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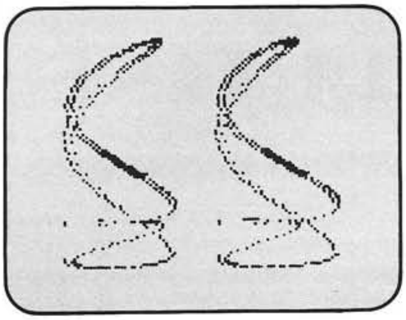

Your Own Roller Coaster!

What is more appropriate this time of year than the midway at a state fair or a trip to the local amusement park? The graphic on this month's cover is probably not immediately recognizable. But then, it is our first three dimensional live action graphic! As the photo suggests, the graphic is of a roller coaster. One of the bonus sections in this month's issue is dedicated to Apple High Resolution Graphics. One article covers the unusual topic of three dimensional moving images. As an example, it shows a roller coaster which you can see moving around its 3D track. So, "Wheeeee...."

Graphic from "True 3-D Images on Apple II" by Art Radcliffe

Photo by Robert Tripp

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MICRO Editorial

Reader Feedback

Many thanks to the readers who took the time to fill out the questionnaire we included in our July issue. We have completed a preliminary analysis and some of the results were very surprising. For instance, we knew that the Apple was the most popular system among our readers, but we didn't suspect that the OSI portion was nearly as high! The proportion of readers using OSI systems at home is approximately equal to that for Apple systems (35.4% *vs.* 35.0%), while the Apple systems are used more at work (18.6% *vs.* 5.8%). The AIM and KIM percentages also came out a little higher than we expected.

Another significant statistic is that more than a quarter of our readers have access to more than one system. Because of this, the percentages below add up to well over 100%.

AIM	13.3%
Apple	50.0%
Atari	6.6%
KIM	14.6%
OSI	39.0%
PET/CBM	12.4%
SYM	6.6%
6809	4.4%
Other	2.7%

Sixty-three percent of our readers have had some formal training in computers, whether it be a masters in computer science or a night course in beginning BASIC. The average hardware level is somewhere between novice and intermediate (43% novice, 44% intermediate, and 12% expert), while the average software level is distinctly intermediate (19% novice, 62% intermediate, and 19% expert).

Readers were asked to rate (with 1 the best and 5 the worst) the various departments that appear in MICRO. Specialized departments such as Micros in Medicine, PET Vet, and the OSI columns, have understandably lower ratings because of the limited number of readers they serve.

Software Catalog	2.3
Hardware Catalog	2.4
Editorial	2.5
Letters	2.5
New Publications	2.6
Bibliography	2.8
OSI columns	3.2
Clubs	3.8
Micros in Medicine	3.9
PET Vet	5.1

Articles overall received higher ratings than departments. The biggest surprise was the lack of interest in Pascal. Specific hardware and software articles received high ratings, but often notes were added: "1 if it's for my system, 5 otherwise."

Specific software	1.8
Specific hardware	2.0
Programming techniques	2.0
BASIC	2.1
Applications	2.1
Assembly language	2.2
Tutorial	2.3
General software	2.4
General hardware	2.7
Pascal	4.0

These results are based on only 225 questionnaires. We have twice as many more to process, and will be doing more analysis to help guide our advertising, promotion, and editorial efforts. We'll keep you updated on new results.

Many readers made specific suggestions and comments. While it is impossible to respond to all of these, you can be assured they all will be read and considered! Thanks again!

Canadian Subscribers:

We hope you've received your August issue by the time you read this. If not, don't despair — it is on the way. Here's the reason for the delay: the post offices here in the U.S. would not accept Canadian mail because of the recent strike and subsequent backlog. However, we will be sending the issues August 17, and they should be in your hands soon!

Letterbox

You'll notice that our letterbox section rated high among readers answering the questionnaire. However, if you check our table of contents this month, you won't find it listed. Unfortunately, we haven't been getting enough general letters to present Letterbox regularly. We ask that you send us your comments, gripes, or thoughts, so we can rejuvenate this popular department.

Loren W Wright

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Jumps and the 6502

The 6502 microprocessor provides a variety of methods for jumping and branching. Several of these methods are not obvious, and can be very useful to the assembly language programmer. A little-known bug in the JMP INDIRECT instruction is also discussed.

Mark Bernstein
12 Oxford Street
Cambridge, Massachusetts 02138

Personal computers are powerful tools for program development, and many programmers have used them to discover the pleasures of machine and assembly language programming. Since current microprocessors are relatively slow, and the available languages (especially BASIC) are even slower, many other computerists find themselves forced to use assembly language routines simply to get the job done. Fortunately, personal computers are powerful tools for developing assembly language routines.

Since the personal computer is completely dedicated to its user, developing machine language routines is simple and often pleasant. Load a monitor or assembler, type in a section of code, and run it! If the program is correct, the results will be as expected. If the program is wrong, testing will reveal incorrect or unexpected results. Looking at the program listing should uncover the defect.

However, certain instructions are fraught with special difficulties. Whenever an instruction transfers control from one segment of program code to another, the instructions responsible must be *perfect* the first time. If an LDA or SBC instruction is misplaced or operates on the wrong address, the consequence will probably be a wrong answer. But if a JMP instruction tells the computer to execute nonsense, the machine will probably require a complete reset, hours of typing may be lost, and (worst of all) no record of the run will be preserved to help the programmer.

Not only are control transfers tricky, they are often the dominant consideration in choosing a program's structure. A program that constantly jumps all over the place without apparent rhyme or reason will be difficult to understand. A program that uses lots of subroutines called by the JSR instruction is much easier to understand, but may prevent any practical use of the stack. On occasion, special and even peculiar methods of transferring control from one program segment to another may be rewarding.

In the following discussion, I'll mention numerous ways of JUMPing through a program. The related issue of conditional jumps or branches is ignored.

The Simple Jump: JMP

The basic 6502 jump command is simple, easily understood, and quite useful. The syntax is simply

```
FROM JMP THERE
THERE...
```

If the computer executes step FROM, it will jump to wherever THERE is, and execute that instruction next. Of course, it is vital that the address THERE contain valid 6502 instructions!

The Simple Subroutine: JSR

The Jump-Subroutine instruction JSR is almost as simple as the JMP instruction. When the computer executes the command

```
FROM JSR SUBROUTINE
```

it jumps to the address SUBROUTINE and continues execution. Before it jumps, though, it leaves a message on the stack containing the address of *the next instruction following the JSR command.*

When (and if) the subroutine wants to return control to the program that called it, it can simply terminate with the command

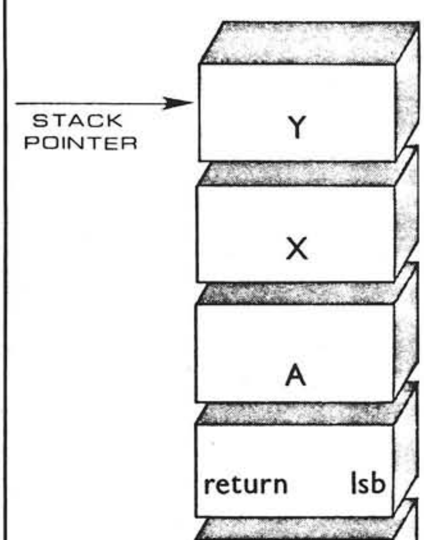
```
RTS
```

which jumps to the address on the top of the stack.

The usefulness of subroutines in writing simple, efficient programs is too familiar to discuss here. A common problem, though, is what to do with the machine registers (A, X, and Y) when calling a subroutine.

In the simplest case, we might allow the subroutine to alter any or all of the machine registers. This approach is fine for many cases, but clearly inadequate if the calling routine needs to preserve one or more registers containing data, loop counters, or other vital information.

Figure 1: **Arrangement of registers on stack after transfer of control.**



Alternatively, we may insist that the subroutine preserve all registers. To do this we may (and normally must) use the stack. All subroutines begin with a sequence:

```
PHA (save the A register)
TXA
PHA (save the X register)
TYA
PHA (save the Y register)
```

and end with the corresponding sequence:

```
PLA (retrieve the Y register)
TAY (put it back into Y)
PLA (retrieve the X register)
TAX (put it back into X)
PLA (retrieve the A register)
RTS
```

Note that the order in which registers are placed on the stack is important. The registers must be reloaded in exactly the reverse order in which they were pushed onto the stack. The sequence, "push A, then X, then Y" is standard and has the advantage of storing the registers in alphabetical sequence.

The programmer may take a page from the authors of the SYM monitor by ending all subroutines with a JMP to a special routine RESTORE:

```
         JMP RESTORE

RESTORE  PLA
         TAY
         PLA
         TAX
         PLA
         RTS
```

Each subroutine must push the registers itself. This may be usefully written as a MACRO if the programmer's assembler is sufficiently powerful.

There are two drawbacks to this method of preserving registers. First, all control transfers are slowed rather drastically by all this pushing and pulling from the stack. Moreover, if subroutines are deeply nested, or especially if they are recursive, (that is, if a subroutine calls itself), all the extra registers on the stack may accumulate and exceed the 6502 stack capacity (256 bytes). A stack overflow is almost certain to cause a crash, and may be miserably difficult to detect if it is unexpected. Of course, each routine could check the stack pointer and abort the program if an overflow is imminent, but this checking adds still more overhead to the control transfer.

In addition, a program that uses the stack extensively for storing registers and subroutine return addresses must be very cautious in using the stack for anything else. In particular, a subroutine *must never leave more or less data on the stack* than were present on the stack when the subroutine was called. If the subroutine wants to leave a value on the stack, it cannot simply push it there:

```
LDA ANSWER
PHA
RTS
```

for the computer will treat ANSWER as part of its return address!

To avoid this disaster, it is possible to manipulate the stack more carefully. First, the return address is pulled from the stack and stored somewhere in memory. Next, the answer is pushed onto the stack. Finally, the return address is replaced on the stack. Notice that if the registers are saved on the stack, they too must be peeled off, stored, and then replaced. Even when the registers don't need to be preserved, the resulting code may seem a bit clumsy:

```
PLA (save the return address)
STA BUFFER1
PLA
STA BUFFER2
;
LDA ANSWER
PHA
;
LDA BUFFER2 (replace the
      return address)
PHA
LDA BUFFER1
PHA
RTS
```

Note also that the calling program or subroutine *must* remove the result ANSWER from the stack. If some program segment forgets to do this, disaster is likely to follow.

The Relocatable Jump

Occasionally, it is important to write a routine which will run, regardless of where it is stored in memory. For example, some utility programs are designed to be stored in the highest available memory locations of a user's computer, regardless of how much memory he actually has.

A normal absolute jump, though, needs to know the address to which the program should jump! If the program is moved in memory, the jump commands still point to the old locations. Of course, a computer program (called a relocator) could be written to search out all the absolute jumps and change them, but relocators are difficult to write and easy to fool.

The normal method of evading this difficulty on the 6502 is to use a *branch* instruction which *always* branches. Since the carry flag is changed infrequently, the most common sequence is:

```
SEC (force the branch)
BCS THERE (always branches)
```

Since branches can only jump (up or down) 127 bytes, this technique favors programs with only short-range jumps. When required, though, a sequence of jumps can move control over longer distances:

```
        SEC (start jumping)
        BCS ISLAND (go to ISLAND
          on the way to THERE)
        ;
        ;
ISLAND  SEC
        BCS THERE
        ;
        ;
THERE   ...
```

Self-Modifying Code

On occasion, it is necessary or convenient to compute the address to which the computer should jump. An obvious analogy is the BASIC statement:

```
ON I GO TO xxx,xxx,xxx
```

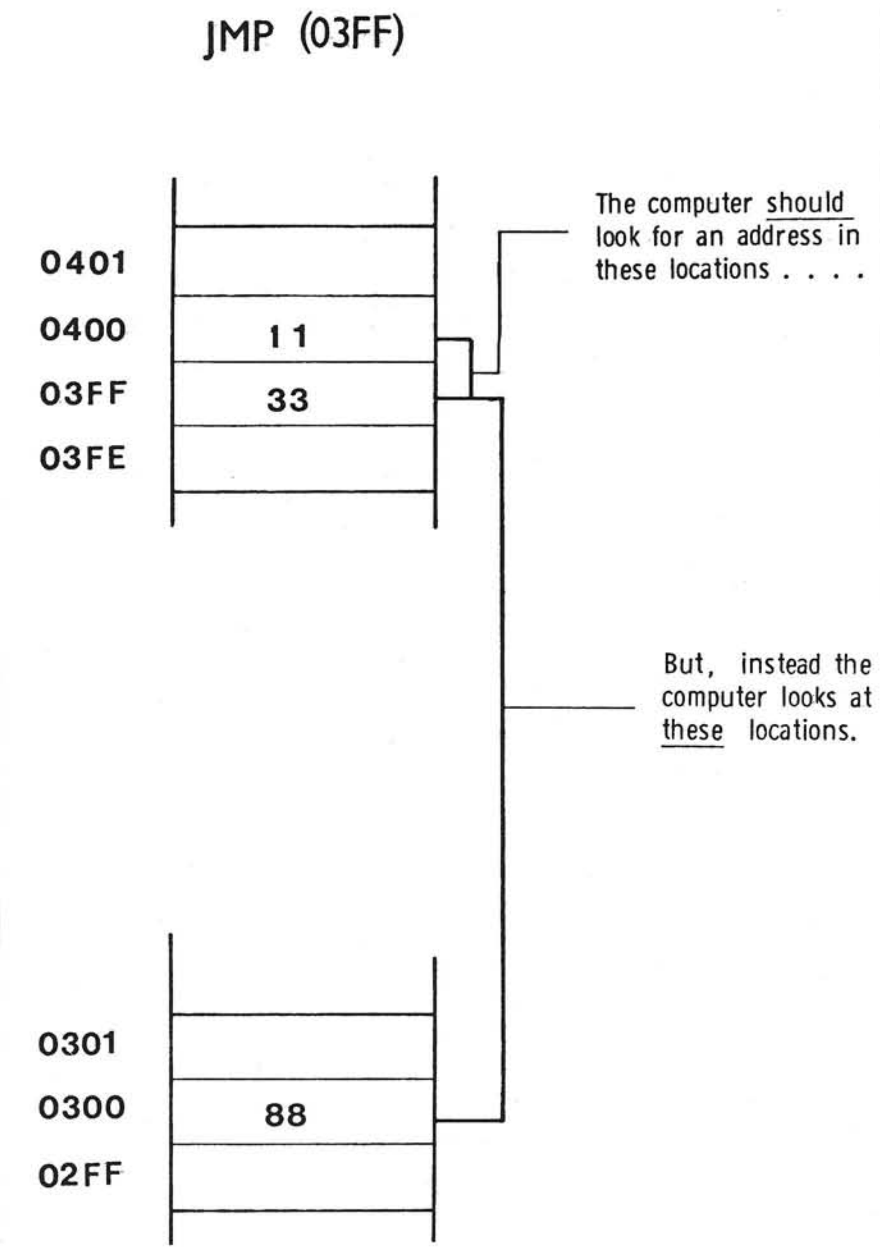
Provided that the program is (at least partially) stored in RAM and not in read-only memory, it is perfectly possible to change the address of a JMP or JSR instruction.

```
     LDA DESTINATION
       (least significant byte)
     STA JUMP+1
       (store into the JMP instruction)
     LDA DESTINATION+1
       (most significant byte)
     STA JUMP+2
JUMP JMP...
```

If required, we could obtain DESTINATION from a table, compute it from a formula, or enter it from a terminal.

