULTS ON GRID.
3140 : REM: ANSWER 'RH' GIVES HARD COPY.
3150 : REM: SET DEVICE # FOR SCREEN OR PRINTER.
3160 DV=3:IF MID$(WD$,2,1)="#" THEN DV=4
3170 : REM: SCREEN OUTPUT LIMITED TO 22 NODES.
3180 IF DV=3 AND MS>0 AND IL>22 THEN RETURN
3190 : REM: IF ON THE 23RD NODE, PRINT ONE-TIME MESSAGE.
3200 MS$="TOO MANY ENTRIES TO DISPLAY GRID ON
3210 IF MS=0 AND IL>23 THEN PRINT MS$:MS=1:RETURN
3220 : REM: SET GRAPHIC CHARACTERS FOR SCREEN OR PRINTER.
3230 LNS=CHR$(219):MK$=CHR$(209):DG$=CHR$(95)
3240 IF DV=4 THEN LNS$="":MK$="X":DG$="<
3250 : REM: OPEN PRINTING FILE.
3260 OPEN 1,DV
3270 : REM: CLEAR SCREEN AND PRINT HEADER.
3280 PRINT "<S>";
3290 PRINT#1,MID$(NM$(1),2):PRINT#1
3300 : REM: SEARCH DOWN TO GET ORDERED LIST OF NODES (GR$) WITHOUT REPEATS.
3310 BR$(0)="" :LL=USR(1+DOWN)
3320 : REM: FOR EACH WORD IN TOPOLOGICAL ORDER,
3330 FOR IO=2 TO IL
3340 : REM: REMOVE ARTICLE,
3350 W1$=MID$(NM$(FNG(IO)),5)
3360 : REM: AND TRUNCATE IF TOO LONG.
3370 W1$=MID$(W1$,1,13)
3380 : REM: THEN PRINT ON NEXT ROW, FOLLOWED BY SPACES TO EDGE OF GRID.
3390 PRINT#1:PRINT#1,LEFT$(W1$+SP$,15);
3400 : REM: GENERATE GRID CHARACTERS.
3410 FOR JO=1 TO IO-1:ODX(JO)=ASC(LN$):NEXT JO:ODX(IO)=ASC(DG$)
3420 : REM: SET SPACING INDEX.
3430 JL=1
3440 : REM: GO THROUGH RECEIVER NODES IN EDGE-LIST TO FIND THIS NODE.
3450 FOR JO=2 TO LEN(L$(0)) STEP 2
3460 IF MID$(L$(0),JO,1)<>MID$(GR$(0),IO,1) THEN NEXT JO:GOTO 3550
3470 : REM: NOW FIND SENDER-NODE'S TOPOLOGICAL ORDER,
3480 FOR JU=1 TO LL
3490 IF MID$(L$(0),JO-1,1)<>MID$(GR$(0),JU,1) THEN NEXT JJ
3500 : REM: INSERT A LINK MARK IN THE GRID LINE,
3510 ODX(JU)=ASC(MK$)
3520 : REM: AND CLOSE LOOPS.

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Tree Analysis (Continued)

```

3530 JJ=LL:NEXT JJ,JO
3540 : REM: WHEN LINE IS FINISHED, PRINT IT.
3550 FOR JO=1 TO IO:PRINT#1,CHR$(ODX(JO));NEXT JO
3560 : REM: CONTINUE THROUGH ALL LINES.
3570 NEXT IO
3580 : REM: IF DOING HARD COPY, PRINT OUT NAMES.
3590 IF DV=4 THEN PRINT#1:FOR IO=1 TO IL:PRINT#1,NM$(FNG(IO)):NEXT IO
3600 : REM: CLOSE THE PRINT FILE, AND PRINT A MESSAGE.
3610 CLOSE 1
3620 PRINT"<S>:PRINT "<R>TYPE RETURN":PRINT "<R>TO CONTINUE
3630 : REM: WAIT FOR USER RESPONSE.
3640 GET #1:IF AS$="" THEN 3640
3650 : REM: CLEAR SCREEN AND RETURN TO ELICITATION.
3660 PRINT "<S>";RETURN
3670 :
3680 : REM: SUBROUTINE TO REVISE A NODE.
3690 : REM: REMOVE : FROM FRONT OF WORD, ADD ARTICLE, AND FIND IN NM$ LIST.
3700 WD$=RIGHT$(WD$,LEN(WD$)-1):K=IL:GOSUB 1340:GOSUB 3060
3710 : REM: ABORT IF WORD WAS NOT IN NM$ LIST.
3720 IF K<IL THEN NM$(IL)="" :IL=IL-1:PRINT "<R>NOT FOUND":RETURN
3725 PRINT "<S>FOUND":PRINT "<R>NM$(ZZ)
3730 : REM: PRINT MENU.
3740 PRINT "YOU CAN <R><R>HANGE THE NAME,
3750 PRINT " OR <R><R>DELETE THE WORD ENTIRELY,
3760 PRINT "<R>ENTER <R><R> OR <R><R>, OR <R><R>.
3770 GET #1:IF AS$="" OR AS$="C" AND AS$="E" THEN 3770
3780 : REM: GO TO SUBROUTINE FOR DELETION.
3790 IF AS$="D" THEN RETURN
3800 : REM: DO NAME CHANGE.
3810 PRINT "<R>NEW NAME FOR <R>:RIGHT$(NM$(ZZ),LEN(NM$(ZZ))-3)
3820 PRINT "<R>";GOSUB 670
3830 : REM: ADD ARTICLE AND REPLACE.
3840 GOSUB 1340:NM$(ZZ)=WD$
3850 RETURN
3860 :
3870 : REM: SUBROUTINE TO DELETE A NODE.
3880 : REM: PUT NODE TO BE REMOVED ON 'STACK'.
3890 ODX(0)=1:ODX(1)=ZZ
3900 : REM: GET LAST NODE, X, ON STACK.
3910 X=ODX(ODX(0))
3920 : REM: DEFINE ITS DOWN-GRAPH,
3930 BR$(0)="" :LL=USR(X+DOWN)
3940 : REM: WITHOUT THE X NODE.
3950 GR$(0)=RIGHT$(GR$(0),L0-1)
3960 : REM: SAVE GR$.
3970 GG$=LEFT$(GR$(0),LEN(GR$(0)))
3972 : REM: WHEN X HAS SUBORDINATES,
3974 IF LEN(GR$(0))=0 THEN 4270
3980 : REM: CONSIDER THE FIRST OF THEM.
3990 J=FNG(1)
4000 : REM: ASK IF NODE J IS TO BE KEPT.
4010 PRINT:PRINT "RETAIN <R>RIGHT$(NM$(J),LEN(NM$(J))-4)"<R>? ":GOSUB 830
4020 : REM: IF NOT, DELETE J RECURSIVELY, THEN START OVER ON X.
4030 IF AS$="N" THEN ODX(0)=ODX(0)+1:ODX(0)=J:GOSUB 3910:GOTO 3910
4040 : REM: IF "YES, GET UP-GRAPH FROM J WITH REPEAT.
4043 BR$(0)="" :LL=USR(UP+256)
4044 : REM: DELETE EDGE FROM X TO J.
4050 AS$=CHR$(X+64)+CHR$(J+64)
4060 K=LEN(L$(0))
4070 FOR I=1 TO K STEP 2
4080 B$=MID$(L$(0),I,2)
4090 IF AS$<>B$ THEN NEXT I:GOTO 4210
4100 AS$="" :IF I>1 THEN AS$=LEFT$(L$(0),I-1)
4110 B$="" :IF I<-1 THEN B$=RIGHT$(L$(0),K-I-1)
4120 L$(0)=AS$+B$
4130 I=K:NEXT I
4140 : REM: AND USE UP-LINKS OF X TO DEFINE UP-LINKS OF J.

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Tree Analysis (continued)

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4150 K=K-2
4160 FOR I=2 TO K STEP 2
4170 IF MID$(L$(0),I,1)<>CHR$(X+64) THEN NEXT I:GOTO 4210
4180 IF MID$(L$(0),I,1)<>CHR$(X+64) THEN NEXT I:GOTO 4210
4190 KK=0
4195 FOR II=1 TO LL
4196 IF MID$(L$(0),I-1,1)=MID$(GR$(0),II,1) THEN KK=KK+1
4197 NEXT II
4198 IF KK>1 THEN 4190
4200 L$(0)=L$(0)+MID$(L$(0),I-1,1)+CHR$(J+64)
4210 NEXT I
4220 L$(0)=LEFT$(GR$(0),LEN(BR$(0)))
4230 L$(0)=LEFT$(GR$(0),LEN(BR$(0)))
4240 : REM: AND CONTINUE WITH OTHER SUBORDINATES OF X.
4250 GOTO 3970
4260 : REM: WHEN X HAS NO SUBORDINATES, REMOVE ITS UP LINKS FROM L$.
4270 K=LEN(L$(0))
4280 FOR I=2 TO K STEP 2
4290 IF MID$(L$(0),I,1)<>CHR$(X+64) THEN NEXT I:GOTO 4350
4300 A$="": IF I>2 THEN A$=LEFT$(L$(0),I-2)
4310 B$="": IF I<K THEN B$=RIGHT$(L$(0),K-I)
4320 L$(0)=A$+B$
4330 I=K:NEXT I:GOTO 4270
4340 : REM: THEN REMOVE THE WORD FROM THE NM$ LIST.
4350 FOR I=X TO 64
4360 NM$(I)=NM$(I+1)
4370 NEXT I:NM$(65)="
4380 IL=IL-1
4390 : REM: LOOK THROUGH L$, AND
4400 FOR I=1 TO K
4410 : REM: IF AN INDEX VALUE IS ABOVE X,
4420 IF FN(I)<X THEN NEXT I:GOTO 4490
4430 : REM: DECREMENT IT TO ADJUST FOR THE DELETED NODE.
4440 A$="": IF I>1 THEN A$=LEFT$(L$(0),I-1)
4450 B$="": IF I<K THEN B$=RIGHT$(L$(0),K-I)
4460 L$(0)=A$+CHR$(ASC(MID$(L$(0),I,1))-1)+B$
4470 NEXT I
4480 : REM: SIMILARLY, ADJUST INDEX VALUES IN THE 'STACK'.
4490 FOR I=1 TO ODZ(0)
4500 IF ODZ(I)>X THEN ODZ(I)=ODZ(I)-1
4510 NEXT I
4520 : REM: REMOVE THE X NODE FROM THE 'STACK'.
4530 ODZ(0)=ODZ(0)-1
4540 : REM: WHEREUPON REMOVAL OF NODE X IS FINISHED.
4550 : REM: RESET SCANNING INDEX.
4560 IP=2
4570 RETURN
4580 :
4590 : REM: SUBROUTINE TO SAVE DATA,
4600 : REM: CALLED BY ENTERING .LABEL OR \LABEL AS A WORD.
4610 : REM: MAKE THE FILE NAME FROM NM$(1) AND THE LABEL.
4620 K=9-TA:IF TA=3 THEN K=4
4630 F$=MID$(ND$,2,7)+". "+MID$(NM$(1),K,8)
4640 : REM: SET UP TAPE SAVE,
4650 DV=1:CH=1
4660 : REM: BUT CHANGE TO DISK SAVE WHEN SLASH PRECEDES LABEL..
4670 IF LEFT$(WD$,1)="/" THEN DV=B:CH=S:FI$="0: "+FI$+".S,W"
4680 : REM: OPEN THE WRITE FILE.
4690 OPEN 1,DV,CH,FI$
4700 : REM: SAVE THE TYPE OF ANALYSIS (FOLLOWED BY 'RETURN'),
4710 PRINT#1,TA;CHR$(13);
4720 : REM: THE NUMBER OF NODES,
4730 PRINT#1,IL;CHR$(13);
4740 : REM: THE NODE NAMES,
4750 FOR I=1 TO IL:PRINT#1,CHR$(34);NM$(I);CHR$(13);:NEXT I
4760 : REM: THE NUMBER OF EDGES,

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4770 PRINT#1,LEN(L$(0))/2;CHR$(13);
4780 : REM: AND THE LIST OF EDGES.
4790 FOR I=1 TO LEN(L$(0)) STEP 2:PRINT#1,MID$(L$(0),I,2);CHR$(13);:NEXT I
4800 : REM: FINISH.
4810 CLOSE 1:RETURN
4820 :
4830 : REM: SUBROUTINE TO READ DATA,
4840 : REM: CALLED BY ENTERING T OR D AT FIRST QUESTION.
4850 : REM: GET THE FILE NAME.
4860 INPUT "<R>FILE NAME<F>:";FI$
4870 : REM: SET UP TAPE READ,
4880 DV=1:CH=0
4890 : REM: BUT CHANGE TO DISK READ WHEN A$=D.
4900 IF WD$="D" THEN DV=B:CH=S:FI$="0: "+FI$+".S,R"
4910 : REM: OPEN THE READ FILE.
4920 OPEN 1,DV,CH,FI$
4930 : REM: GET AND DISPLAY THE TYPE OF ANALYSIS.
4940 INPUT#1,TA:PRINT "<G><G>TYPE OF ANALYSIS =";TA
4950 : REM: THE NUMBER OF NODES,
4960 INPUT#1,IL:PRINT IL;"NODES ARE:"
4970 : REM: THE NODE NAMES,
4980 FOR I=1 TO IL:INPUT#1,NM$(I):PRINT NM$(I);:NEXT I:PRINT
4990 : REM: THE NUMBER OF EDGES,
5000 INPUT#1,LL:PRINT LL;"EDGES:"
5010 : REM: AND THE LIST OF EDGES.
5020 FOR I=1 TO LL:INPUT#1,A$:PRINT A$;:L$(0)=L$(0)+A$:NEXT I:PRINT
5030 : REM: FINISH.
5040 CLOSE 1:ON TA GOSUB 900,1130,1280
5050 RETURN
5060 :
5070 : REM: SUBROUTINE TO DISPLAY COMMONALITIES.
5080 : REM: GET GENERAL DOWN-GRAPH.
5090 BR$(0)="":LL=USR(1+DOWN).
5100 : REM: SHOW NODES IN TYPOLOGICAL ORDER WITH REFERENCE NUMBERS.
5110 FOR I=2 TO IL:PRINT "<R>FNG(I)";:MID$(NM$(FNG(I))+SP$,5,15);:NEXT I
5120 : REM: PROMPT
5130 GG$="":K=1:ODZ(0)=0:PRINT:PRINT"COMMONALITIES FOR WHICH ENTRIES"
5140 INPUT "(ENTER 0 TO END)";ODZ(K):IF ODZ(K)=0 THEN 5210
5150 ODZ(0)=ODZ(0)+1
5160 : REM: CONCATENATE THE UP-GRAPHS.
5170 LL=USR(ODZ(K)+UP)
5180 GG$=GG$+BR$(0)
5190 K=K+1:GOTO 5140
5200 : REM: CREATE A DUMMY SUBORDINATE OF FOCUS NODES.
5210 IL=IL+1:NM$(IL)="00"
5220 FOR I=1 TO ODZ(0):L$(0)=L$(0)+CHR$(ODZ(I)+64)+CHR$(IL+64):NEXT I
5230 : REM: ELIMINATE IRRELEVANT NODES FROM GG$ BY TAKING UP-GRAPH FROM 00.
5240 FOR I=1 TO ODZ(0)-1
5250 BR$(0)=LEFT$(GG$+""",LEN(GG$))
5260 GG$=LEFT$(BR$(0),LEN(BR$(0)))
5270 : REM: REPEAT IF MORE THAN TWO FOCUS NODES.
5280 NEXT I
5290 : REM: LOWEST NODE OF GG$ IS A COMMONALITY.
5300 K=ASC(RIGHT$(GG$,1))-64
5310 PRINT:PRINT"COMMONALITY=";NM$(K)
5320 : REM: ELIMINATE ITS UP-GRAPH
5330 BR$(0)=LEFT$(GG$+""",LEN(GG$))
5340 GG$=LEFT$(BR$(0),LEN(BR$(0)))
5350 : REM: FIND SUBORDINATES LEADING TO EACH FOCUS NODE.
5360 FOR J=1 TO ODZ(0)
5370 : REM: PRINT RELEVANT FOCAL NODE AND ITS SUBCOMMONALITIES.
5380 PRINT "FOR";NM$(ODZ(J));
5390 : REM: GET UP-GRAPH FROM FOCUS NODE.
5400 BR$(0)="":LL=USR(ODZ(J)+UP):A$=LEFT$(BR$(0),LEN(BR$(0)))
5410 : REM: GET DOWN-GRAPH FROM COMMON NODE.
5420 LL=USR(K+DOWN):B$=LEFT$(BR$(0),LEN(BR$(0)))
5430 : REM: SUBTRACT DOWN-GRAPH FROM SUBORDINATE OF COMMON NODE:

```







Trees (continued)

```

3EF1- A9 00      2400 DI      LDA #0      ;BUT IF SEARCHING DOWN,
REQ STOREV      ;INSERT AN INY COMMAND,
LDA #200        STA CMD
3EF3- F0 06      2410          DEY ;
3EF5- A8 08      2420          STX *+1
3EF7- 80 0E 3F  2430 STOREV   ;START GRAPH WITH NODE
3EF9- 88 06 3F  2440          LDA #0      ;GIVEN AS STARTING POINT.
3EEB- A2 00      2460          STA GRAPH,X ;STORE THE CURRENT NODE IN GR$.
3F00- A9 00      2470 SP      LDA #0      ;INITIALIZE Y.
3F02- 9D 7A 02  2480 BUILDGR LDY #0      ;IF CURRENT GR$ NODE = NEXT L$ NODE
3F05- 40 00      2500          CMP (NAME),Y
3F07- D1 42      2510 SEARCHL  BNE NEXTEDGE
3F09- D0 19      2520          PHA ;
3F0B- 48          2530          ;PUT NODE
3F0C- 98          2540          ;AND ITS L$ POSITION
3F0D- 48          2550          ;ON STACK.
3F0E- 88          2560 CMD      DEY ;
3F0F- B1 42      2570          ;(DEY FOR UP SEARCH, INY FOR DOWN..)
3F11- A0 00      2590 RE      LDA (NAME),Y
3F13- D0 0C      2600          LDY #0      ;IF REPEATS ARE NOT WANTED
3F15- 48          2610          BNE PUTV IN ;(TRANSFER X TO Y.)
3F16- 8A          2620          PHA ;
3F17- A8          2630          TXA ;
3F18- 68          2640          PLA ;
3F19- D9 7A 02  2650 UNIQUE  CMP GRAPH,X ;AND NODE ALREADY IS IN GR$
3F1C- F0 11      2660          BEQ BACKUP ;THEN CONTINUE SEARCH.
3F1E- 88          2670          DEY ;
3F1F- 10 F8      2680          BPL UNIQUE
3F21- E8          2690 PUTV IN INX ;
3F22- 10 DE      2700          ;OTHERWISE MAKE IT THE
BPL BUILDGR    ;NEW CURRENT NODE IN GR$.
3F24- C0 00      2720 NEXTEDGE  CPY #0
3F26- F0 07      2730          BEQ BACKUP
3F28- 88          2740          DEY ;
3F29- F0 04      2750          BEQ BACKUP
3F2B- 88          2760          DEY ;
3F2C- 4C 07 3F  2770          JMP SEARCHL ;CONTINUE SEARCHING L$, OR
3F2E- 68          2780 BACKUP  PLA ;
3F30- A8          2790          TXA ;
3F31- 68          2800          PLA ;
3F32- 10 F0      2820          ;AND CONTINUE THAT SEARCH.
3F34- E8          2840          INX ;
3F35- 8E 4D 3F  2850          STX GL+1 ;SEARCH IS DONE IF STACK IS EMPTY.
3F38- 8A          2860          TXA ; ;STORE GR$ LENGTH FOR RECALL.
3F39- A8          2870          TAY ; ;RETURN GR$ LENGTH IN USR.
3F3A- A9 00      2880          LDA #0
3F3C- 20 6D D2  2900          JSR INTFLP
3F3E- A9 07      2910          LDA #0'G' ;GET POINTER TO GR$ HEADER.
3F41- 85 42      2920          STA #NAME
3F43- A9 52      2930          ORA #128
3F45- 09 80      2940          STA #NHE+1
3F47- 85 43      2950          JSR FIND
3F49- 20 1D 3E  2960          LDA #0 ;STORE LENGTH OF GR$
3F4C- A9 00      2970          LDA #1
3F4E- A0 01      2980          STA (LA,POINTER),Y
3F50- 91 54      2990          INY ; ;AND POSITION OF GR$.
3F52- C8          3000          LDA #L,GRAPH
3F53- A9 7A      3010          STA (LA,POINTER),Y
3F55- 91 54      3020          INY ;
3F57- C8          3030          LDA #H,GRAPH
3F58- A9 02      3040          STA (LA,POINTER),Y
3F5A- 91 54      3050          PUT GR$ IN TOPOLOGICAL ORDER.
3F5C- 60          3080          ;
    
```