This approach is not without its hazards. First, it is dangerous. If the wrong address is stuffed into the JMP instruction, garbage is likely to be executed. If the computer is unlucky, the garbage will crash the computer, necessitating a system reset, which will erase all traces of the offending error.

Figure 2: Illustration of bug in 6502 "JMP Indirect" instruction.



Second, many programmers feel that data (things which are computed) and procedures (instructions which are performed) should be rigorously segregated. Preserving the separation of program and data improves clarity and helps ensure the integrity of both. Finally, many programs may need to be transferred to read-only memory at some point in their lives; clearly we cannot alter an address which is stored in read-only memory!

To use a self-modifying procedure in a read-only memory system, a copy of the self-modifying subroutine may be stored in ROM and transferred to read/write memory when the system is initialized. This approach is adopted by Microsoft in its 6502 BASIC. The subroutine NEXTCHAR, which obtains each character in sequence from the BASIC source program, is transferred from ROM to part of memory page zero whenever the system is turned on or reset. Sections of BASIC, and many extensions to Microsoft BASIC (like the "Programmer's Toolkit" produced by Palo Alto ICs Inc.) modify jumps in this routine.

While the above discussion used the JMP instruction as an example, it should be clear that the JSR instruction is equally suitable for use in a self-modifying sequence.

Indirect Jumps: JMP (addr)

A further method of selecting the address to which control will be transferred is the *indirect jump:*

```
JMP (WHERE?)
```

WHERE? is an address in memory which contains the first 8 bits of a 16-bit number. When the computer executes the indirect jump, it goes to the address *stored* in WHERE? The effect is identical to the self-modifying jump described above. The code is cleaner and easier to follow.

JMP (indirect) is also one of the most dangerous instructions of which the 6502 is capable.

Unfortunately, a confusing design decision (otherwise known as a bug) limits the usefulness of the indirect jump command. If WHERE? happens to be stored in an address ending in hexadecimal $FF (for example, at $03FF), the 6502 makes a bizzare and confusing jump. The programmer expects the computer to look at WHERE? for the least significant byte of the jump address, and at WHERE? + 1 for the most significant byte. Unfortunately, the 6502 does *not* carry when executing the JMP indirect instruction, and will look for the high-order byte *not at WHERE? + 1 but at WHERE? – $FF* if WHERE?'s address ends in $FF.

Fortunately, if the programmer knows and remembers this hazard, it is not too difficult to avoid. First, he can simply choose to locate all targets (like WHERE?) at addresses which do not end in $FF. Since indirect jumps are relatively uncommon, this is often perfectly reasonable.

Second, a self-modifying sequence will perform correctly. The disadvantages may be worthwhile if the time loss is not critical.

However, on rare occasions neither approach is fully satisfactory. An interesting example is the design of the 6502 FORTH language for the FORTH Interest Group (by W.F. Ragsdale). Here an indirect jump figures prominently in a crucial routine, which must run as quickly as possible since it is called during every single step in the FORTH program. Ragsdale resigns himself to check each and every possible target for the JMP indirect instruction, and relocates the whole program by a few bytes to move any offending addresses. Fortunately, there is only one chance in 256 that a given address will offend. The programmer has some chance of getting away with ignoring this bug if he simply relies on luck.

Using RTS to Perform a Jump

RTS, of course, is normally used to terminate a subroutine. It performs two pulls from the stack, and jumps back to the address indicated by the two bytes it pulls. In normal usage, this returns control to the instruction that *follows* the JSR which originally invoked the subroutine.

Suppose a subroutine needs to return to an address different from that which called it. For example, we might define a subroutine called KEYBOARD that behaves as follows:

Subroutine Keyboard

1. Get the next key depression from the keyboard.
2. Convert the key code to an ASCII character.
3. Is the key the SYSTEM RESET key? *(a)* If not, then return normally (like a subroutine). *(b)* If so, return to the system monitor. Do not leave any junk on the stack!

End Keyboard

One way to implement step *(3b)* would be to fetch and discard the top two entries on the stack, and then use a simple JMP:

```
PLA (throw out the return
   address!)
PLA (leaving the stack where it
   should be)
JMP MONITOR
```

Alternatively, the address of the monitor could be put onto the stack *as if it were put there by a JSR instruction.*

```
PLA (throw out the old return
   address, as before)
PLA
LDA #L,MONITOR
PHA
LDA #H,MONITOR
PHA (put address of monitor onto
   the stack)
RTS (go to the monitor)
```

Of course, a subroutine can also change the return address of the subroutine that called it, by looking deeper into the stack. For example, we might have a subroutine WHAT-NEXT? that decides what the highest priority task for the computer is, and changes the return address.

Subroutine WHAT-NEXT?

1. Set pointer to DO-NOTHING.
2. Check all sensors.
3. If the room is on fire, set pointer to FIRE!
4. If the room is wet, set the pointer to FLOOD!
5. If the power is failing, set the pointer to FAMINE!
6. Change the return address of the routine that called WHAT-NEXT? to the routine indicated by the pointer.
7. Return to whatever routine called WHAT-NEXT?

A common jump usually performed using the RTS instruction is the *abort exit*. Often, it proves necessary to abort a program immediately upon detecting an error. If the program is called from BASIC or a machine language monitor, the usual method of exit is simply an RTS instruction.

If a subroutine must abort the program, it must be able to return to the master routine (e.g. BASIC), not simply to the routine that called it. If the program saves the stack pointer when it is first called

```
START TSX (stack contains exit
          address)
      STX ABORT
```

then any subroutine, regardless of what other data may be on the stack, can abort execution and exit by restoring the stack pointer:

```
QUIT  LDX ABORT (restore
      original pointer)
      RTS (back all the way to
      BASIC)
```

Software Interrupt:

The BRK Instruction

The BRK instruction allows an interrupt-request to be generated by the program itself. When the computer encounters a BRK, it takes the following steps:

1. Stores the status register and the current execution address +2 on the stack.
2. Sets the BRK flag in the status register.
3. Sets the IRQ Inhibit flag in the status register.
4. Performs an indirect jump via hexadecimal addresses $FFFE-$FFFF.

The BRK instruction is most often used to jump to the system monitor. Since its opcode (00) is a common element in data tables, a program running amok has a fair chance to encounter a "BRK instruction" and so, return control to the monitor. Also, by writing BRK's on top of normal machine code, a simple software-controlled breakpoint monitor may be implemented and simple tracing performed.

Microcomputers, including the 6502, have simple interrupt structures, which cannot accept too much work. Moreover, the obstacles which make jumps difficult to debug make interrupt routines almost intolerably tedious to develop on most personal computers. Hence, use of the BRK routine should not be undertaken lightly.

On occasion, though, BRK comes in handy, either when a special monitor-like routine is to be invoked, or for debugging normal interrupt service routines. Whenever you use it, be sure to remember that RTI will return to the calling program, skipping a byte after the BRK. BRK is really a two-byte operation. Also, remember that BRK inhibits interrupt requests. Some machines, notably the Commodore PET, use interrupt requests to check the keyboard or display. A mysteriously non-responsive system may result.

Changing the IRQ or NMI Vectors

The subject of interrupt handling is too complex to be considered here. However, changing the interrupt service routine vectors can be a valuable tool in several programs, and must be mentioned in the context of control transfers.

Most 6502 systems place the IRQ and NMI vectors in ROM, but use an indirect jump (explicit or via self-modifying code) through a RAM location to service interrupt requests (IRQs). The programmer may alter the RAM addresses to point to his own service routines. Frequently the user's IRQ service routines end by jumping to the normal (system) IRQ routines. For example:

BEFORE ↓
IRQ VECTOR →
SYSTEM IRQ SERVICE

AFTER ↓
IRQ VECTOR →
USER'S ROUTINE →
SYSTEM IRQ SERVICE

Several computers generate periodic interrupts to service their keyboards, displays, or other peripherals. Other systems possess 6522 timer facilities which may be user-programmed to generate such interrupts. Setting the IRQ service vector to point to a user routine ensures that the new routine will be executed within a fixed period of time.

For example, I recently required a modified IRQ routine for the Commodore PET. The PET's screen is only 40 characters wide, and a program has to provide extended text messages and graphics simultaneously. The answer was to scroll the messages across one line of the screen in the manner of a stock-ticker display. The PET generates IRQs every 1/60th of a second. When the program had a message to send, it would add a new letter to the left end of the display line, three times a second. As long as more letters remained in the queue, the user IRQ routine was called. After the entire message was sent, IRQ handling reverted to normal until more text was placed in the queue.

I should add that, whenever this program failed while it was being tested, it would leave a stream of amusing but useless text, cycling endlessly across the message line. The only way to stop the thing was to turn off the power!

The author gratefully acknowledges the support of the Merck Foundation, whose award of a Merck Foundation fellowship helped make this work possible.

Mark Bernstein is a graduate student in Chemistry at Harvard University. His research in picosecond laser spectroscopy, under the direction of Professor Kevin S. Peters, is assisted by several microcomputers. His most recent project has been implementing a FORTH-like language for laboratory data acquisition and analysis,based on an expanded Commodore PET.

MICRO

The Disk Switch

The Disk Switch will add many hours of useful life to your diskettes, extend the life of your disk drives, and even save energy!

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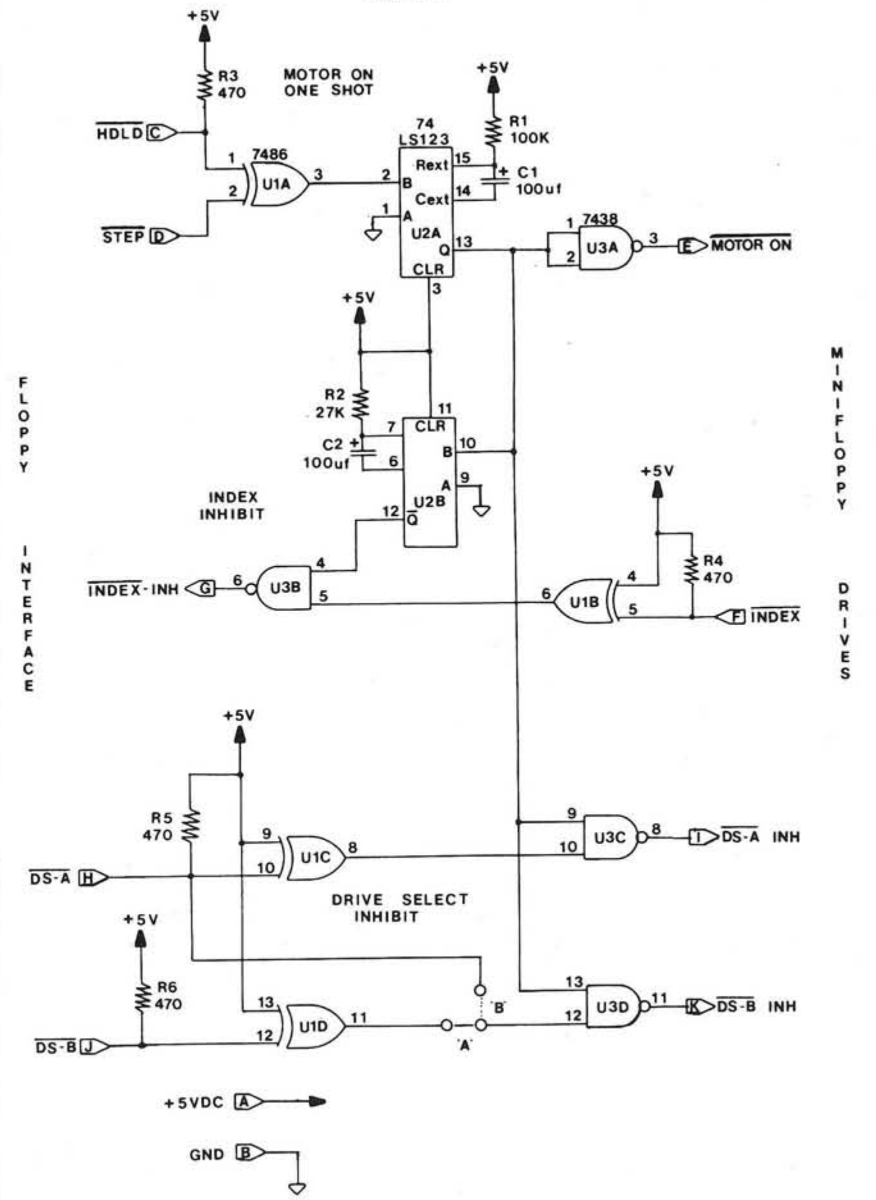
In the last year I have become very familiar with my OSI minifloppy system. I have learned its graces, and I have learned its faults. One of its faults is that OSI minifloppy drives have the nasty habit of eating diskettes.

Minifloppy drives have spindle motors which turn the diskettes inside their protective jackets. Depending on whether the head is loaded, data can be transferred from the rotating diskette to the system. When the disk head is loaded it actually comes into contact with the diskette.

This contact of the disk head with the rotating diskette is very hard on the diskette. It slowly wears away the oxide, which ultimately results in the destruction of the diskette. However, MPI, the company which makes OSI minifloppy drives, is not blind to the plight of diskettes. The MPI minifloppy drives have included in their circuitry the ability to turn off the spindle motor when the drive is not being accessed. MPI recommends that their drives be turned off two seconds (or ten revolutions of the diskette) after the last access.

Figure 1



Regretfully, OSI minifloppy systems do not do this. The MOTOR ON line is permanently wired in the ON state. OSI already had a working 8" floppy interface with the necessary software to drive it when they decided to mate a minifloppy with an OSI personal computer. Redesigning the interface and software would have cost a lot of money, and OSI customers would have had to pay that cost. So, OSI compromised. They kept the same floppy interface and software, added a few necessary modifications, and passed the savings on to us.

Nonetheless, OSI made it imperative that something like the Disk Switch be designed. It is the job of the Disk Switch to turn off the minifloppy spindle motors when the drives are not being used. The Disk Switch works well for both single and dual minifloppy systems. It is reliable, and will extend the life of the media you use in your OSI system. Let's take a look at how the Disk Switch works.

Theory of Operation

Figure 1 is the Disk Switch circuit diagram. The Disk Switch monitors the HDLD (Head Load) and STEP outputs of the OSI floppy interface. Whenever either of these two signals is active, the Disk Switch activates the MOTOR ON line, thereby turning ON the minifloppy spindle motor.

The HDLD and STEP signals from the floppy interface are Exclusive OR'ed together by U1A, a 7486. The resulting signal is used to trigger U2A, the MOTOR ON 74LS123 one shot, into producing a two to three second output pulse. The output of the MOTOR ON one shot is inverted by U3A, a 7438 open collector NAND gate, to become the MOTOR ON signal to the minifloppy drives.

The MOTOR ON one shot and associated circuitry is the heart of the Disk Switch. All other functions of the Disk Switch are dependent upon the correct operation of this circuit. The 74LS123 is used for U2 because larger value resistors can be used in its timing circuit, thereby allowing the use of smaller capacitors. The 7438 open collector NAND gate is used because it can take the electrical load that the minifloppy imposes on the Disk Swtich.

The Q output of the MOTOR ON one shot also drives two other circuits. The first is the INDEX Inhibit circuit; the second is the Drive Select Inhibit circuit.

INDEX is an output from the minifloppy drive which indicates the beginning of a track. The OSI floppy interface must have the Index signal. When Index is missing, the system will wait for it — forever if necessary. Thus, when there is no Index, the system is locked up.

I used this requirement of Index detection to give the spindle motor time to come up to speed before allowing the system to access the drives. The INDEX Inhibit one shot is triggered at the beginning of MOTOR ON. Its output will inhibit Index from getting to the floppy interface for about one second.

While inhibiting Index in this manner adds one second to the minifloppy access time, it is not unreasonable. Once an access has begun, the INDEX Inhibit circuit will no longer affect the operation of the access. Whether the access is two seconds or twenty, only one extra second is added by the INDEX Inhibit circuit.

Note the wiring of the X-OR gate U1B at the input of the INDEX Inhibit circuit. In this configuration the X-OR gate has the function of an inverter. It is cheaper to get an inverter in this manner than to add another chip to the parts list.

At the bottom of the circuit diagram in figure 1 is the Drive Select Inhibit circuit. The Drive Select Inhibit de-selects the minifloppy drives when they are not being accessed. There are several reasons for this. The most important reason is to unload the disk head.

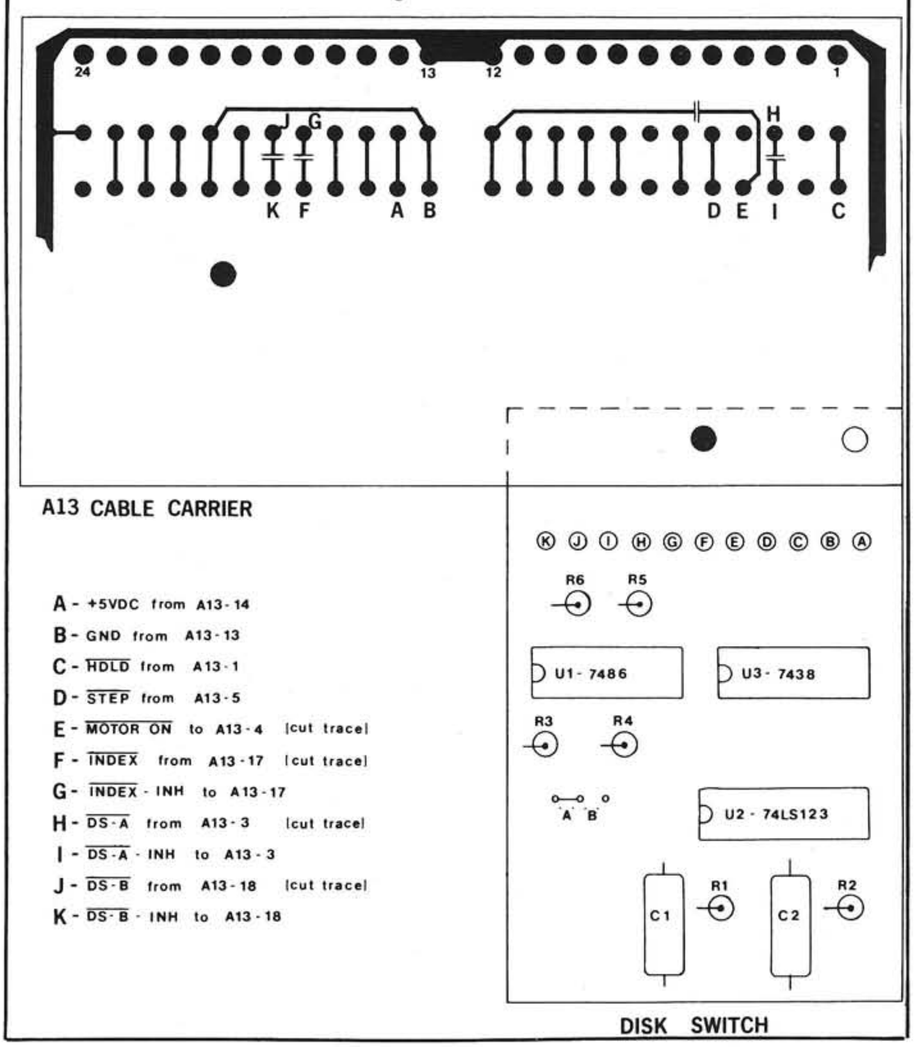
The disk head is loaded by the drive-select input when it is active. Unloading the head is useful in preserving the life of the diskette, and the disk head itself. An additional feature of the Drive Select Inhibit circuit is that it lowers the power consumption of the drive by placing it in the stand-by mode.

In operation, U1C and U1D invert DS-A (Drive Select A) and DS-B (Drive Select B) respectively. The inverted drive select signals are fed into U3C and U3D. U3 is a 7438 open collector NAND gate. The MOTOR ON signal on the second inputs of U3C and U3D prevents the drive select signals from being passed on unless MOTOR ON is a logic high.

Whenever the minifloppy drives have not been accessed for two seconds, the MOTOR ON signal from the MOTOR ON one shot is low. This low at the inputs of U3C and U3D forces their respective outputs high. The high output is the false or non-selected level, and neither of the drives is selected.

An additional feature of the Drive Select Inhibit circuit is that in a dual minifloppy system it can be jumpered to

Figure 2



cause the selection of drives A or B only. This prevents the selection of non-existent drives.

Note the jumper marked 'A' and 'B'. In the 'A' position DS-B is enabled such that its logical state selects drive B. When the jumper is in position 'B', DS-B is disabled and the uninverted state of DS-A selects drive B. This causes the selection of drive B whenever drive A is not selected. This feature will prevent the accidental selection of non-existent minifloppy drives C and D.

The Disk Switch can be simplifed by removing the Drive Select logic. It is not necessary to the operation of the Disk Switch, but helps to prevent diskette wear. In the event that the Drive Select Inhibit circuit is not used, the inputs of U1C, U1D, U3C, and U3D should be tied to +5VDC.

Two of the four 470 ohm pull-up resistors, R5 and R6, should also be removed if the Drive Select logic is not used. The pull-up resistors are necessary, since the interface between floppy and system is made with open collector gates. In the case of the four pull-up resistors, the associated signals are not terminated anywhere else.

By now you are probably wondering about the HDLD signal from the floppy interface. What is it for? The answer is simple — nothing! It is a relic of the floppy interface software used with the larger 8" disk drives. However, for our needs the HDLD signal is very useful. Assume that you need to access a track that has already been found. Since the head is already positioned over the correct track, the system will not generate a STEP signal. The only indication of the access will be the HDLD signal.

Without the use of the HDLD signal an access to the same track would not trigger the MOTOR ON signal, the spindle motor wouldn't spin, so the Index signal would not be generated. Therefore, the system would lock up waiting for the Index signal. It was kind of OSI to leave the HDLD signal lying around like that.

Construction

I have already constructed several versions of the Disk Switch, and have installed the final version in three operational systems. All versions of the Disk Switch that I have built easily fit on a 3 by 2 inch perforated circuit board.

I have used both wire wrap and point-to-point soldering to construct the Disk Switch. I do not recommend wire wrap because of the posts that protrude from the board. Wire wrapping the circuit is definitely easier, but the circuit board must be placed in a tight location. I suggest that the circuit be soldered point-to-point. Since there are no high frequency signals in the Disk Switch, the actual layout is not critical.

The Disk Switch should be mounted on the A13 floppy interface board to facilitate wiring. The A13 board is the cable carrier for the minifloppy cables, and plugs onto the 505 CPU board.

Mounting the Disk Switch on the A13 board is best since all of the signals used are available there. Servicing the Disk Switch is also much easier. The only precaution is to make sure the Disk Switch does not touch the 505 CPU, or whatever board may be located nearest it.

Attaching the input and output signals to the Disk Switch is a relatively simple matter. Just locate the appropriate traces on the A13 board, make the necessary cuts, and attach the wires. In all cases, the wires from the Disk Switch can be soldered into existing pads.

Figure 2 shows where to mount the Disk Switch on the A13 board. All trace cuts are shown, as well as the locations of the various connections to the Disk Switch.

In conclusion I will leave you with a word of caution. You have probably acquired the habit of opening the disk drive door when you don't need to access the disk. It is a reasonable habit that reduces diskette wear. With the Disk Switch this is no longer necessary. You should now leave the door closed when you are using the system. Otherwise, with the door open, the system will miss the Index signal when you try to access a disk. The Disk Switch will time out, and lock you out of your system.

There is a simple fix for this that you might wish to try. You can add a pull-up resistor and a grounding switch to pin 1 of U2, the MOTOR ON one shot. This would allow you to independently trigger the MOTOR ON signal and restart the minifloppy drive.

(If you don't feel up to the task of constructing the Disk Switch, you can obtain a kit from D&N Micro Products, 3684 N. Wells St., Fort Wayne, IN 46808. The kit contains all of the necessary parts and costs $29.00 plus $2.00 shipping and handling.)

MICRO

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It's Time to Stop Dreaming

Part 4

By Robert M. Tripp

Parts 1 and 2 (MICRO 37:07 and MICRO 38:27) of this series introduced the 6809 microprocessor. Part 3 (MICRO 39:16) described the 6809 instruction set from the 6502 user's point of view. That topic was easy to cover since there are so many similarities between the two micros. This month's article discusses the addressing modes of the 6809, and was more difficult to write. While the 6809 and 6502 do share a number of common modes (although often the nomenclature is different), the 6809 offers a number of new modes which will take some getting use to for the 6502 devotee. These additional modes are very significant and contribute a lot to the overall functioning of the 6809. So, the effort involved in understanding them is well spent.

Common Modes

The following modes are essentially identical between the two micros. The name for each mode is different, but the processing is identical.

IMPLIED or ACCUMULATOR (6502) and INHERENT (6809)

This mode is used when the effective address of an instruction is "implied" or "inherent" in the instruction itself. Examples on the 6502 are CLC (clear carry bit in status register), INY (increment Y register), RORA (rotate accumulator right, and so forth. "Accumulator" is another form of "implied." Examples on the 6809 are ABX (add B register to X register), CLRA (clear A register), and so forth. The basic addressing element of this mode is that any registers which will be affected are specified within the opcode and do not require additional information.

IMMEDIATE

The "immediate" mode is identical on the two processors. It takes as its effective address the location(s) immediately following the opcode. On the 6502 the immediate data is always 8 bits since that is all that the 6502's registers can handle. On the 6809 the immediate data may be 8- or 16-bit. For example, an LDA #$05 would be 8 bits into the A register, but an LDX #$1234 would load 16 bits into the X register.

ABSOLUTE (6502) and EXTENDED (6809)

These two modes are identical. The effective address is provided in the two bytes following the opcode. LDA $1234 will load A from the absolute/extended address $1234. This mode of addressing permits the processor to directly access any location in its 64K addressing space.

ABSOLUTE INDIRECT (6502) and EXTENDED INDIRECT (6809)

The only instruction on the 6502 which can use the absolute indirect addressing mode is the JMP. Any other instruction which requires an absolute indirect mode must either set the X register to zero and use the Indexed Indirect mode LDA (ADDR,X), or set the Y register to zero and use the Indirect Indexed mode LDA (ADR),Y. The 6809 does not require such chicanery, but provides the Extended Indirect mode for all major operations, such as LDA (JUNK). This makes indirect addressing much simpler.

ZERO PAGE (6502) and DIRECT PAGE (6809)

These two modes are conceptually similar, and, for the zero page of memory, are identical. On the 6502, any address in page zero may be absolutely referred to by providing only the low 8 bits of the address, with the mode defined by the opcode specifying that the high 8 bits are all zero. This makes accessing the 256 locations on page zero faster and requires only one byte of addressing instead of two.

The 6809 carries this concept of only providing the low byte of the address a bit further. Instead of forcing the high byte of the address to zeros, it has a separate register called the "Direct Page Register," which contains the high byte of the address. If the DP register is set to zero, which it is automatically on RESET, then a "direct page" mode reference will be identical to the 6502 "zero page" mode. But, the DP reigster may be changed to any other value, allowing the directly referenced page to be anywhere in memory!

This function can be very useful. First, it removes the limitation of only 256 bytes of directly addressable memory. Second, and probably more significant, it will support multiple tasks and multiple users. Code can be written which makes all task/user references in the direct page mode. By setting the DP register to a different value for each task/user, there will be no conflict and multiple tasks/users can easily share the same program code. One other addition to the 6809 mode is that JMP and JSR instructions are permitted via the Direct page.

RELATIVE (6502 and 6809)

This mode is used on both micros for the Branch operations. The data following the branch opcode is added to the Program Counter (PC) to determine the effective address for the branch. On the 6502, the signed data is limited to one byte, providing a branch range of 127 locations forward and 128 locations backward. The 6809 permits the signed data to be either one byte, in which case it is identical to the 6502, or two bytes, in which case any address in the normal 64K addressing space is accessible.