Trees (continued)

```

3F5D- A0 00      3090 REORDER  LDY #0
3F5F- 8C 66 3F  3100          STY IAGR+1 ;START WITH 1ST ELEMENT IN TLIST
LDA TLIST,Y    ;AND GR$.
3F62- B9 B3 03  3110 TORDER  LDA TLIST,Y ;GET NODE FROM TLIST.
LDX #0         ;COMPARE TO UNORDERED NODE
3F67- DD 7A 02  3130 FINDANODE CMP GRAPH,X ;IN GR$.
3F6A- D0 1D      3140          BNE NEXTGR ;IF IT MATCHES
3F6C- 48          3150          PHA ;
3F6D- 8E 88 3F  3160          STX JAGR+1 ;STORE SEARCH PARAMETERS.
3F70- F0 09      3170          BEQ SHIFT ;TRANSFER GR$ NODE FROM OLD POSITION
3F72- CA          3180 DO\SHIFT ;TO NEXT ORDERED POSITION.
3F73- BD 7A 02  3190          LDA GRAPH,X
3F76- E8          3200          INX ;
3F77- 9D 7A 02  3210          STA GRAPH,X
3F7A- CA          3220          DEY ;
3F7B- 8C 66 3F  3230          CPX IAGR+1
3F7E- D0 F2      3240          BNE DO\SHIFT
3F80- E6 66 3F  3250          STX IAGR+1 ;MOVE START OF UNORDERED PART OF GR$.
3F83- 68          3260          PLA ; ;MOVE THE ORIGINAL CHARACTER.
3F84- 9D 7A 02  3270          STA GRAPH,X ;CONTINUE SEARCH TO END OF GR$.
LDA #0         ;(LENGTH OF GR$)
3F87- A2 00      3280 JGR      INX ;
3F89- E8          3290 NEXTGR  BNE FINDANODE
3F8D- D0 D8      3310          INY ; ;ADVANCE IN TLIST.
3F8F- C8          3320          CPY LL+1 ;(# OF NODES)
3F90- CC B0 3E  3330          BNE TORDER
3F93- D0 CD      3340          RTS
3F95- 60          3350          ;
3F96- A9 42      3370          ; *****
3F98- 85 42      3380          ; REMOVE GR$ NODES FROM BR$
3F99- A9 52      3400          ; ;FIND BR$.
LDA #1'R'     ;
3F9C- 09 80      3420          ORA #128
3F9E- 85 43      3430          STA #NAME+1
3FA0- 20 1D 3E  3440          JSR FIND
3FA3- AE 4D 3F  3450          LDX GL+1 ;GET LENGTH OF GR$.
3FA6- CA          3460          DEY ; ;SET CURRENT LENGTH OF BR$
3FAI- AC 8A 3E  3470          LDY LL+1 ; ;AS LOOP LIMITER.
3FAH- C8          3480          INY ;
3FAB- 8C D5 3F  3490          STY BR\END+1 ;SET INDEXES FOR REWRITING BR$.
LDA #0         ;
3FAD- A0 00      3500          ; ;
3FBD- 8C BA 3F  3510          ; ;
3FB3- 8C D3 3F  3520          ; ;
3FB6- B8          3530          CLV ; ;CLEAR FLAG FOR COPYING.
3FB7- B1 42      3540          ; ;READ CHARACTER FROM BR$
3FB9- A0 00      3550          ; ;AND REWRITE IT FOR NEW VERSION.
3FBB- 91 42      3570          STA (NAME),Y
3FBD- 70 D0      3580          BVS COPY ;IF CHARACTER IS NOT DELETED YET
3FBE- DD 7A 02  3590          CMP GRAPH,X ;AND IS SAME AS THE GR$ CHARACTER,
3FC2- D0 08      3600          BNE COPY ;
3FC4- CE 8A 3E  3610          ; ;DECREMENT BR$ LENGTH
3FC7- 2C E5 3E  3620          BIT TRACE+1 ;AND SET THE FLAG FOR COPYING.
3FCA- 70 03      3630          BVS BUMP\OLD ;OTHERWISE INCREMENT WRITE INDEX
3FCC- EE BA 3F  3650          ; ;
3FCE- EE D3 3F  3660          ; ;
3FD2- A0 00      3670 BUMP\OLD ;ALWAYS INCREMENT READ INDEX,
3FD4- C0 00      3680 OLD\BR  LDY #0
3FD8- D0 DF      3690 BR\END  CPY 40 ;AND CONTINUE THROUGH BR$.
3FDB- E0 00      3700          BNE REWRITE ;
3FDD- E0 00      3710          CPX #0 ;REPEAT FOR NEXT GR$ CHARACTER.
3FDE- D0 CA      3720          BNE STARTV ;STORE FINAL LENGTH OF BR$
3FDF- A0 01      3730          LDA LL+1 ;IN BR$ HEADER.
3FE1- 91 54      3750          STA (LA,POINTER),Y
3FE3- 60          3760          RTS
    
```

MICRO





# sensational software



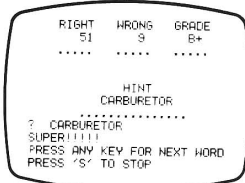
## CAI Programs Vol I

Cassette CS-4201 \$11.95

Requires 16K Apple II or Apple II Plus



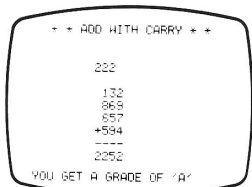
**U.S. Map.** Identify states and their capitals.



**Spelling.** Study aid with your list of troublesome words.



**Math Drill.** Arithmetic drill and practice with large or small display.



**Add With Carry.** Drill and practice on sums requiring numbers to be carried.

## Ecology Simulations - I

Disk CS-4706, \$24.95

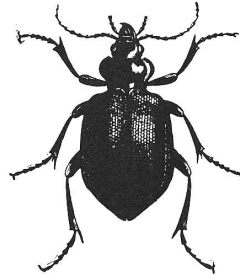
Requires 48K Applesoft in ROM or Apple II Plus

**Sterl**  
STERL allows you to investigate the effectiveness of two different methods of pest control—the use of pesticides and the release of sterile males into a screw-worm fly population. The concept of a more environmentally sound approach versus traditional chemical methods is introduced. In addition, STERL demonstrates the effectiveness of an integrated approach over either alternative by itself.

**Pop**  
The POP series of models examines three different methods of population projection, including exponential, S-shaped or logistical, and logistical with low density effects. At the same time the programs introduce the concept of successive refinement of a model, since each POP model adds more details than the previous one.

**TAG**  
TAG simulates the tagging and recovery method that is used by scientists to estimate animal populations. You attempt to estimate the bass population in a warm-water, bass-bluegill farm pond. Tagged fish are released in the pond and samples are recovered at timed intervals. By presenting a detailed simulation of real sampling by "tagging and recovery," TAG helps you to understand this process.

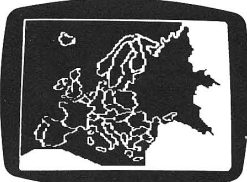
**Buffalo**  
BUFFALO simulates the yearly cycle of buffalo population growth and decline, and allows you to investigate the effects of different herd management policies. Simulations such as BUFFALO allow you to explore "what if" questions and experiment with approaches that might be disastrous in real life.



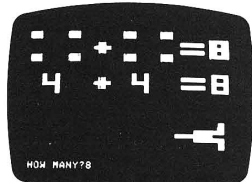
## CAI Programs Vol II

Cassette CS-4202 \$11.95

Requires 16K Apple II or Apple II Plus



**European Map.** Identify countries and their capitals.



**Meteor Math.** Learn math skills by destroying menacing meteors.

**Music Composing Aid.** Make and play your own music on the Apple. No additional hardware required. Includes a sample from Bach's Tocatta & Fugue in D minor.



## Ecology Simulations - II

Disk CS-4707 \$24.95

Requires 48K Applesoft in ROM or Apple II Plus

**Pollute**  
POLLUTE focuses on one part of the water pollution problem; the accumulation of certain waste materials in waterways and their effect on dissolved oxygen levels in the water. You can use the computer to investigate the effects of different variables such as the body of water, temperature, and the rate of dumping waste material. Various types of primary and secondary waste treatment, as well as the impact of scientific and economic decisions can be examined.

**Rats**  
In RATS, you play the role of a Health Department official devising an effective, practical plan to control rats. The plan may combine the use of sanitation and slow kill and quick kill poisons to eliminate a rat population. It is also possible to change the initial population size, growth rate, and whether the simulation will take place in an apartment building or an entire city.

**Malaria**  
With MALARIA, you are a Health Official trying to control a malaria epidemic while taking into account financial considerations in setting up a program. The budgeted use of field hospitals, drugs for the ill, three types of pesticides, and preventative medication, must be properly combined for an effective control program.

**Diet**  
DIET is designed to explore the effect of four basic substances, protein, lipids, calories and carbohydrates, on your diet. You enter a list of the types and amounts of food eaten in a typical day, as well as your age, weight, sex, health and a physical activity factor. DIET is particularly valuable in indicating how a diet can be changed to raise or lower body weights and provide proper nutrition.



### CAI Programs I and II

Disk CS-4701, \$24.95  
Requires 32K Integer Basic

This disk contains all 7 programs from cassettes CS-4201 and CS-4202.

**Note:** The ecology simulations programs are not available on cassette.

### Stock & Options Analysis

Disk CS-4801, \$99.95  
Requires 32K Applesoft or Apple II Plus

This is a comprehensive set of four programs for the investment strategy of hedging listed options against common stocks. A complete description is in the TRS-80 section. Available August 1981.

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# PET Menu and Tape Timer

by Dale De Priest

This article describes a menu program that allows rapid access to any program on either side of a cassette tape. In addition, a tape timer is presented that supplies the fast forward times for the menu program. These two programs feature advanced cassette control and use the WAIT command extensively.

**MENU and TAPE TIMER**  
require:  
PET  
cassette

Every disk operating system has a way of maintaining a directory or menu on each disk. This directory allows you to find out the names of all the programs on the disk, and allows the disk operating system to locate these programs. A workable tape operating system should also provide a directory for its tapes.

The PET operating system is capable of locating and loading programs from tape but it is slow. We need some way to index the programs so that they can be located with the fast-forward mode. Unfortunately Commodore didn't provide for an index counter on their tape drive. So, I decided to develop a program to simulate an index counter and the directory or menu operation.

## Menu Program

My original goal in creating the menu program was to provide a loader that would allow you to access any portion of the tape in as much time as it would take to get to the second program on a conventional tape. Since an average program takes about 90 seconds to load, I needed a program that would load in 30 seconds, thereby allowing 60 seconds for the fast-forward time.