The 8-bit mode is called a "short" branch and the 16-bit mode is called a "long" branch. (*Note:* Several years ago the savings associations of Red Bank, NJ and Long Branch, NJ were planning a merger, but it fell through because they did not want to be known as the Long Branch Branch of the Red Bank Bank! But, I digress.) Since the 6809 has a Branch to Subroutine and a Branch Always, the value of the long branch is even geater since JSRs and JMPs can be replaced by the relative BSRs and BRAs.

INDEXED Addressing on the 6502

Since the 6502 has 8-bit index registers, its indexing can only cover a range of 256 bytes and the 16-bit base address for all indexing operations must come from somewhere else. This may be an ABSOLUTE 16-bit address as in LDA JUNK,X or STA JUNK,Y. It may be a PAGE ZERO address which assumes the high 8 bits to be zero and directly specifies the low 8 bits as in LDA JUNK,ZX or CMP JUNK,ZY. Or, it may be one of the two special modes which combine indexing and indirect addressing.

INDEXED INDIRECT uses X as an index to a set of Page Zero byte-pairs which are 16-bit addresses to the final effective address anywhere in memory. An example is ADC (JUNK,X) which will take the byte-pair that is X locations above JUNK in Page Zero as the effective address for the operation. INDIRECT INDEXED uses a Page Zero byte-pair as the 16-bit address of the start of a 256-byte section of memory which is indexed by Y. An example is SBC (JUNK),Y which will take the 16-bit value of JUNK and JUNK + 1 in Page Zero and add to it the current contents of Y to form the effective address.

All of the indexed address modes are not available for all instructions, which while not fatal, can be a nuisance. Have you ever written a clever piece of code based on an INC (JUNK),Y only to find that there is no such animal?! Although the designers of the 6502 gave us some very useful indexed addressing modes, they were limited by the fact that the X and Y registers are only 8-bit.

INDEXED Addressing on the 6809

The best way to understand the 6809 indexed addressing modes is to first forget all about the 6502's. While there are some similarities, they are outweighed by the great differences. So, let's depart from the comparative evaluation of the 6809 and look at the index addressing from scratch.

One of the most important features of the 6809 is that its index registers are all 16-bit. A second significant feature is the multiple index registers: X, Y, S, U, and sometimes PC. That's right! The two stack registers, S and U, can perform all of the indexing operations, and the program counter, PC, can be used in several special index operations. This is quite different from the 6502 with its two 8-bit index registers. There are three major categories of indexed addressing modes which can use the X, Y, S and U registers.

Constant Offset from X, Y, S or U

In this mode, a constant value is added to the contents of the specified index register to form the effective address. This is similar to the Absolute Indexed mode of the 6502: LDA JUNK,X in which JUNK is a 16-bit constant value to which is added the current value of X to form the effective address. The 6809 supports this 16-bit mode of constant offset, but also provides three other modes: No offset, 5-bit offset, and 8-bit offset. Since the index register is 16 bits, it can contain the entire effective address. It makes sense, then, to have a mode in which the contents of the index are used directly without any additional constants. The instruction of the form LDA ,X on the 6809 will use the current contents of X as the effective address.

There are many instances in which the offsets required are within a limited range. For example, if an index points to the base address of a VIA device which has 16 internal registers, only four bits of offset would be required to access all registers. Why use 16 bits when fewer will suffice (especially if you can save time and space with a smaller value)?

The 5-bit constant offset of the 6809 provides for a signed offset which can cover the range of + F to − F locations from the 16-bit index. The format of the instruction is the same as for the 16-bit constant offset: CLR JUNK,Y but JUNK is now a 5-bit or less signed value. Similarly, the 6809 provides an 8-bit constant offset. It covers a range of + 7F to − 7F locations from the 16-bit index. In summary, the 6809 provides four forms of Constant Offset indexing: No Offset, 5-bit Offset, 8-bit Offset and 16-bit Offset. Each mode of increasing the number of bits requires either more instruction cycles, more instruction bytes, or both.

Accumulator Offset from Index Register

The 6809 can use one register to index another. Any one of the accumulators, A, B, or D, can be combined with the X, Y, S or U registers. The instruction form is INC B,U which will perform a two's complement addition of the B register and the U register to form the effective address. All combinations are valid and may be used for all major operations. The Accumulator Offset mode can be very powerful in performing table lookups in which the position within the table is calculated by some routine and then implemented through this indexing mode. The A and B registers provide 8-bit signed offsets; the D register provides a 16-bit signed offset.

Auto Increment/Auto Decrement

One very common use of an index is to step through a set of values. This is used in searching a table, moving a number of bytes from one location to another, and so forth. The 6809 provides four modes which either increment or decrement the index register as part of each operation. All four index registers may be used. They may be incremented or decremented by one when used for stepping through a table of single bytes, or may be incremented or decremented by two when working with 16-bit words, such as addresses. The form of the single increment is LDA ,X+ in which X has the 16-bit address which is used by the instruction as the effective address, and which is then incremented by one after the operation has taken place. The double increment form is LDA ,Y++ and the register is incremented twice after each operation.

The decrement modes work in an identical fashion except that the decrement is done *before* the operation. If X contained $2000 at the start of a decrement instruction such as LDA , −X then the value loaded into A would come from location $1FFF. A double decrement instruction would be STA , − −S. Note that the minus sign(s) in the decrement comes before the register and that the plus sign(s) in the increment comes after the register. This indicates the order of the operation: decrement before the operation and increment after the operation.

Program Counter Relative Addressing

The previously discussed indexing modes all use the X, Y, S or U registers. It is very important in writing position-independent code to be able to refer to data in a position-independent manner. One way this is supported on the 6809 is

Indexed Addressing Mode Summary for the 6809

Type	Forms	Non-Indirect	Indirect
Constant Offset from R	No Offset	,R	[,R]
(2's Complement Offsets)	5-bit Offset	n,R	defaults to 8-bit
	8-bit Offset	n,R	[n,R]
	16-bit Offset	n,R	[n,R]
Accumulator Offset from R	A Register Offset	A,R	[A,R]
(2's Complement Offsets)	B Register Offset	B,R	[B,R]
	D Register Offset	D,R	[D,R]
Auto Increment/Decrement	Increment by 1	,R+	not allowed
	Increment by 2	,R++	[,R++]
	Decrement by 1	,−R	not allowed
	Decrement by 2	,−−R	[,−−R]
Constant Offset from PC	8-bit Offset	n,PCR	[n,PCR]
(2's Complement Offsets)	16-bit Offset	n,PCR	[n,PCR]
Extended Indirect	16-bit Address	xxxxx	[n]

NOTES: R is X, Y, S or U register.
Extended Indirect is not an index mode but is included in the table for the sake of completeness on the Indirect Addressing forms.

through an indexing mode which uses the current value of the Program Counter Register (PCR) as the base for calculating the effective address. There are two forms of this mode: 8-bit offset and 16-bit offset. These two modes are identical except for the size of the offset. LDA JUNK,PCR will add the 8-bit or 16-bit offset of "JUNK" to the current value of PCR to calculate the current location of JUNK. This is identical in concept to the Relative Addressing used by the Branch instructions. Combined with the Load Effective Address instruction, this mode permits the easy loading of an index register with the relocated address of a table. LEAY TABLE,PCR will put the absolute addresss of TABLE into the Y register where it can be used by the other modes of indexing to access the entire table.

INDIRECT Addressing on the 6809

All of the indexing modes discussed above, with the exception of the Auto Increment One and Auto Decrement One, can also have a level of Indirect addressing. This means that all of the calculations which go into producing the Effective Address take place as usual, but then this Effective Address is used to access a location which contains the final Effective Address. This provides many modes for implementing the Indexed Indirect which the 6502 supports in a limited manner for the X register only.

The Indirect Indexed mode, which is very important on the 6502, is not needed as such on the 6809. Since the 6809 has a variety of ways of getting the correct 16-bit address into one of its four index registers, there is no real need for the "indirect" portion of the mode. Why specify an address "indirect" on page zero as in the 6502 when it can be specified "direct" so easily on the 6809? The "index "portion of the mode is, of course, supported by all of the normal 6809 indexing modes.

Summary

This four-part series has presented an introduction to the 6809 microprocessor as seen through the eyes of a 6502 user. If it has encouraged you to find out more about this potential successor to the 6502, then the series has served its purpose. As an admitted novice on this particular microprocessor, I have tried to make an accurate presentation of the major features of the 6809, but may have made some mistakes! If you are serious about using this device, I recommend that you obtain the MC6809 or MC6809E data sheet from your Motorola representative.

I am actively working with the 6809E on the Flexi Plus board that my sister company The COMPUTERIST, Inc. introduced in August 1981. I am sure that I will be finding out a lot more about this micro and will write additional articles as needed. Meanwhile, several very knowledgeable 6809 computerists have offered to write articles. It will obviously take time to get our coverage of the 6809 rolling, so, if you have 6809 information to contribute, please contact me.

MICRO

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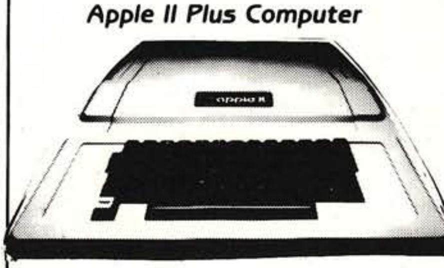

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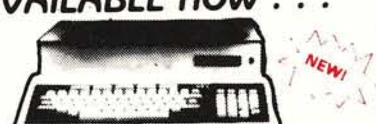

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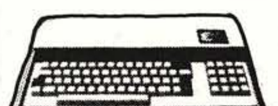

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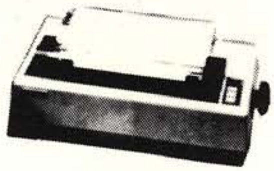

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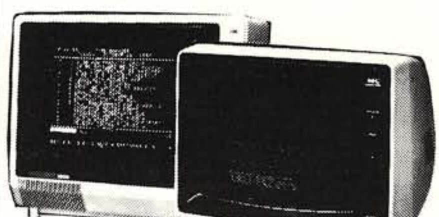

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Journal It: Screen Print Utility for Atari

This program describes a versatile utility for the Atari. It will 'capture' all screen text I/O, including user-program generated data and system prompts or responses, and then 'journal' it on a printer. The journal will provide the user with a hard copy of a session's transactions, for logging or debugging purposes.

John Elliott
33 Gold Street, Apt. #708
New York, New York 10038

The program described in this article is a screen print utility for the Atari 400/800, and it will be of interest to both BASIC and assembly language programmers. Readers not familiar with assembly language will want to start with the section, "Using the Program," which describes how to use the program with BASIC.

My need for a program to print screen text arose when I began using the Atari Assembler Editor cartridge. This cartridge contains three separate programs:

1. The EDITOR program allows you to create and maintain assembler language source files.

2. The ASSEMBLER program converts the source code to machine language.

3. The DEBUG program provides many program testing aids, such as single-stepping through a program and/or tracing its execution path. DEBUG will also disassemble machine code, display the contents of memory, etc.

Developing programs in assembly language can be difficult and time-consuming. Therefore a good debug package is a welcome addition to the assembly language programmer's systems software library. I found the Atari DEBUG program to be very useful, but I was disappointed to find that output from the debugger could not be directed to a printer.

Fortunately, the Atari I/O subsystem is very flexible, and a straightforward 'patch' to the system I/O tables can be used to reroute data from one device to another. Specifically, it is not difficult to 'trap' data directed to the screen through the screen-editor, and then redirect it to a printer.

The program in listing 1 is a logical extension of this idea. However, instead of *rerouting* data directed to the screen,

Figure 1: **Normal Screen Editor Data Flow.**

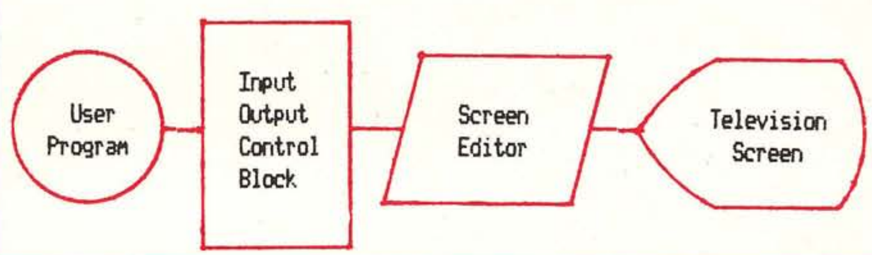
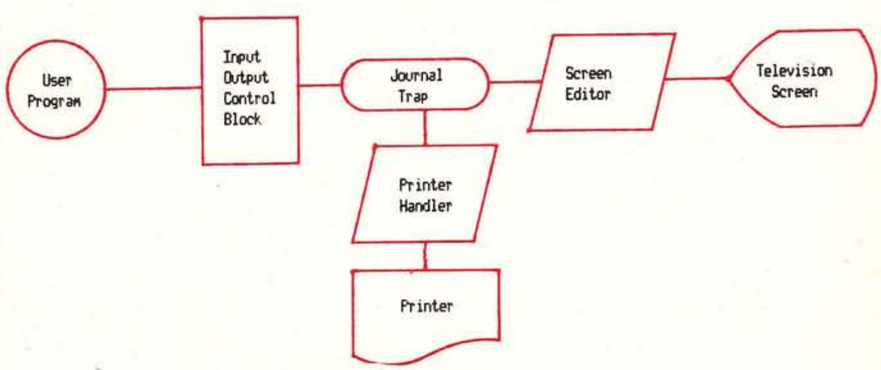


Figure 2: **Data Flow with Journal Trap Installed.**



Listing 1: **Screen Journal**

```
0000                 .PAGE
          ;+++++++++++++++++++++++++++++
          ;+     ASSEMBLER ROUTINE TO     +
          ;+   TRAP SCREEN INPUT/OUTPUT   +
          ;+ &  JOURNAL IT ON A PRINTER +
          ;+    JOHN ELLIOTT   MAY '81    +
          ;+++++++++++++++++++++++++++++
0008      WARMST =      $0008      ;WARM START FLAG
031A      HATABS =      $031A      ;DEVICE HANDLERS
          ;
```

(Continued)

the program will *duplicate* it on a printer. That is, the data will appear on both the screen and the printer. Additionally, the program will trap data coming from the screen editor, and copy that on a printer. The result is a 'journal' of all screen activity.