Listing 1

```

50 REM DOCUMENTED SAMPLE MENU PROGRAM
52 REM WRITTEN BY DALE DE PRIEST
54 :
56 :
58 REM VARIABLE USAGE
60 REM A = INPUT NUMERIC VALUE
62 REM B = LOCATION OF INPUT BUFFER
64 REM C = CASSETTE #1 SWITCH FLAG
66 REM D = ADDRESS POINTING TO NUMBER OF CHARACTERS IN INPUT BUFFER
68 REM F = NUMBER OF PROGRAMS ON THIS ENTIRE TAPE
70 REM G = THE NUMBER OF THE FIRST PROGRAM ON THE OTHER SIDE
72 REM J = VARIABLE FOR 'FOR' LOOP
74 REM T1 = TIME AT THE BEGINNING OF THE SEARCH
76 REM A$ = INPUT VARIABLE
78 REM B$ = A MESSAGE
80 REM C$ = THE LOAD/RUN COMMAND STRING
82 REM A$(F) = NAMES OF ALL THE PROGRAMS ON THIS TAPE
84 REM A(F) = FAST FORWARD SEARCH TIMES FOR EACH PROGRAM
86 :           IN TENTHS OF SECONDS
88 :
90 REM INITIALIZE AND RANDOMIZE THE RANDOM NUMBER GENERATOR
100 F=36:G=20:A=RND(-T1):PRINT"MENU":DIM A$(F),A(F)
106 :
108 REM CORRECT ADDRESSES FOR OLD AND NEW ROMS
110 B=527:C=519:D=525:IFPEEK(5E4)THEN D=158:B=623:C=249
116 :
118 REM PRINT THE NAMES OF ALL THE PROGRAMS AND THE SELECTION NUMBER
120 FORJ=1TOF:IFJ=21THENPRINT"END"
130 READA$(J):READA(J):IFJ>20THENPRINTTAB(20);
140 PRINTJ:A$(J):NEXT:IFF>20THENFORJ=FTO39:PRINT:NEXT
150 PRINT"ENTER THE NUMBER BESIDE THEM"
156 :
158 REM THE 4 BLANKS AFTER 'WISH' ARE SHIFTED BLANKS
160 INPUT"PROGRAM YOU WISH   ████";A$:A=VAL(A$):IFAC<10RA>FTHEN160
170 IFA<A><1THEN200
176 :
178 REM THIS SIMULATES THE RUN/STOP KEY
180 C$="LOAD"+CHR$(13)+"RUN"+CHR$(13):FORJ=0TO8:POKEB+J,ASC(MID$(C$,J+1))
190 NEXT:POKE D,J:END
198 :
200 B$="PLEASE PRESS STOP ON THE CASSETTE":PRINTB$:WAIT59400.16
206 :
208 REM THE OPERATING SYSTEM AUTOMATICALLY GIVES MOTOR CONTROL TO THE USER
210 PRINT"PRESS THE FAST FWD BUTTON":WAIT59400.16.16
216 :
218 REM THE POKE RETURNS MOTOR CONTROL BACK TO THE COMPUTER
220 PRINT"LOOKING FOR "A$(A):POKEC,52:T1=T1
240 IFT1-T1<A>#6THEN240
246 :
248 REM THE COMPUTER ACTUALLY STOPS THE TAPE MOTION
250 POKE59411,61:PRINT" "MID$(B$,9):WAIT59400.16:IFAC<GTHEN180
260 PRINT"TURN THE CASSETTE OVER":FORJ=1TO3000:NEXTJ:GOTO180
496 :
498 REM SAMPLE NAMES AND SEARCH TIMES
500 DATA COVER1,1,NAB1,52,FIRE!,133,ALIENS!,195,BONZO!,246,CATCH!,309
510 DATA COVER17,349,POLICE!,393,SPOT,460,RULER,507,LETTER,539,MERGE,594
520 DATA PACK,630,COVER18,661,DROMEDA!,691,JOUST,750,WEATHER,797
530 DATA HI RES,856,SHEEP,900
536 :
538 REM THESE PROGRAMS ARE ON THE BACK SIDE OF THE TAPE
540 DATA COVER19,938,FROG!,896,GODZILLA!,847,MINER!,795,RAIL,746,BOOKA,703
550 DATA BOOKB,663,COVER20,617,MUSIC!,584,BETS,528,CHECKERS,470
560 DATA CURVES,420,EQUIP,375,COVER21!,304,CAPTURE!,239,DANCE!,178,
  BOSWAIN,93
564 :
566 REM THIS LINE IS NOT USED BY THE PROGRAM BUT PROVIDES DATA
  FOR THE USER IF
568 REM YOU WISH TO ADD AN ADDITIONAL PROGRAM TO THIS TAPE
570 DATA END OF TAPE,948,1790

```

Listing 1 shows the result of this effort. It allows for up to 40 programs to be located on the same tape and will find any one of 30 programs in approximately 60 seconds. This program should be the first program on each of your cassettes, but it could be on a separate tape and contain the menu for several tapes. This would be desirable for tapes such as Cursor Magazine. Several interesting things can be learned from this program, so let me show you how it works.

*Line 100:* The statement `A=RND(-TI)` doesn't have anything to do with the rest of the program. It is simply an easy way to insure that the RND function is randomized for every program on the tape.

*Line 110:* The variable C points to the location of a flag that the PET uses to determine whether it or the user has control of the cassette motor. When you push one of the switches down, the PET turns on the motor for you. Since it believes that the operator should have control, it won't let the program stop the drive unless variable C is changed. A zero in this location means that the operator has control; any other value gives control to the PET.

*Line 170:* By convention the first program after the menu will contain a fast-forward value of one. This means no fast-forward is required.

*Line 180-190:* This is a special trick on the PET. This line stores the two commands LOAD and RUN in the PET's input buffer. You may wonder why the simpler method of

```
180 POKE B, 131:POKE D,1: END
```

is not used. This line forces the PET to respond as if the operator just hit the RUN/STOP key. The PET will load and run the next program. Unfortunately BASIC 4.0 directs this command to the disk, so you must put the command in the buffer yourself to make this program work with all versions of PET software. This technique is frequently useful when one program wants to turn control over to another program.

*Line 200:* This is the mysterious WAIT command. Here it is used to detect whether or not a key has been pressed. 59408 is the address whose contents will change and 16 is the decimal equivalent for the bit (bit 4) which will change to a 1 when the key is pressed. (If the bit were changing from 1 to 0, then the command would be `WAIT 59408,16,16`.)

*Line 500-540:* These lines contain the DATA statements that define the program names and the search times. The names recorded here do not need to be exactly the same as the name the program is stored under. They are only used by this program and not by the actual load routine. When setting up a tape for the first time you may not yet know the names of the programs that you are going to put on that tape. Be sure that you add enough filler to allow room to add these names later. I usually copy the menu from a different tape and then change the names as I need to. Setting F in line 100 will avoid confusion of the real contents of tape and the data that may be present simply to take up space. As each program is added I go back and update the menu program. This is easy since the long leaders prevent wiping out the second program.

This program works fine, but there is no way to easily determine what the fast-forward times should be. Now look at listing 2.

### Tape Timer

This program supplies the fast-forward times for the menu program. In addition, it will provide a listing of your tape along with the load times for each program. The significant details are outlined below.

*Line 120:* This line finds headers and then measures the length of time between them. You should notice that although a program LOAD can distinguish between programs and data, an OPEN cannot. The last statement on the line initializes the program name variable.

*Line 130:* This line shows a method of getting the name of a program or data header into the program. The technique is to build a string right from the header buffer area. This is a useful line of code and shows you how to read beyond the sixteenth character of the header.

*Line 150:* H is the variable that is used to accumulate the time for all programs. Fast forward on a cassette tape is not linear. That is, there is no direct correlation between fast-forward times and normal play times. Although there is probably a mathematical formula that could be developed to calculate this relationship, the program uses a group of straight lines to approximate the curve. It then calculates a proportional relationship between these values. Empirically I have determined that the relationship between H and M for the first 200 seconds is .78.

Therefore if a load time of 100 seconds were measured, then this program would calculate the fast-forward time to be 7.8 seconds. All fast-forward times are calculated in tenths of seconds.

*Lines 160-210:* These lines continue the straight line approximations to the curve. Each value has been determined empirically to stop the tape 10 to 15 seconds in front of a header. This program should be fairly accurate for cassettes up to 60 minutes long. Longer cassettes use thinner tape which will invalidate the times.

*Line 230:* This line assumes that the menu program was stored with the name MENU as the first four characters. This is a convention that I always follow. Checking for this name allows the program to recalibrate itself to do all timings just after the menu load. The program will also work correctly when your program menu is on a different tape since the time is then from the beginning of tape.

*Line 250:* This program assumes that tapes have been properly ended with an end-of-tape header. The search times may then be copied to enter into the menu program. This program uses a feature of the cassette unit that causes it to shut off automatically when it reaches the end of a tape. When this happens, the program calculates the actual length of the tape. If you were to fast-forward the tape from the other end, it would then compute the fast-forward times. These times should be entered on a MENU program located at the beginning of the back side of the tape.

### Putting It All Together

Now that you have seen the two programs, let's see how we can put them to work. First, you must build your tape by putting a MENU on the front of the tape followed by several programs. The tape must end with a file named "END OF TAPE." The easiest way is to type the following command in immediate mode.

```
OPEN1,1,2,"END OF TAPE":CLOSE1
```

Then load the TAPE TIMER program and time the tape. Write the front side search times as well as the names on a piece of paper. Hit the space bar and record the reverse side search times. Load in a copy of the MENU program and modify it with the correct names and reverse search times. Set the values of F and G to the correct values. Store



## PET FEATURE

this new program as the first program on the back side.

Next, fast-forward the tape to the beginning of side one. Change the search times to the correct ones for the front side. Change variable G, and save this new update over the top of the old MENU program. You now have a complete tape that can be searched from either direction. Of course you could also add programs to the back of the tape.

To use this program, rewind the tape to either end. Then simply use the SHIFT/RUN keys to get the MENU program in and running. (This will not work for BASIC 4.0 users.) The MENU program will then do the rest. This way, someone who is not familiar with programming will be able to use your tapes.

### Manual Updating

There will be times when you want to add a program to the end of a tape. Simply position your tape just past the current last program, either by loading or verifying it, and then save your program. Be sure to add a new "END OF

TAPE" header. You could then load in the tape timer and retape your tape. Then go back and update your MENUS. There is an easier way. It takes a little bit of advance planning but it works like a charm.

When the tape timer program finds the end of tape it outputs two things

about that point: the fast-forward search time and the total load time. When you create your menu program for that tape you should add these two numbers to the program. They can be added as additional data statements that are never read or they can be added in a remark. Now when you wish to add a program you will be ready.

### Listing 2

```

10 REM TAPE TIMER
12 REM WRITTEN BY DALE DE PRIEST
14 :
16 :
18 REM VARIABLE USAGE
20 REM C = CASSETTE #1 SWITCH FLAG
22 REM H = ACCUMULATED TOTAL LOAD TIME
24 REM I = VARIABLE FOR 'FOR' LOOP
26 REM J = COUNTER FOR NUMBER OF PROGRAMS
28 REM M = COMPUTED SEARCH TIME
30 REM T1 = INITIAL TIME OF TIMER
32 REM A$(24) = NAMES OF EACH OF THE PROGRAMS
34 REM R(24) = LOAD TIMES FOR EACH OF THE PROGRAMS
36 REM LR = LENGTH OF RECORD IN BYTES
38 :
40 :
50 PRINT"PLEASE INSERT AND START THE TAPE YOU":PRINTTAB(16)
60 PRINT"HIGH TO TIME IN TAPE # 1
62 :
68 REM DEFINE FUNCTION FOR ADDRESS PEEKING AND CORRECT FOR OLD AND NEW ROMS
70 DEFFNAD(C)=PEEK(C)+PEEK(C+1)*256:C=519:IFPEEK(5E4)THENC=249
74 :
76 REM WAIT UNTIL TAPE STOP IS DEPRESSED THEN WAIT FOR THE PLAY BUTTON
78 REM THEN GIVE MOTOR CONTROL BACK TO THE COMPUTER
80 WAITS9408,16:WAITS9408,16,16:POKEC,52
90 DIMA(30),R$(30):A$(0)="BEGINNING OF TAPE "
100 PRINT"NAME SEARCH TIME LOAD TIME
106 :
108 REM ALL TAPES MUST END WITH A FILE NAMED "END OF TAPE"
110 PRINTA$(J):INT(M),IFLEFT$(A$(J),11)="END OF TAPE"THEN250
114 REM INITIALIZE TIME & START THE TAPE MOVING
115 T1=TI:POKE59411,53
116 :
118 REM SPACE OVER THE PROGRAM FILE WITHOUT READING
120 IFTI-T1<LRGOTO120
122 :
124 REM OPEN WILL FIND BOTH PROGRAM AND DATA FILES
125 J=J+1:OPEN1,1:A(J)=(TI-T1)/60:A$(J)=" "
126 :
128 REM THIS LINE FINDS THE PROGRAM NAME FROM THE TAPE HEADER
130 FORI=639TO659:A$(J)=A$(J)+CHR$(PEEK(I)):NEXT:CLOSE1:PRINTINT(A(J))
140 GOSUB150:LR=1:IFPEEK(634)=1THENLR=.0182*60*(FNAD(637)-FNAD(635))+200
145 GOTO110
146 :
148 REM THESE LINES ACTUALLY COMPUTE THE FAST FORWARD TIMES
150 H=H+A(J):M=H:IFM<200THENM=.78*M:GOTO230:REM <200
160 M=M-200:IFM<200THENM=153+.67*M:RETURN:REM 200-400
170 M=M-200:IFM<200THENM=285+.58*M:RETURN:REM 400-600
180 M=M-200:IFM<200THENM=401+.54*M:RETURN:REM 600-800
190 M=M-200:IFM<200THENM=507+.49*M:RETURN:REM 800-1000
200 M=M-200:IFM<200THENM=605+.46*M:RETURN:REM 1000-1200
210 M=M-300:M=740+.42*M:RETURN:REM >1200
230 IFLEFT$(A$(J-1),4)="MENU"THENH=0:M=1
240 RETURN
244 :
246 REM TURN THE MOTOR ON AND WAIT FOR THE AUTO SHUT OFF FEATURE
248 REM "H" NOW REPRESENTS THE TOTAL ACCUMULATED LOAD TIMES
250 T1=TI:POKE59411,53:PRINTINT(H)
260 PRINT"WAIT UNTIL THE PHYSICAL END":WAITS9408,16:H=H+(TI-T1)/60-10
270 PRINT"PRESS SPACE FOR REVERSE SEARCH TIMES":WAITS9410,4,4
276 :
278 REM TOTAL TAPE LENGTH = LOAD TIMES + BLANK TAPE AT END + MENU LOAD TIME
280 IFLEFT$(A$(1),4)="MENU"THENH=H+A(2)
290 PRINT"CORRECTED TAPE LENGTH"INT(H)
296 :
298 REM THE REVERSE SIDE SEARCH TIMES ARE NOW CALCULATED
300 FORI=1TOJ:H=H-A(I):M=H:IFM<200THENM=.78*M:GOTO320
310 GOSUB160:IFM>740THENM=M+3
320 PRINTA$(I):INT(M)
330 IFI/22=INT(I/22)THENPRINT"PRESS SPACE TO CONTINUE":WAITS9410,4,4
340 NEXT

```

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First position the tape to the correct point and then type in the following line to save your program.

```
TI = TI:SAVE "NAME" :?(TI - T)/60
```

The program will save in the normal fashion, but it will also tell you how long it took. Note this time, rewind the tape and load in your menu. The menu can be updated by adding your new program name, changing variables F and G and using the search time number that you had previously entered. Then calculate a new search time for the next addition, add the save time to the accumulated time, and change your note in the program. Use this time and the listing for the tape timer to calculate your new time.

Simply pick the line you need from the choices beginning at line 150. The remarks at the end of each line should make your choice easy, and the PET calculator mode will make the calculation easy. The value of M in the equation is the length of the tape minus the left number in the remark statement. For example, suppose your time to that point is 682 and you just saved an 87-second program. Adding those two numbers gives you 769 seconds. That

places us on line 180 of the listing so we must subtract 600 to get M (169). The new search value is  $401 + .54 * 169$  or 492 (49.2 seconds).

By the way, if the record and play buttons weren't already pressed when you typed in the save command, you'll have to be very careful to get the times to come out right. Type the line in but do not hit the return key. Then push the record and play keys at the same time that you push the return key.

**Final Thoughts**

When typing in the menu program be sure to remove all remarks. Your program will load about twice as fast that way. I hope that you get as much use out of this as I have. These programs have greatly enhanced my use of the PET Tape Operating System.

Dale De Priest is the manager of Circuit Development and Document Control at ISS Sperry Univac. He has an associate degree in Electrical Engineering Technology from Central Technical Institute in Kansas City. He can be contacted at: 611 Galen Drive, San Jose, CA 95123.

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(Continued from page 21)

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(Continued on page 105)



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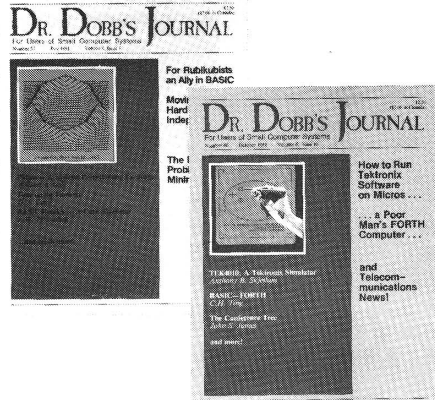
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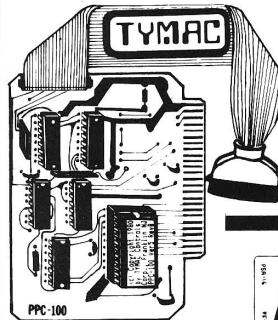
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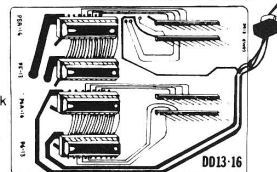
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# MICRO™

## Software Catalog

Name: **Color Editor**  
System: TRS-80C  
Memory: 32K  
Language: Assembly  
Language

Description: *Color Editor* is used for program development and text processing. It allows use of the upper and lower case features of the Color Computer and can print letters or programs on a printer attached to the RS-232 port. It has change and search commands that work on one or all lines and can copy or move sentences or paragraphs anywhere in the file. Lines can be inserted, deleted, or moved. Your work can be saved and later retrieved on cassette.

Price: \$29.95 includes cassette and instructions

Available:  
Computerware  
P.O. Box 668  
Encinitas, CA 92024  
(714) 436-3512

Name: **The Merger  
VisiBlend**  
System: Apple II or Apple II Plus

Memory: 48K  
Language: Applesoft in ROM  
Hardware: Disk II  
Description: *The Merger* is a utility that aids users of *The Data Factory* and *The Invoice Factory*. Merge data from fields in either program into those of another file. *VisiBlend* allows users of *VisiCalc™* to combine the data in multiple *VisiCalc™* files, merging data across files. (*VisiCalc* is a trademark of Personal Software, Inc.)

Price: \$50 each  
Available:  
Micro Lab  
2310 Skokie Valley Rd.  
Highland Park, IL 60035

Name: **PET Library Card  
Maker**  
System: PET  
Memory: 16K  
Language: BASIC  
Hardware: IDS 460 printer  
Description: Prints a full set of library cards on tear-off card stock. The information is

typed once to the PET screen. You can preview the card, make corrections, then with one keystroke, print a set of up to 7 library cards. The program does all the formatting. A tape file can be made. For all small libraries.

Price: \$80 - Canadian  
Includes cassette tape  
Author: J. Horemans

Available:  
M&W Computer Stores  
Sheridan Corporate Centre  
2155 Leanne Blvd., Unit 3  
Mississauga, Ontario  
Canada L5K 2K8

Name: **Inventory System**  
System: OS65U  
Memory: 48K  
Language: BASIC  
Hardware: OSI C-2 or C-3 series

Description: *Inventory System* is an integrated portion of EIS General Accounting Systems. It has perpetual inventory, sales invoicing, accounts receivable, bills of materials, and interrelated purchase orders; information on availability, cost ordering of low or out-of-stock inventory items.

Price: \$1,200.00  
Includes three program disks and a step-by-step user's manual.

Available:  
Electronic Information  
Systems, Inc.  
P.O. Box 5893  
Athens, GA 30604  
(404) 353-2858

Name: **Turf Management**  
System: OSI C4P MF  
Language: BASIC under OSI 65D

Hardware: Disk drive, optional printer  
Description: A program that provides the characteristics of eight common grass species, giving optimum growing conditions, use, techniques for establishment, lime and fertilizer requirements, and pest management and control for general insect and weed problems. Rates of seed required for establishment and amounts of

chemicals needed for each required application can be calculated given the dimensions of the area. The program can be customized to suit the area of the country and availability of chemicals used for fertilizer and pest control.

Price: \$100.00  
Includes 5¼" disk and documentation ppd.  
Modification to operate with other systems can be requested.

Author: J. Benton Jones, Jr.  
Available:  
Benton Laboratories, Inc.  
P.O. Box 5455  
Athens, GA 30604

Name: **SCORE: The  
Academic  
Assistant**

System: Apple II Plus (or Apple II with Applesoft on firmware card)  
Memory: 48K

Language: Applesoft and machine  
Hardware: 80-column printer; optical mark reader (Chatsworth, HEI or Scan-tron) highly recommended

Description: *SCORE* is a comprehensive set of programs which will score multiple choice tests, conduct comprehensive item analyses, maintain academic records, prepare frequency distributions, and individualized student feedback, and much more. This package interfaces the Apple with the Chatsworth, HEI, or Scan-tron optical mark readers.

Price: \$395.00  
Includes program disk, backup disk, data disk, comprehensive manual, ongoing support

Author: Bryan Hendricks, and Bob Bermant

Available:  
Scientific Software Assoc., Ltd.  
P.O. Box 208  
Wausau, WI 54401  
(715) 845-2066

Name: **Napoleon's  
Campaigns: 1813  
& 1815**

System: Apple II  
Memory: 48K  
Language: Applesoft in ROM  
Hardware: Disk Drive  
Description: Corps-level game simulating the last campaigns of Napoleon: Leipzig and Waterloo. Displayed on 18 x 21 hex grid maps in hi-res graphics. Computer acts as corps commander.

Price: \$59.95  
Includes one diskette, rulebook, player aid card, two-sided map boards, 100 counters.

Available:  
Strategic Simulations, Inc.  
465 Fairchild Drive  
Suite 108  
Mountain View, CA 94043

Name: **TRS-80 Color  
Computer  
Learning Lab  
(26-3153)**

System: TRS-80 Color Computer  
Memory: 4K, 16K, 32K  
Language: Color BASIC  
Hardware: Cassette  
Description: A new self-instruction system that teaches user how to program in Color BASIC. Allows student to develop gradually through writing and editing longer, more complex programs. Example programs are practical and can be used for educational, family and personal purposes. The lab is divided into three sections: introduction to the computer; programming the computer; programming guides and tools to make programming easier, faster and more fun. The lessons take full advantage of color graphics and sound available from the TRS-80 Color Computer.

Price: \$49.95  
Includes eight program cassettes and 30-lesson text

Author: Radio Shack  
Available:  
Radio Shack

(Continued on page 94)



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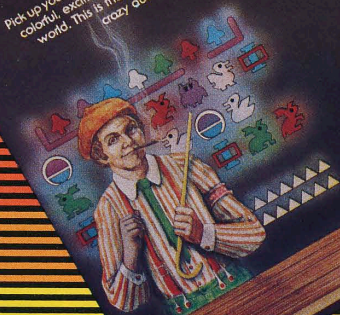
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## Software Catalog (Continued)

**Name:** The Terrapin Logo Language

**System:** Apple II or Apple II Plus

**Memory:** 64K, 48K Apple with 16K memory extension

**Language:** Terrapin Logo Language

**Hardware:** 1 disk drive

**Description:** The Logo language is the most powerful interpretive language ever devised for the Apple II. Yet, it is probably the easiest to use as well. It is designed so that young children can easily control the power of computers without having to know how to program. However, advanced programmers will enjoy the many features common to artificial intelligence research languages permitting programs of great power to be written quickly and easily. (Language is licensed by Mass. Institute of Technology.)