Program Description

To understand how the program works, we need to look at how the Atari talks to the outside world. The Atari OS (operating system) includes an I/O subsystem for communicating with the system I/O devices, such as disks, cassette drives, printers, etc. The subsystem is composed of resident 'handlers,' one per device. In the normal environment the user program will communicate with the handlers via an IOCB (input/output control block). Typical data flow is illustrated in figure 1.

In addition to providing a means of passing parameters, such as data addresses and request codes, the IOCB contains pointers to the handler routines. Since the IOCBs are in RAM these pointers can be changed to address custom routines, and that is exactly what the journal program does. The handler pointers in the screen editor IOCB (IOCB # zero) are changed to point to the I/O trap routines. The result is that all data coming from, or going to, the screen through the screen editor (not the display handler) will be intercepted. These routines then call the printer handler to duplicate all screen I/O. The data flow is illustrated in figure 2.

Besides intercepting screen I/O, the program performs a certain amount of control code translation. This is because the screen editor recognizes sixteen control codes, most of which are treated as unprintable characters by the printer, and will appear as spaces on a printout. The translation is as follows:

1. the "Clear Screen" code ($7D) is translated to an EOL (end of line) character ($9B);
2. the "Insert Line" code ($9D) is translated to an EOL character ($9B);
3. all codes and characters with a hexadecimal value of less than $20 are ignored.

This is by no means a comprehensive translation, but I have found it to be satisfactory for journaling most BASIC, Assembler Editor, and DOS transactions.

Listing 1 *(Continued)*

```
                ;INPUT/OUTPUT CONTROL BLOCKS
                ;
0000            IOCB    *=   $0340      ;I/O CONTROL BLOCKS
0340            ICHID   *=   *+1        ;HANDLER ID
0341            ICDNO   *=   *+1        ;DEVICE NUMBER
0342            ICCOM   *=   *+1        ;COMMAND CODE
0343            ICSTA   *=   *+1        ;STATUS
0344            ICBAL   *=   *+1        ;BUFFER ADDRESS LSB
0345            ICBAH   *=   *+1        ;BUFFER ADDRESS MSB
0346            ICPUT   *=   *+2        ;PUT ROUTINE ADDRESS
0348            ICBLL   *=   *+1        ;BUFFER LENGTH LSB
0349            ICBLH   *=   *+1        ;BUFFER LENGTH MSB
034A            ICAX1   *=   *+1        ;AUX CONTROL BYTE 1
034B            ICAX2   *=   *+1        ;AUX CONTROL BYTE 2
                ;
                ;ENVIRONMENT ADDRESSES/EQUATES
                ;
BFFA            CSTART =     $BFFA      ;CARTRIDGE START
007D            CLEAR  =     $7D        ;CLEAR SCREEN CODE
0020            SPACE  =     $20        ;FIRST PRINTABLE CHAR
009C            DELETE =     $9C        ;DELETE-LINE CODE
009B            EOL    =     $9B        ;END OF LINE CODE
                ;
034C                    *=   $E400      ;START OF VECTOR TABLES
                ;
                ;EDITOR VECTOR TABLE
                ;
E400            EDITRV =     *          ;<E:> VECTOR TABLE
E400            EDOPEN *=    *+2        ;OPEN VECTOR
E402            EDCLOS *=    *+2        ;CLOSE VECTOR
E404            EDGETB *=    *+2        ;GETCHAR VECTOR
E406            EDPUTB *=    *+2        ;PUTCHAR VECTOR
E408            EDSTAT *=    *+2        ;STATUS VECTOR
E40A            EDSPEC *=    *+2        ;SPECIAL VECTOR
E40C            EDINIT *=    *+3        ;INITIALIZATION
E40F                   *=    *+1        ;SPARE
                ;
E410            SCRENV *=    *+16       ;S: VECTOR TABLE
E420            KEYBDV *=    *+16       ;K:VECTOR TABLE
                ;
                ;PRINTER VECTOR TABLE
                ;
E430            PRINTV =     *          ;<P:> VECTOR TABLE
E430            PROPEN *=    *+2        ;OPEN VECTOR
E432            PRCLOS *=    *+2        ;CLOSE VECTOR
E434            PRGETB *=    *+2        ;GETCHAR VECTOR
E436            PRPUTB *=    *+2        ;PUTCHAR VECTOR
E438            PRSTAT *=    *+2        ;STATUS VECTOR
E43A            PRSPEC *=    *+2        ;SPECIAL VECTOR
E43C            PRINIT *=    *+3        ;INITIALIZATION
E43F                   *=    *+1        ;SPARE
E440                   .PAGE
0600            BEGIN  =     $0600      ;PROGRAM ORIGIN
E440                   *=    BEGIN
                ;
                ;COPY <E:> VECTOR TABLE
                ;
0600 A00F              LDY   #15        ;LENGTH OF VECTOR TABLE
0602            COPVEC =     *          ;COPY <E:> VECTOR TABLE
0602 B900E4            LDA   EDITRV,Y
0605 998306            STA   HAVECS,Y
0608 88                DEY
0609 10F7              BPL   COPVEC     ;LOOP 'TIL ALL COPIED
                ;
                ;CHANGE <E:> HANDLER VECTOR
                ; TO POINT TO OUR TABLE
                ;
060B A983              LDA   #HAVECS&$FF
060D 8D2103            STA   HATABS+7   ;<E:> VECTOR LSB
0610 A906              LDA   #HAVECS/256
0612 8D2203            STA   HATABS+8   ;<E:> VECTOR MSB
                ;
                ;POINT TO OUR PUTCHAR ROUTINE
                ;
0615 A94A              LDA   #OUTPUT-1&$FF
0617 8D8906            STA   HAPUTB     ;HANDLER TABLE...
061A 8D4603            STA   ICPUT      ;...AND IOCB
061D A906              LDA   #OUTPUT-1/256
061F 8D8A06            STA   HAPUTB+1
0622 8D4703            STA   ICPUT+1
                ;
                ;POINT TO OUR GETCHAR ROUTINE
                ;
```

(Continued)

Listing 1 *(Continued)*

```
0625 A933   1050          LDA   #INPUT-1&$FF
0627 8D8706 1060          STA   HAGETB     ;HANDLER TABLE ONLY
062A A906   1070          LDA   #INPUT-1/256
062C 8D8806 1080          STA   HAGETB+1
            1090 ;
            1100 ;VECTORS ESTABLISHED - NOW EXIT
            1110 ;
062F 8508   1120          STA   WARMST     ;SET WARMSTART FLAG
0631 6CFABF 1130          JMP   (CSTART)   ;CARTRIDGE START
            1140 ;
            1150 ;
            1160 ;MIRROR SCREEN INPUT TO PRINTER
            1170 ;
0634        1180 INPUT   =     *
0634 8D9206 1190          STA   SAVEA      ;SAVE ACCUMULATOR
0637 203F06 1200          JSR   EGET       ;GO GET SCREEN INPUT
063A 206006 1210          JSR   PPUT       ;JOURNAL INPUT ON PRINTER
063D D017   1220          BNE   EXIT       ;BACK TO CALLER
            1230 ;
            1240 ;GO GET SCREEN INPUT
            1250 ;
063F        1260 EGET    =     *
063F AD05E4 1270          LDA   EDGETB+1   ;HI BYTE FIRST
0642 48     1280          PHA
0643 AD04E4 1290          LDA   EDGETB     ;LO BYTE LAST
0646 48     1300          PHA
0647 AD9206 1310          LDA   SAVEA
064A 60     1320          RTS              ;GO GET THE SCREEN INPUT
064B        1330          .PAGE
            1340 ;
            1350 ;MIRROR SCREEN OUTPUT TO PRINTER
            1360 ;
064B        1370 OUTPUT =     *
064B 206006 1380          JSR   PPUT       ;PUT CHARACTER TO <P:>
            1400 ;PUT CHAR TO <E:>
            1410 ;
064E        1420 EPUT    =     *
064E AD07E4 1430          LDA   EDPUTB+1   ;HI BYTE FIRST
0651 48     1440          PHA
0652 AD06E4 1450          LDA   EDPUTB     ;LO BYTE LAST
0655 48     1460          PHA
0656        1470 EXIT    =     *           ;COMMON EXIT POINT
0656 AD9206 1480          LDA   SAVEA      ;RESTORE ACCUMULATOR
0659 AE9306 1490          LDX   SAVEX      ;RESTORE REGISTER  X
065C AC9406 1500          LDY   SAVEY      ;RESTORE REGISTER  Y
065F 60     1510          RTS              ;PUT CHAR TO SCREEN/EXIT
            1520 ;
            1530 ;PUT CHAR TO <P:>
0660        1550 PPUT    =     *
0660 8D9206 1560          STA   SAVEA      ;SAVE ACCUMULATOR
0663 8E9306 1570          STX   SAVEX      ;SAVE REGISTER  X
0666 8C9406 1580          STY   SAVEY      ;SAVE REGISTER  Y
0669 C920   1590          CMP   #SPACE     ;PRINTABLE CHAR?
066B 9015   1600          BCC   PCALL      ;NO...IGNORE IT
066D AD37E4 1610          LDA   PRPUTB+1   ;HI BYTE FIRST
0670 48     1620          PHA
0671 AD36E4 1630          LDA   PRPUTB     ;LO BYTE SECOND
0674 48     1640          PHA
0675 AD9206 1650          LDA   SAVEA      ;PICKUP CHARACTER...
0678 C97D   1660          CMP   #CLEAR     ;CLEAR SCREEN?
067A F004   1670          BEQ   PSUB       ;YES...SUBSTITUTE EOL
067C C99C   1680          CMP   #DELETE    ;DELETE LINE?
067E D002   1690          BNE   PCALL      ;NO...PRINT IT
0680        1700 PSUB    =     *           ;SUBSTITUTE EOL
0680 A99B   1710          LDA   #EOL       ;SUBSTITUTE EOL
0682        1720 PCALL   =     *
0682 60     1730          RTS              ;...AND PRINT IT
            1750 ;MODIFIED <E:> VECTOR TABLE
            1760 ;
0683        1770 HAVECS =     *            ;HANDLER VECTORS
0683        1780 HAOPEN *=    *+2          ;OPEN VECTOR
0685        1790 HACLOS *=    *+2          ;CLOSE VECTOR
0687        1800 HAGETB *=    *+2          ;GETCHAR VECTOR
0689        1810 HAPUTB *=    *+2          ;PUTCHAR VECTOR
068B        1820 HASTAT *=    *+2          ;STATUS VECTOR
068D        1830 HASPEC *=    *+2          ;SPECIAL VECTOR
068F        1840 HAINIT *=    *+3          ;INITIALIZATION
            1860 ;REGISTER SAVE AREAS
            1870 ;
0692        1880 SAVEA   *=    *+1         ;ACCUM SAVE AREA
0693        1890 SAVEX   *=    *+1         ;REG X SAVE AREA
0694        1900 SAVEY   *=    *+1         ;REG Y SAVE AREA
0695        1910          .END
```

Program Environment

The program is designed to work equally well with BASIC or the Assembler Editor cartridge, with or without DOS. It does not conflict with any of the BASIC or Editor functions, nor does it impose any limitations on application programs. It does not use any of the IOCBs (other than the screen editor's), therefore no program changes will be required before it can be used.

Other than the system I/O tables, the program's use of RAM is limited exclusively to page 6; no page zero locations are used. Page 6 is not used by BASIC or any other Atari system software, and so is available for our use. Once loaded into RAM, the program will remain intact until removed by the user. None of the system programs will encroach upon it. Conversely, the program does not encroach upon the RAM allocated to the system programs. Therefore it does not have an impact on memory availability, and will run on the minimum 8K system configuration.

The program is compatible with all the standard Atari software. However, it uses the in-ROM system vectors to call the printer handler. If you have installed a non-resident printer handler, you will need to modify the journal program to conform to the interfacing conventions of your handler.

So far as hardware is concerned, the program will work with either the Atari 820 or 825 printer. It should also work with the Atari 822 Thermal Printer, although I have not been able to verify this.

Using the Program

The program is an assembly language routine, written to reside on page 6 of RAM. Those of you who have the Assembler should assemble the program shown in listing 1. For those of you who do not have the Assembler, I include a BASIC program (listing 2) which will POKE the machine code into RAM. (Listing 3 shows a sample RUN of this program.) If you use the BASIC program, be sure that you enter the DATA statements exactly as shown, otherwise the system might crash when you use the journal program.

When you have loaded the program into RAM, you should execute it whenever you wish to initiate journaling. Before doing so, be sure that the printer is connected and powered on. If you are using BASIC, execute the pro-

***Listing 2:* BASIC program to set up Screen Journal Program.**

```
10 REM +++++++++++++++++++++++++++++
11 REM +                           +
12 REM +   BASIC PROGRAM TO SETUP  +
13 REM +  MACHINE LANGUAGE ROUTINE +
14 REM +          THAT  WILL       +
15 REM + TRAP SCREEN INPUT / OUTPUT +
16 REM + &  JOURNAL IT TO A PRINTER +
17 REM + JOHN ELLIOTT        MAY '81 +
18 REM +                           +
19 REM +++++++++++++++++++++++++++++
20 REM
22 DIM HEX$(3)
24 MLPROG=1536:REM PAGE 6 ADDRESS
26 GRAPHICS 0
28 POKE 752,1:REM CURSOR OFF
30 ? :? "LOADING JOURNAL":?
35 REM
36 REM +++++++++++++++++++++++++++++
37 REM + SETUP MACHINE LANGUAGE PGM +
38 REM +++++++++++++++++++++++++++++
39 REM
40 FOR ADDR=MLPROG TO MLPROG+1024
45 READ HEX$:SOUND 0,ADDR-MLPROG,10,4
50 IF HEX$="END" THEN POP :GOTO 80
55 HI=ASC(HEX$(1,1))-48
60 IF HI>9 THEN HI=HI-7
65 LO=ASC(HEX$(2,2))-48
70 IF LO>9 THEN LO=LO-7
75 POKE ADDR,HI*16+LO:NEXT ADDR
80 REM
81 REM +++++++++++++++++++++++++++++
82 REM +     DISPLAY INSTRUCTIONS    +
83 REM +++++++++++++++++++++++++++++
84 REM
85 ? "JOURNAL LOADED":? :POKE 752,0
90 ? "TO INITIATE JOURNALLING TYPE :"
95 ? :? "X=USR(";MLPROG;")"
100 REM
101 REM +++++++++++++++++++++++++++++
102 REM +  HEXADECIMAL M/L PROGRAM   +
103 REM +++++++++++++++++++++++++++++
104 REM
105 DATA A0,0F,B9,00,E4,99,83,06
110 DATA 88,10,F7,A9,83,8D,21,03
115 DATA A9,06,8D,22,03,A9,4A
120 DATA 8D,89,06,8D,46,03,A9,06
125 DATA 8D,8A,06,8D,47,03,A9,33
130 DATA 8D,87,06,A9,06,8D,88,06
135 DATA 85,08,6C,FA,BF,8D,92,06
140 DATA 20,3F,06,20,60,06,D0,17
145 DATA AD,05,E4,48,AD,04,E4,48
150 DATA AD,92,06,60,20,60,06
155 DATA AD,07,E4,48,AD,06,E4,48
160 DATA AD,92,06,AE,93,06
165 DATA AC,94,06,60,8D,92,06
170 DATA 8E,93,06,8C,94,06,C9,20
175 DATA 90,15,AD,37,E4,48,AD,36,E4
180 DATA 48,AD,92,06,C9,7D,F0,04
185 DATA C9,9C,D0,02,A9,9B,60
190 DATA END
```

gram, using the command X=USR (1536), as shown in listing 3. If you are using the Assembler Editor cartridge, use the DEBUGGER's GO (execute program) command, as shown in listing 4. Those of you who have DOS may use the RUN AT ADDRESS option to execute the program, as shown in listing 5. Note that both the DEBUGGER and DOS expect the address to be given in hexadecimal, whereas BASIC expects the address in decimal.