**Price:** \$149.95

Includes language disk, utilities disk and documentation including tutorial and technical manual

**Author:** Leigh Klotz, Pat Sobalvarro, Steve Hain

**Available:**

Terrapin, Inc.  
678 Massachusetts Ave.  
Cambridge, MA 02139  
(617) 492-8816

**Name:** Alkemstone™

**System:** Apple II, Apple II Plus, Apple III

**Memory:** 48K

**Language:** Machine

**Hardware:** DOS 3.3

**Description:** *Alkemstone*, is a computer adventure which offers a \$7500 cash reward to the first person who can recover the missing Alkemstone. The quest for the Alkemstone will lead the player through underground paths of the lair of the original owner. There are unusual messages, fragments of words, sketches and other clues written on the walls. Some items are distributed randomly, so that one may be visible numerous times while some will only appear once in several trips. Each trip will result in a different combination of possible hints. If all bits of information are pieced

together correctly, then the location of the Alkemstone will be obvious.

**Price:** \$39.95

Includes 1 disk, 24-page booklet

**Author:** Level-10

**Available:**

Level-10, a division of Dakin5 Corp.  
7475 Dakin St.  
Denver, CO 80221  
or local Apple dealer

**Name:** Chem Lab Simulations #3 and #4

**System:** Apple II Atari 800

**Memory:** 48K

**Language:** Applesoft or Atari BASIC

**Hardware:** 48K Apple II with disk drive or 40K Atari 800 with disk drive

**Description:** High Technology Software Products, Inc., is pleased to announce the third and fourth additions to its series of chemistry laboratory simulations. *Chem Lab Simulations #3* contains four calorimetry experiments through which Hess' Law is demonstrated. *Chem Lab Simulations #4* utilizes two capillary tube experiments to illustrate principles of thermodynamics. Designed for college-level introductory chemistry courses, these simulations are also well suited for advanced high school students.

**Price:** \$100 each

Includes program diskette, 3-ring binder with complete documentation.

**Author:** J.I. Gelder

**Available:**

High Technology Software Products, Inc.  
2201 N.E. 63rd St.  
P.O. Box 14665  
Oklahoma City, OK 73113  
or computer retailers

**Name:** K-RAZY Shoot-Out

**System:** Atari 400/800

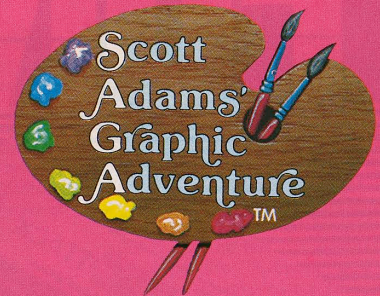
**Memory:** 8K ROM

**Language:** 6502 machine

**Description:** Fast action game.

(Continued on page 96)

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Author: K-BYTE

Available:

K-Byte  
1705 Austin  
Troy, Michigan 48099  
or your dealer

Name: **Debug**  
System: OSI C1P/MF,  
C4/MF

Memory: No Additional

Language: Machine

Description: This machine-code program is used with OSI's Extended Monitor to provide single stepping of your computer to trace machine-code programs one instruction at a time. As you step through the program the display will

show the mnemonic instruction before it is executed in the same form as the disassembler shows it. You can set high and low trace limits; this lets the program execute without displaying the instructions until the address is within these limits. The third feature is the ability to set a breakpoint. This will let you stop execution at any address in memory. This breakpoint, and tracing, can be done in ROM.

Price: \$12.95

Includes 5 1/4" disk, documentation.

Author: Dave Pompea

Available:

DMP Systems  
319 Hampton Blvd.  
Rochester, N.Y. 14612

Name: **UTIL1**  
System: AIM 65  
Memory: 16K  
Language: AIM Assembler  
Hardware: Standard AIM  
Description: *UTIL1* is a 2K extension of the AIM 65 monitor. It interfaces to AIM via the user I/O ports and the user

function key 3. It adds 18 commands to AIM. Eight of these are associated with a Buffer Manager that gives AIM a virtual I/O capability. Up to 8 I/O devices are emulated in RAM. This gives the AIM editor move and copy capability. These I/O devices can be used with any AIM firmware or software that uses the AIM Active Output Device (AOD) and the Active Input Device (AID). An additional 10 commands provide utilities such as memory display, search and move, and an offset loader for AIM object files.

Price: \$25 object on cassette

\$5 16-page manual

\$25 commented assembly listing

Includes object assembled to your specified address.

Should reside at top of RAM. Specify Address.

Author: Joel Swank

Available:

Nehalem Bay Software  
P.O. Box 2006  
Beaverton, OR 97075

Name: **Creature of the Maze**

System: Ohio Scientific

Memory: 8K  
Language: BASIC-in-ROM  
Hardware: Challenger C1P or Superboard Series I or II

Description: Incredibly realistic 3-D graphics lock you into combat with the "Creature of the Maze." Each game starts with a new and different maze, created and displayed for you to ponder, but only for a short moment. Then the screen clears and you find yourself looking down long corridors, peeking around corners and searching for your enemy. The hallways explode with your lazer blasts as the message across the screen spells out, "The monster is near." Tremendous fun with ten skill levels and hundreds of maze sizes to choose from.

Price: \$14.95

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Author: John H. DeRosa

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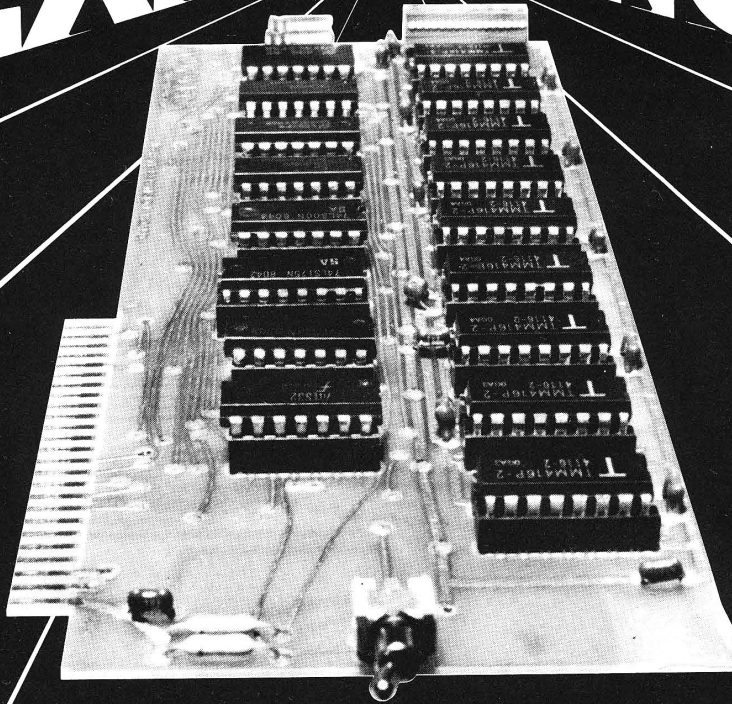
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Questions and answers on the new Super PET based on a 6502 plus 6809.
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The 6809 is much easier to work with than the 6800, and the programs are about 30 percent shorter and run about 30-40 percent faster.  
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The TRS-80 Color Computer is one of the most popular and versatile 6809-based systems to date. An outline of the features is given.
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Wiggs, Chris and Sander-Cederlof, Robert, "6809 Cross Assembler," pg. 12.  
Patches for the S-C Assembler Version 4.0 are available to give a brand new assembler for the 6809.
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Steiner, John, "Lunar Lander," pg. 41-44.  
Animated graphics in BASIC for the 6809-based TRS-80 Color Computer.  
Capouch, Brian, "OS-9 and the 6809: Revolutionary Tools," pg. 81-86.  
The Microware OS-9 operating system is an advanced software package for the 6809. Also described is BASIC09, a high-level programming system (alternative to a BASIC interpreter or compiler). Illustrative listings of a pair of BASIC09 procedures in source code are given.
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Hardenburg, Hal and McVay, Ray, "Concerning the 6502 and 6800," pg. 25-26.  
Notes comparing the 6502, 6809 and the 68000 microprocessors, including a report that the Apple in the future may use the new 68000 microprocessor.
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Walker, Gregory, "Toward a Structured 6809 Assembly Language, Part 1," pg. 370-382.  
An introduction to structured assembly language for the 6809.
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Hardenbergh, Hal W., "To Persons Interested in Both the 6502 and the 6800," pg. 5-14.  
A comparison of the 6502, 6809 and the 68000 microprocessors, including an assembly language program for the 68000 multiply routine.
- 25. Compute! 3, No. 10, Issue 18 (November, 1981)**  
MacLean, Bill, "SuperPET: A Preview," pg. 38-40.  
A rundown on the SuperPET micro which incorporates both the 6502 and the 6809.
- 26. BYTE 6, No. 12 (December, 1981)**  
Barden, William, "Color Computer from A to D," pg. 134-160.  
A detailed look at the Radio Shack TRS-80 Color Computer, based on the 6809 microprocessor.  
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Part 2 discusses implementing a structured assembler.
- 27. KB Microcomputing 5, No. 12, Issue No. 160 (December, 1981)**  
Stark, Peter A., "68XX Secrets," pg. 116-130.  
A review of Dynamite, a good disassembler running on a 6809 FLEX 9 disk operating system. Notes on building a 6809 48K system.
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Anon., "A Look at SuperPET," pg. 130-132.  
Features of the CBM SuperPET and several useful utilities for this 6809-based system.
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Mansfield, Richard, "BRANCH NEVER and QUIF Assembling on SuperPET," pg. 146-149.  
Discussion of using some of the special 6809 statements available when assembling on the SuperPET.
- 30. MICRO No. 44 (January, 1982)**  
Tenny, Ralph, "Experimenters and the Color Computer," pg. 18-22.  
A summary of the normal capabilities of the TRS-80 Color Computer and an examination of the unit's I/O capability. Also information on hardware for I/O use.
- 31. Apple Assembly Line 2, Issue 3 (December, 1981)**  
Sander-Cederlof, Bob, "EXCEL-9: A 6809 Card with FLEX," pg. 1.  
A board with a 6809E CPU, 8K of ROM and an interval timer with built-in linkage routines for calling 6809 routines from Applesoft, Integer BASIC, or from 6502 machine language.
- 32. KB Microcomputing 6, No. 1, Issue 61 (January, 1982)**  
Wolf, Michael A., "Changing Chips in Midstream," pg. 96-100.  
Discussion of the use of the 6809 microprocessor in the Radio Shack Color Computer.
- 33. KB Microcomputing 6, No. 2, Issue 62 (February, 1982)**  
Stark, Peter A., "6800 Secrets," pg. 84-98.  
More bench tests on various microprocessor-equipped systems. Includes several related to the 6809 chip.
- 34. MICRO No. 45 (February, 1982)**  
Garrett, Leo E., "Utilities for the Color Computer," pg. 9-15.  
A versatile routine allowing TRS-80 Color Computer users to dump or disassemble the 6809 or ASCII code in any section of memory, including the BASIC or expansion ROMs.  
Staff, "MICRO Software Catalog," pg. 117-121.  
Includes items of software for 6809 systems.

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### 1. MICRO No. 43 (December, 1981)

Traeger, John C., "Data Collection with Your Micro," pg. 9-11.

How to construct and implement an interface which enables high-speed sampling and recording of experimental data. Written for an AIM 65, it is readily adapted to any 6502 microprocessor with either a 6502 or 6222 interface adapter.

### 2. PEEK(65) 2, No. 12 (December, 1981)

Cook, William H., "Add an 8-Inch Floppy to the C2-4F/C4P," pg. 2-4.

A hardware article for OSI users. Modifications for the 502 CPU board and detailed information on the interconnections of the 470 Floppy Disk Controller board with the disk drive are given. Thirteen signal lines are run to the Siemens FDD 400-8 drive.

### 3. BYTE 6, No. 12 (December, 1981)

Jacobs, Jacob R., "Generating Programs Automatically," pg. 352-362.

Let your Apple II do the programming. Three programs are written in Applesoft BASIC. These utilities help set up your desired program with data entry, data output, instructions, etc. Sample dialogs in running the program are given in the article.

### 4. BYTE 6, No. 12 (December, 1981)

Kopp, Gregory L., "Discovering Atari's 'Hidden' Graphics," pg. 98-102.

Improper graphics commands on the Atari often leads to unexpected results. Some of these undocumented commands may be used to advantage. A chart of useful 'hidden' commands are given and example listings demonstrate the effect.

### 5. Apple-Dayton 2, No. 12 (December, 1981)

Brungart, David L., "Organizing Applesoft," pg. 19-25.

Listing and discussion of a program utility package used to set up temporary utility routines to ease the task of writing Applesoft programs in an orderly manner.

### 6. KB Microcomputing 5, No. 12, Issue No. 60 (December, 1981)

Young, John E., "Poor Man's Memory Expansion for the OSI," pg. 56-60.

An inexpensive way to expand the memory of the Superboard II or Challenger C1P. Instead of using a \$300 OSI 610 expansion board, a method to implement a \$30 16K static RAM board is described.

### 7. Call —A.P.P.L.E. 4, No. 9 (November/December, 1981)

Anon., "Puffin," pg. 13-42.

A DOS to Pascal File Converter for the Apple. A menu of four commands is presented: Catalog, Display, Transfer and Quit. Earlier a program called Huffin to convert Pascal files back to DOS was published [Call —A.P.P.L.E. Oct., 1982].

### 8. Softalk 2, No. 4 (December, 1981)

Coats, Douglas E. and Waldman, Cy H., "FORTRAN," pg. 160-172.

Comparisons of Apple FORTRAN and Microsoft FORTRAN for the Apple. Includes versions using "The Mill" and the Softcard accessories for the Apple.

### 9. Nibble 2, No. 8 (December, 1981)

Exner, Chris; Guy, Rudy; and Harvery, Mike, "Trend Reporting, Analysis, and Control," pg. 7-29.

A group of three extensions to the Apple-based TRAC system. Budget TRAC allows you to be aware of where your money goes, TRAC Spending Graph will graph the data in hi-res, and TRAC Plus shows how to get the best use of the system.

### 10. Creative Computing 7, No. 12 (December, 1981)

Brewster, Keith, "Who's Afraid of the Big Bad Matrix?," pg. 168-173.

Arrays and Matrix operations on the Atari are discussed and illustrated with numerous listings.

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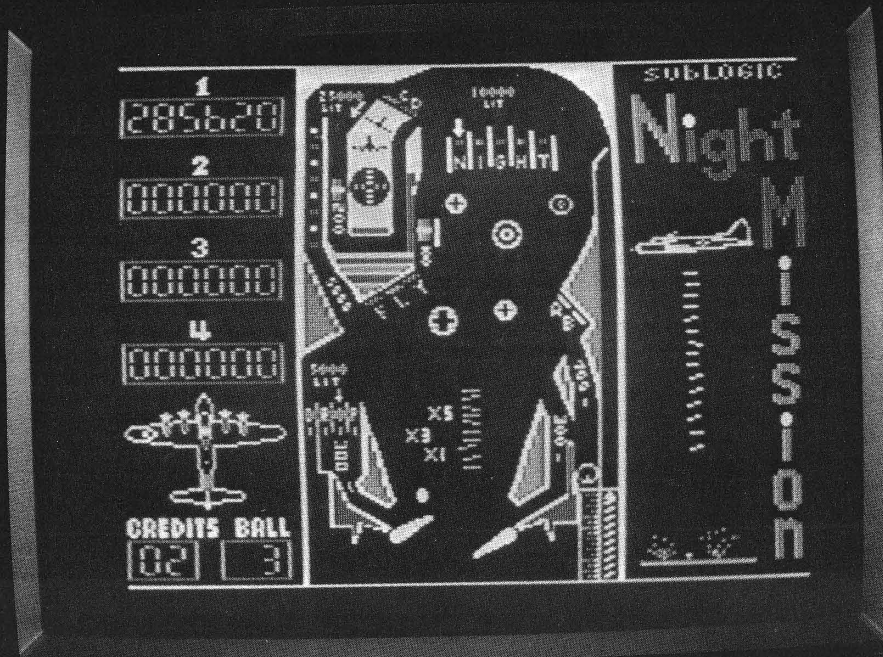
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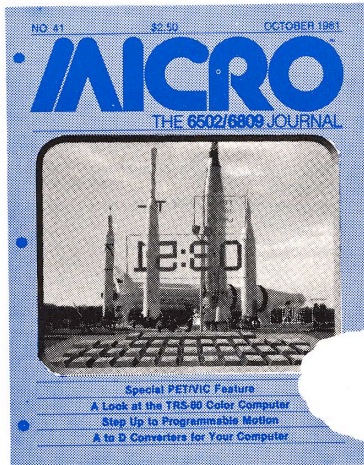
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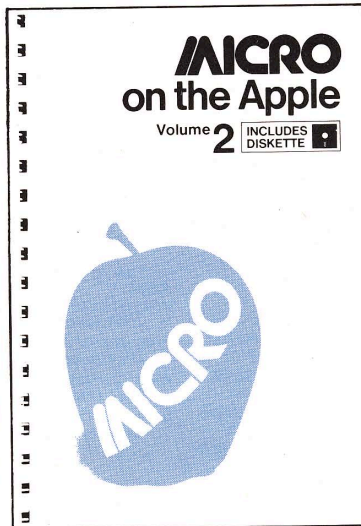
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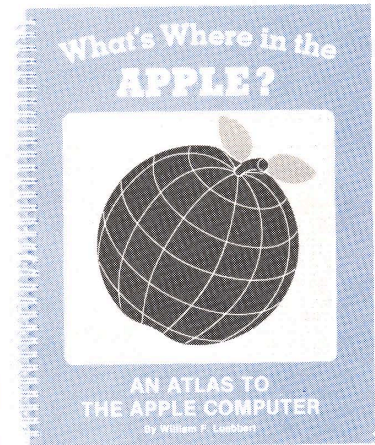
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# PET/CBM

PET — "Personal Electronic Transactor"

CBM — "Commodore Business Machine"

6502-based computer, manufactured by Commodore Business Machines

PET models include graphic keyboard

CBM models include business keyboard

Available in 4K, 8K, 16K, 32K, and 96K configurations

All models, except 8000 series, include 25-row by 40-column screen. 8016, 8032, and 8096 have 25 by 80 screen.

Two 256-character sets — one for graphics, one (with lower case) for business

Memory expansion bus, parallel interface, IEEE-488 instrumentation bus standard

Reliable cassette operating system, powerful screen editing and character-programmable cursor control are characteristic of PET/CBM.

VIC and SuperPET have many features in common with PET/CBM.

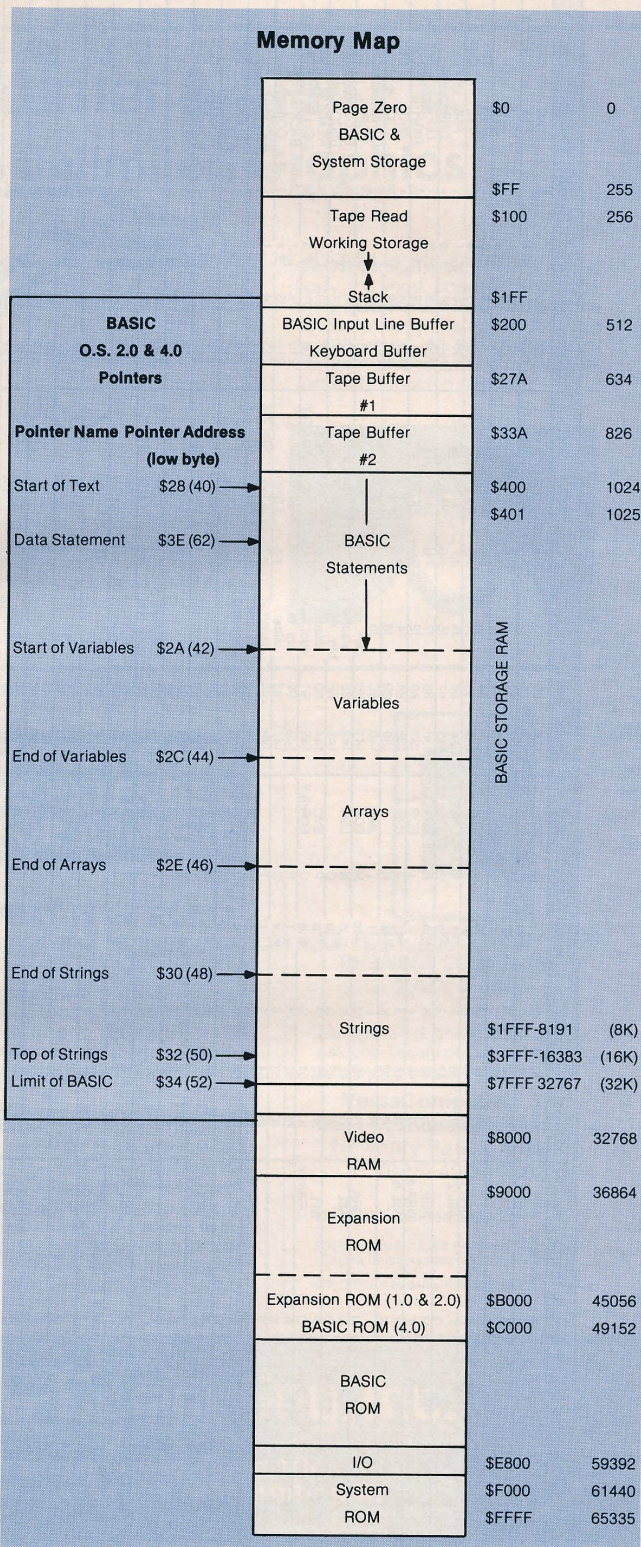
## Parallel Port Connector

Upper Pin Identification Character	Signal Label	Lower Pin Identification Character	Signal Label
1	Ground	A	GND
2	T.V. Video	B	CA1
3	IEEE-SRQ	C	PA0
4	IEEE-EOI	D	PA1
5	Diagnostic Sense	E	PA2
6	Tape #1 READ	F	PA3
7	Tape #2 READ	H	PA4
8	Tape Write	J	PA5
9	T.V. Vertical	K	PA6
10	T.V. Horizontal	L	PA7
11	GND	M	CB2
12	GND	N	GND