To terminate journaling, press the SYSTEM RESET button on the console. The program will remain intact in RAM, and can be re-executed whenever you wish to re-initiate journaling. Turning the printer power off will, of course, terminate journaling. However, this is not recommended, since the trap program will continue to try to journal screen I/O, and will succeed only in wasting time.

These operating instructions are intended only as guidelines. There are many other ways the program can be invoked and you should use the procedure which best suits your own operating environment.

Conclusion

I believe you will find that the more you use this program, the more uses you will find for it. In addition to providing a journal of screen transactions, the program can be used to provide printed output from in-ROM programs which you cannot change, as in the case of the DEBUG program. Furthermore, you need never again go through your own programs, changing all the PRINT statements to LPRINT statements when you want the output to go to a printer. Another interesting feature is that you can communicate with your Atari using

***Listing 3:* Sample run of program in listing 2.**

```
READY
RUN

LOADING JOURNAL

JOURNAL LOADED

TO INITIATE JOURNALLING
  TYPE :

X=USR(1536)

READY
```

the printer instead of the TV screen: turn off the TV and talk to the computer through the printer. Or, you can treat your Atari as an intelligent typewriter, using the screen editing features to correct errors.

In short, there are many possible applications for this program, and I'm sure you will find even more uses than are listed here. I will be pleased to hear from those of you who do.

***Listing 4:* Example of using the debugger to initiate journalling.**

```
EDIT
BUG

DEBUG
G600

EDIT
```

***Listing 5:* Example of using DOS to initiate journalling.**

```
READY
DOS

DISK OPERATING SYSTEM      9/24/79
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A. DISK DIRECTORY
B. RUN CARTRIDGE
C. COPY FILE
D. DELETE FILE(S)
E. RENAME FILE
F. LOCK FILE
G. UNLOCK FILE
H. WRITE DOS FILE
I. FORMAT DISK
J. DUPLICATE DISK
K. BINARY SAVE
L. BINARY LOAD
M. RUN AT ADDRESS
N. DEFINE DEVICE
O. DUPLICATE FILE
SELECT ITEM
M
RUN FROM WHAT ADDRESS?
600
READY
```

John Elliott is currently a Systems Consultant for On-Line Software International. He has been in the data processing field for over twelve years, specializing in implementing telecommunications software on large computer systems. He has served as a consultant in various locations in the USA, Europe and the Middle East. He finds that tinkering with his Atari provides an interesting contrast to his work on mainframes.

MICRO™

MICRO PET Vet

By Loren Wright

2114 RAM Adaptor

If you have one of the old PETs with 6550 RAM chips, you probably have had one or more of them fail by now. You probably had to pay a high price for the replacement, if, in fact, you were able to find one. Optimized Data Systems (P.O. Box 595, Placentia, CA 92670) offers an inexpensive board that plugs into a pair of empty 6550 sockets and allows substitution of up to half of the 6550s with the considerably more common and less expensive 2114 RAM chips. The board is available in a number of versions, from a bare board ($8.95) to an assembled version with one 2114 and two sockets ($24.95). The board is conveniently laid out and works well.

PET Power Problems

Owners of older PETs may have experienced various forms of flakiness, particularly when additional devices draw from the PET's power supplies. The universal advice has been simply to avoid placing additional loads on the PET supplies. The fault, however, is not in the capacity of the power supplies, but rather in the poor design of the power connection to the main logic board. The board has a male connector consisting of round pins, while the female connector has flat spring contacts — not a very good connection! Under normal operation, the whole thing heats up and may eventually cause loss of contact and a crash. With an additional draw on the supply, the critical point is reached more quickly. Jim Yost of Somerville, Massachusetts, has come up with a simple and cheap solution:

> Identify the two outside wires (usually brown) on the female power connector. These lead to two separate terminals of the power transformer. Between these two transformer terminals and the positive (+) terminal of the large electrolytic capacitor connect two rectifier diodes (3A, 100V PIV). The diode positive terminals should lead to the capacitor positive terminal. This bypasses the power surges to the capacitor. See figure 1 for details.

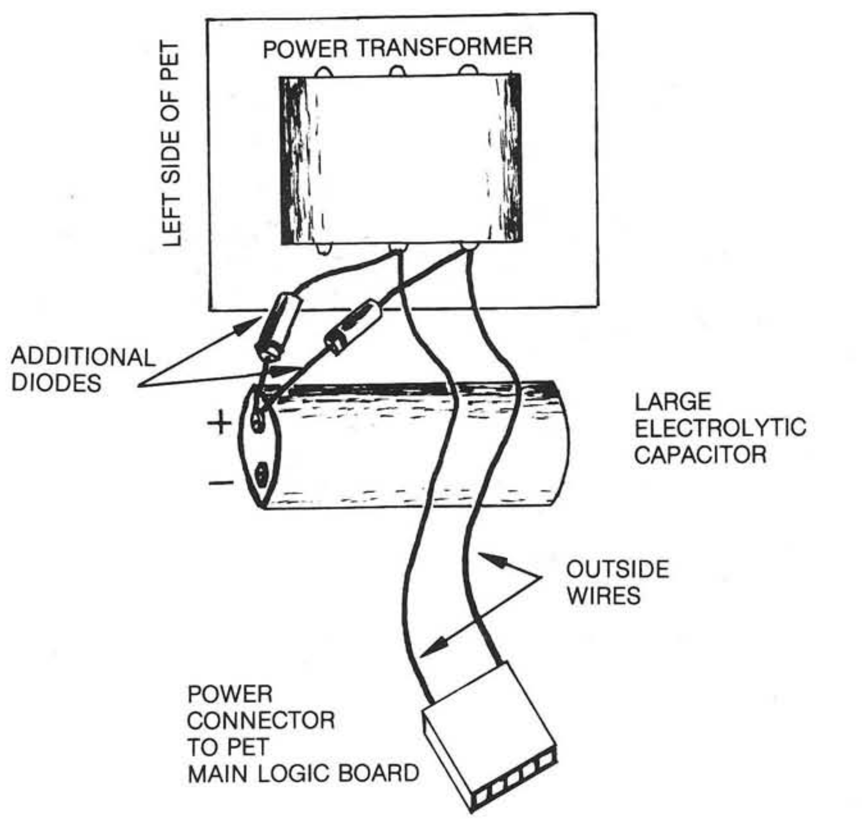

Figure 1: **Installation of diodes (not to scale — not all wires shown).**

Old PETs Live On!

Duncan Moyer of Auburn, California, points out that while a SYS 64824 on the old PET does a system reset, it fails to reset the Auxilliary Control Register to 0. To get the cassette to work properly, you must also POKE 59467,0. I have received a number of letters in support of the old PET, and I *will* treat it as a respected member of the Commodore family.

More on Command-O

During the course of writing an 8032 program to process the questionnaires included in the July MICRO, I made good use of Command-O's SCROLL and "softkey" features. The "softkey" saved me from typing lots of repetitive lines. It's nice to be able to enter with a single keystroke "X= :Y= :GOSUB5000" (followed by the appropriate number of back cursors to wind up right after the first '=').

In my review of BASIC upgrades (36:62), I casually mentioned that the FIND command of Command-O had been improved. It allows specification of a range of lines in which the search will occur. Each occurrence causes the line found to be listed with the beginning of the search string in reverse field. This means that if the same string appears three times in the same line, then that line will be listed three times.

Be careful when you make corrections to lines listed by the FIND command, though. If the found string is within quotes, then the first character will stay reversed. This is not a problem, unless you happen to hit one of the special 8032 control characters. It took me about 20 minutes one day to discover an embedded reverse 'o' as the cause of an unwanted WINDOW command!

Typesetting for the Common Man?

Type Share (8315 Firestone Blvd., Downey, CA 90241) has announced an inexpensive typesetting input system based on the Commodore VIC-20. The announced price is less than $500 including the VIC and software, but does not include the video display. Users record the input text on cassette for transfer to a larger computer for further editing/merging, or the cassette can be sent directly to one of the Type Share centers. The VIC-based system makes typesetting available to a number of small volume users, who could not otherwise afford to have typesetting done.

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ASMLST: Full-Sized Assembler Listing for AIM

ASMLST reads an AIM 20-column assembly listing produced by the AIM ROM assembler and reformats it into a full-sized assembly listing.

Joel Swank
25730 Beach Drive
Rockaway OR 97136

The AIM 4K ROM assembler is one of the most useful features of the AIM. You can enter assembler source code into memory with the AIM editor, assemble it directly from memory, and store the object in memory for quick testing. The AIM assembler can also read source from any system device and write object and assembly listing to any device.

The listing output of the AIM assembler is designed for the AIM onboard 20-column printer. Single statements are broken into as many as three lines for the AIM printer. This format is fine for short programs, but cumbersome for longer ones, and wastes a lot of paper on a TTY or full size printer. As the size of the programs I was writing increased, I realized that I would need full size listings. First I contacted 6502 software vendors, looking for a full-feature AIM compatible assembler. The only one I could find came with disk systems. So, as a last resort I decided to write ASMLST.

ASMLST reads a listing generated by the AIM assembler and constructs a full size listing. The format of the listing produced is similar to the listing format in the AIM monitor program listing manual. ASMLST produces a listing with six fields. The first field is the four character address. This address is taken from the AIM listing lines beginning with '= ='. The address is then updated as each object code line is processed. It is printed on each line, not just on the lines with labels, as with the AIM for-

Listing 1

```
                   ;*    ASMLST       *
                   ;ZERO PAGE STORAGE
                   ;
                   INDEXO EPZ $00           ;OUTPUT INDEX
                   LOC    EPZ $01           ;LOCATION COUNTER
                   LOCL   EPZ $01
                   LOCH   EPZ $02
                   TEMP   EPZ $03           ;TEMPORARY STORAGE
                   CODEIN EPZ $04           ;FLAG TO FORCE PUTLIN
                   EOF    EPZ $05           ;END OF FILE FLAG
                   LOCUP  EPZ $06           ;LOCATION COUNTER UPDATE
                   ;
                   ;AIM SUBROUTINES
                   ;
                   CRLF   EQU $E9F0         ;SEND CRLF TO AOD
                   RCHEK  EQU $E907         ;INTERRUPT CHECK
                   WHEREO EQU $E871         ;OPEN OUTPUT
                   WHEREI EQU $E848         ;OPEN INPUT
                   INALL  EQU $E993         ;GET A CHARACTER
                   OUTALL EQU $E9BC         ;PUT A CHARACTER
                   NUMA   EQU $EA46         ;PUT A HEX BYTE
                   PACK   EQU $EA84         ;ASCII TO HEX
                   DU12   EQU $E511         ;TAPE CLOSE ROUTINE
                   COMIN  EQU $E1A1         ;RETURN TO MONITOR
                   ;
                   ;EQUATES
                   ;
                   ;OUTPUT LINE FIELDS
                   ;
                   ADD    EPZ $00           ;ADDRESS
                   CODE   EPZ $05           ;OBJECT CODE
                   LABEL  EPZ $0D           ;LABEL
                   OPCODE EPZ $14           ;OPCODE
                   OPER   EPZ $18           ;OPERAND
                   COMM   EPZ $24           ;COMMENT
                   ;
                   CR     EPZ $0D
                   LF     EPZ $0A
                   CTLZ   EPZ $1A
                   ;
                   OUTFLG EQU $A413         ;OUTPUT DEVICE
                   ;
                          ORG $200
                   ;
0200 2048E8        ASMLST JSR WHEREI        ;OPEN INPUT DEVICE
0203 2071E8               JSR WHEREO        ;OPEN OUTPUT DEVICE
0206 A905                 LDA #$05
0208 8503                 STA TEMP          ;SKIP THE FIRST 5 LINES
020A 208103        SKLOOP JSR GETLIN
020D C603                 DEC TEMP
020F D0F9                 BNE SKLOOP
0211 A900                 LDA #$00          ;CLEAR LOCATION INCREMENT
0213 8506                 STA LOCUP
0215 8505                 STA EOF           ;AND END FLAG
0217 8501                 STA LOCL          ;AND LOCATION COUNTER
0219 8502                 STA LOCH
021B 20B303               JSR CLROUT        ;INIT OUTPUT BUFFER
021E 2007E9        NXTLIN JSR RCHEK         ;INTERRUPT?
0221 A505                 LDA EOF           ;AT END?
0223 D029                 BNE CLOSE         ;YES, GO FINISH UP
0225 208103               JSR GETLIN        ;GET A LINE
```

(Continued)

mat. The next field is the object code field. This field contains 0 to 3 bytes of object code generated by the statement. The label field is next, followed by the opcode and operand fields. Last is the comment field. The actual positions of these fields are defined by equates in the assembly source (see listing 1).

Because of the format of the AIM assembly listing, it is not always possible to tell how the source was entered. One problem is that all comments are printed on a separate line. This means that ASMLST cannot tell whether a comment was part of the preceding line or entered on a separate line. But, if you follow a few rules, you can enter your source so that you get the desired listing.

If you want a comment to be placed at the end of a line in the comment field, enter it on that line separated from the operand by a blank, or instead, enter it in column 1 of the following line. Both of these methods generate the same listing from the AIM assembler. This is true except for comments on the '=' directive. The AIM print format for the '=' directive is different. If the comment is entered on the same line as the '=' directive, the assembler will insert a blank line between the directive and the comment. So, if you want a comment on an '=' directive, you must enter it in the first column of the next line. If you want a comment to appear on a line by itself, you may enter it starting in column two or greater. This will generate a blank line and the comment will appear starting in the label field. A comment that follows a comment always appears on a line by itself.

There is also a problem with the data assignment directives (.BYTE, .WORD, etc.). ASMLST may not be able to keep the address field updated properly if the NOGEN listing option is used. When you use NOGEN, the generated data bytes are not printed. ASMLST must count these bytes to keep the address field updated. To avoid this problem you must assemble with the GEN option or specify only one operand on each directive.

ASMLST inserts a form feed ($0C) when it detects a page break (from the .PAGE directive). It deletes the first five lines (PASS 1, PASS 2, etc.) of the listing and copies **ERROR messages are they are. ASMLST is designed to work on debugged listings; an error in your program may foul it up. ASMLST recognizes the .END directive as the end of the listing.

```
0228 ADD103        LDA LBUFI          ;FIRST CHARACTER
022B          ;
022B          ;FIRST CHARACTER DETERMINES ROUTINE
022B          ;
022B C920          CMP '              ;BLANK?
022D D003          BNE NOBL           ;NOPE
022F 4CB102        JMP BLHAN
0232 C93D   NOBL   CMP '=             ;EQUALS?
0234 D003          BNE NOEQ           ;NOPE
0236 4CF102        JMP EQHAN
0239 C93B   NOEQ   CMP ';             ;SEMICOLON?
023B D003          BNE NOCOM          ;NOPE
023D 4C1003        JMP COMHAN
0240 C95F   NOCOM  CMP #$5F           ;UNDERSCORE?
0242 D003          BNE NOPAG          ;NOPE
0244 4C2703        JMP PAGHAN
0247 C92A   NOPAG  CMP '*             ;ASTERISK?
0249 D029          BNE HEXHAN         ;NO, MUST BE HEX CODE
024B 4C4503        JMP ASTHAN
024E          ;
024E          ;CLOSE : PUT LAST LINES, CLOSE TAPE,
024E          ;        AND RETURN TO MONITOR
024E 209503 CLOSE  JSR PUTLIN         ;SEND CURRENT LINE
0251 208103        JSR GETLIN         ;GET LAST LINE
0254 A20D          LDX #LABEL         ;COPY TO OUTPUT BUFFER
0256 206803        JSR COPOVR
0259 209503        JSR PUTLIN         ;SEND IT
025C A91A          LDA #CTLZ          ;SEND A CONTROL-Z
025E 20BCE9        JSR OUTALL
0261 20F0E9        JSR CRLF
0264 20F0E9        JSR CRLF           ;AND A COUPLA CRLFS
0267 AD13A4        LDA OUTFLG         ;CHECK OUTPUT DEVICE
026A C954          CMP 'T             ;IT IS TAPE?
026C D003          BNE NOTAP          ;NO
026E 2011E5        JSR DU12           ;YES, CLOSE FILE
0271 4CA1E1 NOTAP  JMP COMIN          ;RETURN TO MONITOR
0274          ;
0274          ;END OF MAINLINE
0274          ;
0274          ;THE FOLLOWING 6 ROUTINES EACH HANDLE 1 TYPE
0274          ;    OF INPUT LINE
0274          ;
0274          ;HEXHAN : PROCESS LINE OF OBJECT CODE
0274          ;
0274 A504   HEXHAN LDA CODEIN         ;BEEN HERE ON THIS STMT?
0276 D006          BNE PUTC           :YES
0278 A500          LDA INDEXO         ;GET OUTPUT INDEX
027A C915          CMP #OPCODE+1      ;OPCODE PRESENT?
027C 9003          BCC COPHEX         ;NO, DON'T SEND
027E 209503 PUTC   JSR PUTLIN         ;YES, PUT CURRENT LINE
0281 A000   COPHEX LDY #$00           ;BEGINNING OF INPUT
0283 A205          LDX #CODE          ;OUTPUT INDEX
0285 8604          STX CODEIN         ;SHOW WE BEEN HERE
0287 B9D103 CHLUP  LDA LBUFI,Y        ;GET A CHAR
028A C90D          CMP #CR            ;END OF LINE?
028C F018          BEQ PUTHEX         ;YES, GO SEND
028E C920          CMP '              ;SPACE?
0290 F007          BEQ SKIPSP         ;YES, GO FINISH LINE
0292 9D5104        STA LBUFO,X        ;COPY A CHAR
0295 C8            INY                ;BUMP POINTERS
0296 E8            INX
0297 10EE          BPL CHLUP          ;NEXT CHARACTER
0299 206203 SKIPSP JSR UPLOC          ;UPDATE LOCATION COUNTER
029C A007          LDY #$07
029E A214   COPCOD LDX #OPCODE        ;OPCODE OFFSET
02A0 206A03        JSR COPOV2         ;COPY TO OUTPUT BUFF
02A3 4C1E02        JMP NXTLIN         ;
02A6 206203 PUTHEX JSR UPLOC          ;UPDATE LOCATION COUNTER
02A9 8600          STX INDEXO         ;MARK END OF LINE
02AB 209503        JSR PUTLIN         ;SEND LINE
02AE 4C1E02        JMP NXTLIN         ;NEXT LINE
02B1          ;
02B1          ;BLHAN : PROCESS LINE STARTING WITH BLANK
02B1          ;
02B1 A500   BLHAN  LDA INDEXO         ;WHERE IN OUTPUT LINE?
02B3 C90D          CMP #LABEL         ;LABEL PRESENT?
02B5 9004          BCC NEWL           ;NO, SEND LINE
02B7 C915          CMP #OPCODE+1      ;OPCODE PRESENT?
```

(Continued)

```
02B9 9003               BCC SCANC           ;NO, DON'T SEND
02BB 209503      NEWL   JSR PUTLIN          ;SEND CURRENT LINE
02BE A001        SCANC  LDY #$01            ;START SEARCH AT COLUMN 1
02C0 B9D103      BLSCH  LDA LBUFI,Y         ;SCAN TO FIRST NON-BLANK
02C3 C90D               CMP #CR             ;WATCH FOR END
02C5 F01C               BEQ EMPLIN          ;NULL LINE
02C7 C920               CMP '               ;BLANK?
02C9 D003               BNE DOTCHK          ;NO, GO CHECK FOR DOT
02CB C8                 INY                 ;NEXT CHAR
02CC 10F2               BPL BLSCH
02CE C92E        DOTCHK CMP '.              ;CHECK FOR END STMT
02D0 D009               BNE BLCOP           ;NO
02D2 B9D203             LDA LBUFI+1,Y       ;GOT A DIRECTIVE, IS IT .END?
02D5 C945               CMP 'E
02D7 D002               BNE BLCOP           ;NO
02D9 8505               STA EOF             ;YES, FLAG END OF FILE
02DB A214        BLCOP  LDX #OPCODE         ;OUTPUT INDEX
02DD 206A03             JSR COPOV2          ;COPY REST OF LINE
02E0 4C1E02             JMP NXTLIN          ;NEXT LINE
02E3 209503      EMPLIN JSR PUTLIN          ;SEND LINE
02E6 A920               LDA '
02E8 20BCE9             JSR OUTALL
02EB 20F0E9             JSR CRLF            ;AND AN EMPTY LINE
02EE 4C1E02             JMP NXTLIN          ;NEXT LINE
02F1             ;
02F1             ;EQHAN : PROCESS A LINE BEGINNING WITH '='
02F1             ;
02F1 209503      EQHAN  JSR PUTLIN          ;SEND LINE IF ANY
02F4 A002               LDY #$02            ;POINT TO ADDRESS
02F6 205303             JSR GETHEX          ;CONVERT HIGH BYTE
02F9 8502               STA LOCH            ;SAVE IT IN LOCATION COUNTER
02FB 205303             JSR GETHEX          ;CONVERT LOW BYTE
02FE 8501               STA LOCL            ;SAVE
0300 B9D103             LDA LBUFI,Y         ;ANY MORE?
0303 C90D               CMP #CR
0305 F006               BEQ JNEXT1
0307 C8                 INY
0308 A20D               LDX #LABEL          ;PREPARE FOR LABEL
030A 206A03      COPLAB JSR COPOV2          ;COPY LABEL
030D 4C1E02      JNEXT1 JMP NXTLIN          ;NEXT LINE
0310             ;
0310             ;COMHAN : PROCESS A COMMENT
0310             ;
0310 A600        COMHAN LDX INDEXO          ;ANY LINE IN PROCESS
0312 F008               BEQ COMLAB          ;NO
0314 E024               CPX #COMM           ;PAST COMMENT FIELD?
0316 B006               BCS COMCOP          ;YES, USE VALUE
0318 A224               LDX #COMM           ;NO, COPY TO COMMENT FIELD
031A D002               BNE COMCOP
031C A20D        COMLAB LDX #LABEL          ;COPY TO LABEL
031E 206803      COMCOP JSR COPOVR
0321 209503             JSR PUTLIN          ;SEND LINE
0324 4C1E02             JMP NXTLIN
0327             ;
0327             ;PAGHAN : PROCESS A NEW PAGE
0327             ;
0327 209503      PAGHAN JSR PUTLIN          ;SEND CURRENT LINE
032A A90C               LDA #$0C            ;SEND A FORM FEED
032C 20BCE9             JSR OUTALL
032F A20D               LDX #LABEL          ;COPY UNDERSCORES TO LABEL
0331 206803             JSR COPOVR
0334 209503             JSR PUTLIN          ;SEND IT
0337 208103             JSR GETLIN          ;GET TITLE
033A A20D               LDX #LABEL          ;COPY TO OUTPUT LINE
033C 206803             JSR COPOVR
033F 209503             JSR PUTLIN          ;SEND IT
0342 4C1E02             JMP NXTLIN          ;NEXT LINE
0345             ;
0345             ;ASTHAN : PROCESS ERROR STATEMENT
0345             ;
0345 209503      ASTHAN JSR PUTLIN          ;SEND CURRENT LINE
0348 A205               LDX #CODE
034A 206803             JSR COPOVR          ;COPY TO OUTPUT BUFF
034D 209503             JSR PUTLIN          ;SEND IT
0350 4C1E02             JMP NXTLIN
0353             ;
0353             ;
0353             ;SUBROUTINES FOLLOW
```

(Continued)

ASMLST inputs an AIM assembly listing from the AID (Active Input Device) and outputs the new listing to the AOD (Active Output Device). Start ASMLST at $200. You will receive the Standard IN= and OUT= prompts for the input and output devices. You can input from tape and send the output to a printer through the user port or to a TTY or CRT through the AIM TTY port. You can also input from tape and output to tape, if you have two remote controlled tape recorders. For long listings you may want to partition the listing output with the LIST and NOLIST Options. This is fine as long as you are sure that the .END statement is listed so that ASMLST can recognize the end of the listing.

ASMLST works if you have a full sized printer or terminal, but what about those of us with only the AIM 20-column printer? Help is available with 'SPLIT' program, which allows the AIM printer to print listings up 80 characters wide. It inputs the output from ASMLST and splits it into 20-column sections for printing on the AIM onboard printer. You then cut and paste to create a full width listing. Execute SPLIT at $200 and it will first prompt the section to be printed. Each section is 20 columns wide and numbered 1 to 4. Section 1 is columns 1-20, section 2 is columns 21-40, and so on. SPLIT then issues the standard IN= and OUT= prompts. The input file must be read once to print each section. The number of sections allowed can be increased to 7, simply by changing the value in the compare instruction at $221. The size of each section is controlled by the value assigned to the label 'SIZE'. If you would like to use ASMLST with SPLIT, you may want to change the equates in ASMLST for the output line fields as follows:

ADD	= 0
CODE	= 5
LABEL	= 12
OPCODE	= 19
OPER	= 23
COMM	= 31

ASMLST then produces a listing format that will fit into 40 columns. This leaves only 10 columns for the comment field. The 40-column format makes the most efficient use of two passes of SPLIT On the AIM printer. ASMLST and SPLIT are especially valuable if you want to publish a program in a magazine or newsletter. The reader will appreciate the increased readability of your listing. You can also use SPLIT to print BASIC files. In fact any ASCII file that ends with a Control-Z can be printed in sections with SPLIT.

```
0353             ;
0353             ;
0353             ;GETHEX : GET A BYTE OF ASCII HEX FROM INPUT LINE
0353             ;
0353 B9D103      GETHEX LDA LBUFI,Y          ;GET HIGH NYBBLE
0356 2084EA             JSR PACK             ;CONVERT TO BINARY
0359 C8                 INY
035A B9D103             LDA LBUFI,Y          ;GET LO NYBBLE
035D 2084EA             JSR PACK             ;CONVERT TO BIN
0360 C8                 INY
0361 60                 RTS
0362             ;
0362             ;UPLOC ; SAVE LOCATION COUNTER INCREMENT
0362             ;
0362 C8         UPLOC   INY                  ;BUMP POINTER
0363 98                 TYA
0364 4A                 LSR                  ;DIVIDE BY 2
0365 8506               STA LOCUP            ;SAVE
0367 60                 RTS
0368             ;
0368             ;COPOVER : COPY ALL OR PART OF THE INPUT LINE TO THE
0368             ;          OUTPUT BUFFER AT OFFSET IN X
0368             ;
0368 A000        COPOVR LDY #$00             ;BEGINNING OF INPUT LINE
036A             ;ENTRY TO COPY PARTIAL LINE
036A B9D103      COPOV2 LDA LBUFI,Y          ;GET A CHAR
036D C90D               CMP #CR              ;END?
036F F00D               BEQ COPOUT           ;YES, QUIT
0371 C93D               CMP '=               ;CHECK FOR '=' DIRECTIVE
0373 D002               BNE STOCH            ;NOPE
0375 8504               STA CODEIN           ;REMEMBER
0377 9D5104      STOCH  STA LBUFO,X          ;STORE IN OUTPUT BUFFER
037A E8                 INX                  ;NEXT
037B C8                 INY                  ;NEXT
037C 10EC               BPL COPOV2
037E 8600        COPOUT STX INDEXO           ;SAVE LAST
0380 60                 RTS
0381             ;
0381             ;GETLIN : GET ONE LINE INTO INPUT BUFFER
0381             ;
0381 A000        GETLIN LDY #$00             ;BEGINNING
0383 2093E9      GETCHR JSR INALL            ;GET A CHAR
0386 C90A               CMP #LF              ;LINE FEED?
0388 F0F9               BEQ GETCHR           ;YES, IGNORE IT
038A 99D103             STA LBUFI,Y          ;SAVE
038D C90D               CMP #CR              ;END?
038F F003               BEQ GOTLIN           ;YES, QUIT
0391 C8                 INY
0392 10EF               BPL GETCHR           ;NEXT CHAR
0394 60          GOTLIN RTS
0395             ;
0395             ;PUTLIN : SEND OUTPUT BUFFER TO OUTPUT DEVICE
0395             ;
0395 A500        PUTLIN LDA INDEXO           ;ANYTHING THERE?
0397 F037               BEQ NOPUT            ;NO, SKIPPIT
0399 A502               LDA LOCH             ;GET HI BYTE OF LOC COUNTER
039B 2046EA             JSR NUMA             ;SEND TO OUTPUT
039E A501               LDA LOCL             ;GET LO BYTE
03A0 2046EA             JSR NUMA             ;SEND IT
03A3 A204               LDX #$04             ;INIT INDEX
03A5 BD5104      PUTCHR LDA LBUFO,X          ;GET A CHAR
03A8 20BCE9             JSR OUTALL           ;SEND IT
03AB E8                 INX
03AC E400               CPX INDEXO           ;END OF LINE?
03AE 90F5               BCC PUTCHR           ;NO
03B0 20F0E9             JSR CRLF             ;TERMINATE LINE
03B3 A27F        CLROUT LDX #$7F             ;CLEAR OUTPUT BUFFER
03B5 A920               LDA '
03B7 9D5104      CLRLUP STA LBUFO,X
03BA CA                 DEX
03BB 10FA               BPL CLRLUP
03BD A506               LDA LOCUP            ;UPDATE LOCATION COUNTER
03BF 18                 CLC
03C0 6501               ADC LOCL
03C2 8501               STA LOCL
03C4 9002               BCC NOCY
03C6 E602               INC LOCH
03C8 A900        NOCY   LDA #$00             ;CLEAR DATA
```