## IEEE-488 Connector

PET Edge-card Pin Numbers	Standard IEEE Connector Pin Numbers	IEEE Signal Mnemonic
<b>Upper Pins</b>		
1	1	DI01
2	2	DI02
3	3	DI03
4	4	DI04
5	5	EOI
6	6	DAV
7	7	NRFD
8	8	NDAC
9	9	IFC
10	10	SRQ
11	11	ATN
12	12	GND
<b>Lower Pins</b>		
A	13	DI05
B	14	DI06
C	15	DI07
D	16	DI08
E	17	REN
F	18	GND
H	19	GND
J	20	GND
K	21	GND
L	22	GND
M	23	GND
N	24	GND

## Memory Map



MICRO

PET/CBM

Data Sheet #4



Decimal	Hex	ASCII	Screen	BASIC	6502	Decimal	Hex	ASCII	Screen	BASIC	6502	Decimal	Hex	ASCII	Screen	BASIC	6502	Decimal	Hex	ASCII	Screen	BASIC	6502
0	00		@	end line	BRK ORA(L,X)	64	40	@				128	80		␣	END	STAI(L,X)	192	C0			TAN	CPY #
1	01		A		ORA(L,X)	65	41	A				129	81		␣	FOR		193	C1			ATN	CMPI(Y)
2	02		B			66	42	B				130	82		␣	DATA		194	C2			PEEK	
3	03		C			67	43	C				131	83		␣	NEXT		195	C3			LEN	
4	04		D			68	44	D				132	84		␣	INPUT#		196	C4			STR\$	CPY Z
5	05	white	E		ORA Z	69	45	E				133	85	11	␣	STY Z		197	C5			ASC	DEC Z
6	06		F		ASL Z	70	46	F				134	86	12	␣	REAR		198	C6			CHR\$	
7	07	bell	G			71	47	G				135	87	13	␣	DEY		200	C8			LEFT\$	INY
8	08	lock	H		PHP	72	48	H				136	88	14	␣	ROU		201	C9			RIGHT\$	CMPI #
9	09	unlock	I		ORA #	73	49	I				137	89	15	␣	TXA		202	CA			MID\$	DEX
10	0A		J		ASL A	74	4A	J				138	8A	16	␣	IF		203	CB			MID\$	
11	0B		K			75	4B	K				139	8B	17	␣	RESTORE	STY	204	CC			COCAT	CPY
12	0C		L		ORA	76	4C	L				140	8C	18	␣	STY		205	CD			COCAT	CMPI
13	0D	carf. ret.	M		ASL	77	4D	M				141	8D	19	␣	FORN	STA	206	CE			DOOPEN	CMPI
14	0E	text	N			78	4E	N				142	8E	20	␣	REM		207	CF			DOOPEN	DEC
15	0F	top-left	O		BPL	79	4F	O				143	8F	21	␣	STOP		208	D0			RECORD	
16	10		P		ORA(L,Y)	80	50	P				144	90	22	␣	BOC		209	D1			HEADER	BNE
17	11	cur. down	Q			81	51	Q				145	91	23	␣	ON	STAI(Y)	210	D2			COLLECT	CMPI(Y)
18	12	rev. home	R			82	52	R				146	92	24	␣	WAIT		211	D3			BACKUP	
19	13	cur. home	S			83	53	S				147	93	25	␣	ORAP		212	D4			APPEND	
20	14	delete	T		ORA Z,X	84	54	T				148	94	26	␣	ORAP	STY Z,X	213	D5			DSAVE	CMPI Z,X
21	15	del. line	U		ASL Z,X	85	55	U				149	95	27	␣	ORAP	STY Z,X	214	D6			DLOAD	CMPI Z,X
22	16	erase begin	V			86	56	V				150	96	28	␣	ORAP	SIX Z,X	215	D7			CATALOG	
23	17		W			87	57	W				151	97	29	␣	POKE		216	D8			RENAME	CLD
24	18		X		CLC	88	58	X				152	98	30	␣	PRINT#	TYA	217	D9			SPEATRY	CMPI Y
25	19		Y		ORA Y	89	59	Y				153	99	31	␣	PRINT#	STA Y	218	DA			CMPI Y	
26	1A	scroll up	Z			90	5A	Z				154	9A	32	␣	CONT	TXS	219	DB			CMPI X	
27	1B					91	5B					155	9B	33	␣	CONT	TXS	220	DC			CMPI X	
28	1C	red			ORA X	92	5C					156	9C	34	␣	ORAP	STA X	221	DD			CMPI X	
29	1D	cur. right			ASL X	93	5D					157	9D	35	␣	ORAP		222	DE			CMPI X	
30	1E	blue				94	5E					158	9E	36	␣	ORAP		223	DF			CMPI X	
31	1F	space	space	space	JSR	95	5F					159	9F	37	␣	ORAP		224	E0			CMPI X	
32	20	space	space	space	AND(L,X)	96	60					160	A0	38	␣	ORAP		225	E1			CMPI X	
33	21	space	space	space		97	61					161	A1	39	␣	ORAP		226	E2			CMPI X	
34	22	space	space	space		98	62					162	A2	40	␣	ORAP		227	E3			CMPI X	
35	23	space	space	space		99	63					163	A3	41	␣	ORAP		228	E4			CMPI X	
36	24	space	space	space	BIT Z	100	64					164	A4	42	␣	ORAP		229	E5			CMPI X	
37	25	space	space	space	AND Z	101	65					165	A5	43	␣	ORAP		230	E6			CMPI X	
38	26	space	space	space	ROL Z	102	66					166	A6	44	␣	ORAP		231	E7			CMPI X	
39	27	space	space	space		103	67					167	A7	45	␣	ORAP		232	E8			CMPI X	
40	28	space	space	space		104	68					168	A8	46	␣	ORAP		233	E9			CMPI X	
41	29	space	space	space	PLP	105	69					169	A9	47	␣	ORAP		234	EA			CMPI X	
42	2A	space	space	space	AND #	106	6A					170	AA	48	␣	ORAP		235	EB			CMPI X	
43	2B	space	space	space	ROL #	107	6B					171	AB	49	␣	ORAP		236	EC			CMPI X	
44	2C	space	space	space		108	6C					172	AC	50	␣	ORAP		237	ED			CMPI X	
45	2D	space	space	space	BIT	109	6D					173	AD	51	␣	ORAP		238	EE			CMPI X	
46	2E	space	space	space	AND	110	6E					174	AE	52	␣	ORAP		239	EF			CMPI X	
47	2F	space	space	space	ROL	111	6F					175	AF	53	␣	ORAP		240	F0			CMPI X	
48	30	space	space	space		112	70					176	B0	54	␣	ORAP		241	F1			CMPI X	
49	31	space	space	space	BMI	113	71					177	B1	55	␣	ORAP		242	F2			CMPI X	
50	32	space	space	space	AND(L,Y)	114	72					178	B2	56	␣	ORAP		243	F3			CMPI X	
51	33	space	space	space		115	73					179	B3	57	␣	ORAP		244	F4			CMPI X	
52	34	space	space	space		116	74					180	B4	58	␣	ORAP		245	F5			CMPI X	
53	35	space	space	space	AND Z,X	117	75					181	B5	59	␣	ORAP		246	F6			CMPI X	
54	36	space	space	space	ROL Z,X	118	76					182	B6	60	␣	ORAP		247	F7			CMPI X	
55	37	space	space	space		119	77					183	B7	61	␣	ORAP		248	F8			CMPI X	
56	38	space	space	space		120	78					184	B8	62	␣	ORAP		249	F9			CMPI X	
57	39	space	space	space	SEC	121	79					185	B9	63	␣	ORAP		250	FA			CMPI X	
58	3A	space	space	space	AND Y	122	7A					186	BA	64	␣	ORAP		251	FB			CMPI X	
59	3B	space	space	space	CLI	123	7B					187	BB	65	␣	ORAP		252	FC			CMPI X	
60	3C	space	space	space		124	7C					188	BC	66	␣	ORAP		253	FD			CMPI X	
61	3D	space	space	space	AND X	125	7D					189	BD	67	␣	ORAP		254	FE			CMPI X	
62	3E	space	space	space	ROL X	126	7E					190	BE	68	␣	ORAP		255	FF			CMPI X	
63	3F	space	space	space		127	7F					191	BF	69	␣	ORAP						CMPI X	



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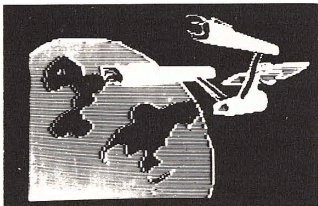
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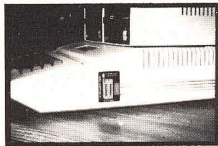
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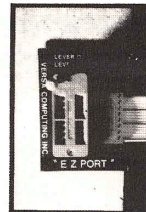
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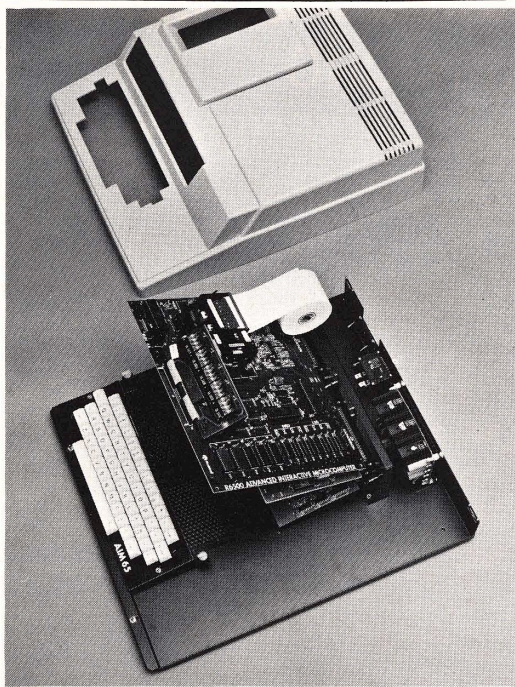
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# Next Month in MICRO

## June Applications Feature

- **A Low-Cost Digitizer for the Apple II** — This article tells you how to use a sheet of half-reflecting plastic to build a digitizer for your high-resolution graphics computer.
- **AIM Logic Trainer** — Test your logic circuits with this program. It allows you to control the inputs and send the outputs to LEDs or printer.
- **Face Synthesizer** — This program creates an animated face on a PET screen that changes expression on keyboard command. Animation can also be controlled from BASIC programs, so the PET face can be used in any application — education, marketing, games, etc.
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July — Apple  
August — Programming Techniques  
September — 68000  
October — Education  
November — Atari/Games  
December — PET

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