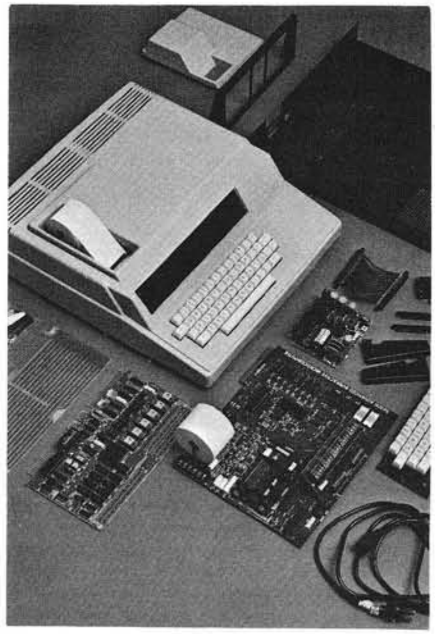
(Continued)

```
03CA 8506           STA LOCUP
03CC 8500           STA INDEXO
03CE 8504           STA CODEIN
03D0 60      NOPUT  RTS
03D1         ;
03D1         ;BUFFERS
03D1         ;
0A51         LBUFI  DFS $80
0AD1         LBUFO  DFS $80
04D1         ;
                    END
```

Listing 2

```
              ;*          SPLIT        *
              ;ZERO PAGE STORAGE
              ;
              COUNT  EPZ $00           ;CHARACTER COUNT
              SECTON EPZ $01           ;CURRENT SECTION
              ;
              ;AIM SUBROUTINES
              ;
              BLANK  EQU $E83E         ;SEND BLANK TO D/P
              REDOUT EQU $E973         ;INPUT AN ASCII CHAR
              CRLF   EQU $E9F0         ;SEND CRLF TO AOD
              RCHEK  EQU $E907         ;INTERRUPT CHECK
              WHEREO EQU $E871         ;OPEN OUTPUT
              WHEREI EQU $E848         ;OPEN INPUT
              INALL  EQU $E993         ;GET A CHARACTER
              OUTALL EQU $E9BC         ;PUT A CHARACTER
              CKER00 EQU $E394         ;DISPLAY 'ERROR'
              OUTPUT EQU $E97A         ;SEND TO DISPLAY
              DU12   EQU $E511         ;TAPE CLOSE ROUTINE
              COMIN  EQU $E1A1         ;RETURN TO MONITOR
              ;EQUATES
              CR     EQU $0D
              CTLZ   EQU $1A
              SIZE   EQU $14
              LF     EQU $0A
              OUTFLG EQU $A413
                     ORG $0200
                     OBJ $0800
              ;
0200 A000     SPLIT  LDY #$00          ;INIT INDEX
0202 B9AF02   MSGLUP LDA MESG,Y        ;GET A CHAR
0205 F006            BEQ GSPLIT        ;QUIT ON ZERO
0207 207AE9          JSR OUTPUT        ;DISPLAY IT
020A C8              INY
020B 10F5            BPL MSGLUP        ;NEXT
020D 2073E9   GSPLIT JSR REDOUT        ;GET REPLY
0210 C931            CMP '1            ;LEGAL (1 TO 4)?
0212 9004            BCC BADNUM        ;NO
0214 C935            CMP '5
0216 9009            BCC GOODNM        ;YES
0218 2094E3   BADNUM JSR CKER00        ;PRINT ERROR MSG
021B 20F0E9          JSR CRLF
021E 4C0002          JMP SPLIT         ;TRY AGAIN
0221 2907     GOODNM AND #$07          ;CLEAR HI BYTES
0223 8501            STA SECTON        ;SAVE IT
0225 203EE8          JSR BLANK
0228 2048E8          JSR WHEREI        ;OPEN INPUT
022B 2071E8          JSR WHEREO        ;OPEN OUTPUT
022E 205802   NXTLIN JSR GETLIN        ;GET A LINE FROM INPUT DEVICE
0231 B009            BCS FIN           ;QUIT ON CTLZ
0233 209502          JSR SPLCHK        ;CALCULATE SPLIT
0236 207B02          JSR PUTLIN        ;SEND LINE
0239 4C2E02          JMP NXTLIN        ;GET ANOTHER LINE
023C AD13A4   FIN    LDA OUTFLG        ;CHECK OUTPUT DEVICE
023F C950            CMP 'P            ;PRINTER?
0241 F012            BEQ NOTAP         ;YES SKIP EOF MARK
0243 A91A            LDA #CTLZ         ;SEND A CONTROL-Z
0245 20BCE9          JSR OUTALL
0248 20F0E9          JSR CRLF
024B 20F0E9          JSR CRLF          ;AND 2 CRLFS
024E C954            CMP 'T            ;IS IT TAPE?
0250 D003            BNE NOTAP         ;NO
0252 2011E5          JSR DU12          ;YES, CLOSE FILE
0255 4CA1E1   NOTAP  JMP COMIN         ;RETURN TO MONITOR
0258          ;END OF MAINLINE
0258          ;SUBROUTINES FOLLOW
0258          ;
0258          ;GETLIN : GET ONE LINE INTO INPUT BUFFER
```

(Continued)



```
0258                ;
0258 A080          GETLIN LDY #$80          ;CLEAR BUFFER
025A A920                 LDA '
025C 99B802        CLRLUP STA LBUF,Y
025F 88                   DEY
0260 D0FA                 BNE CLRLUP
0262 2093E9        GETCHR JSR INALL         ;GET A CHAR
0265 C90A                 CMP #LF           ;LINE FEED?
0267 F0F9                 BEQ GETCHR        ;YES, IGNORE IT
0269 C91A                 CMP #CTLZ         ;END OF FILE?
026B F00C                 BEQ ZOUT          ;YES
026D 99B802               STA LBUF,Y        ;SAVE
0270 C90D                 CMP #CR           ;END?
0272 F003                 BEQ GOTLIN        ;YES, QUIT
0274 C8                   INY
0275 10EB                 BPL GETCHR        ;NEXT CHAR
0277 18            GOTLIN CLC
0278 60                   RTS
0279 38            ZOUT   SEC
027A 60                   RTS
027B                ;
027B                ;PUTLIN : SEND OUTPUT BUFFER TO OUTPUT DEVICE
027B                ;
027B A914          PUTLIN LDA #SIZE         ;INIT CHAR COUNT
027D 8500                 STA COUNT
027F B9B802        PRLUP  LDA LBUF,Y        ;GET A CHARACTER
0282 C90D                 CMP #CR           ;END OF LINE?
0284 F008                 BEQ EOL           ;YES
0286 20BCE9               JSR OUTALL
0289 C8                   INY
028A C600                 DEC COUNT         ;COUNT IT
028C D0F1                 BNE PRLUP         ;CONTINUE UNTIL SIZE
028E 2007E9        EOL    JSR RCHEK         ;CHECK FOR INTERRUPT
0291 20F0E9               JSR CRLF          ;END LINE
0294 60                   RTS
0295                ;
0295                ;SPLCHK : SET Y FOR PROPER SECTION OF LISTING
0295                ;
0295 A601          SPLCHK LDX SECTON        ;GET SECTION NUMBER
0297 A000                 LDY #$00          ;BEGINNING OF LINE
0299 CA            SPLUP1 DEX               ;COUNT SECTION
029A F012                 BEQ SPOUT         ;DUN
029C A914                 LDA #SIZE         ;GET LINESIZE
029E 8500                 STA COUNT
02A0 B9B802        SPLUP2 LDA LBUF,Y        ;GET A CHAR
02A3 C90D                 CMP #CR           ;END OF LINE?
02A5 F007                 BEQ SPOUT         ;YES, QUIT
02A7 C8                   INY
02A8 C600                 DEC COUNT         ;END OF SECTION?
02AA D0F4                 BNE SPLUP2        ;NO, GET ANOTHER CHAR
02AC F0EB                 BEQ SPLUP1        ;YES, TRY NEXT SECTION
02AE 60            SPOUT  RTS
02AF 534543        MESG   ASC 'SECTION='
02B2 54494F
02B5 4E3D
02B7 00                   HEX 00
02B8                ;BUFFER
02B8                ;
0938               LBUF   DFS $80
                          END
```

Note: When the AIM assembler listing is directed to tape, the assembler does not properly close the file at the end of the assembly. This will cause the last block of data to never be written. To circumvent this problem you must run one of the following programs immediately after the assembly is finished.

If you are using any device EXCEPT tape for the source input, then execute the following routine:

```
CLD
JSR E511 (close tape file)
JMP E1A1 (return to AIM)
```

If you are using tape for both source input and listing output, execute the following program:

```
CLD
LDA #54     (move 'T' to INFLG
STA A412    and OUTFLG so
            alternate buffer
STA A413    will be used.)
JSR E511    (close tape file)
JMP E1A1    (return to AIM)
```

Either of these programs can be located in any unused spot in memory and can be executed with the GO command.

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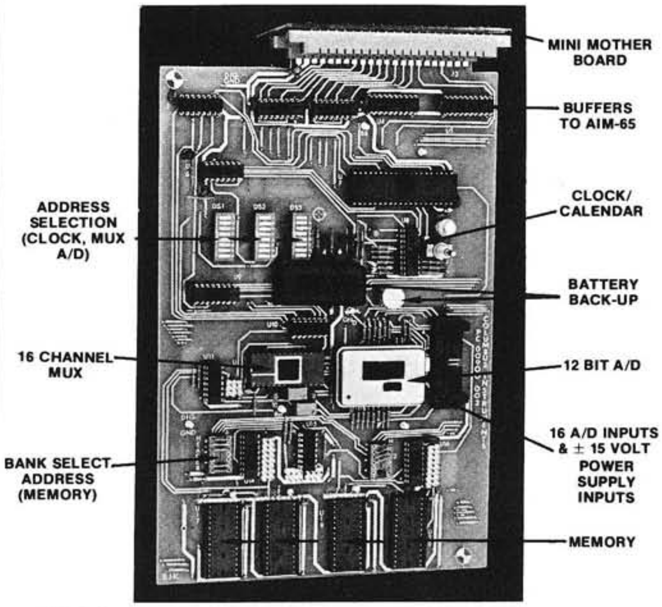

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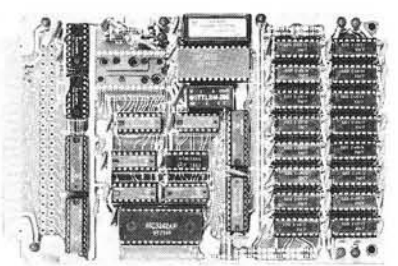

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MICRO

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6809

CHROMASETTE Magazine is a monthly issued on cassette tape and devoted entirely to the TRS-80 Extended BASIC Color Computer. The first issue appeared in July 1981. Each monthly tape contains six to eight programs that directly load and run on the color computer. They include games, tutorials, utilities, and application programs by various authors. The same publisher issues *CLOAD Magazine*, for the TRS-80 Models I and III. Subscriptions are available for one year ($45.00) or half-a-year ($25.00) from CHROMASETTE Magazine, P.O. Box 1087, Santa Barbara, California 93102.

Atari

The Atari Assembler by Don Inman and Kurt Inman. Reston Publishing Company, Inc. (Reston, Virginia), 1981, xii, 270 pages, 78 illustrations, 6¼ × 9¼ inches.
ISBN: 0-8359-0237-4 (cloth) $14.95
ISBN: 0-8359-0236-6 (paper) $ 9.95

This is an introduction to assembly language programming for use with the Atari Assembler Cartridge. The book is written for the beginning assembly language programmer who has some knowledge of BASIC.

CONTENTS: *Introduction*—Computer Architecture; Review of BASIC; Graphics Keywords. *Machine Language from BASIC*—Binary Number Patterns; Hexadecimal Notation; Hexadecimal-to-Decimal Conversion; How the Machine Language Program Works; Summary; Exercises; Answers. *Memory Use*—Atari Memory Map; How BASIC Finds the Machine Language Program; Passing Variables to Machine Language Subroutine; Using the One-Variable Program; Passing More Than One Variable; A Machine Language Loop; New Instructions Used; Tracing Through the Subroutine; Summary; Exercises; Answers. *Getting Started with the Assembler*—The Writer/Editor; The Assembler Program; Executing the Machine Language Program—The Debugger; Summary; Exercises; Answers. *Special-Purpose Registers and Addressing Modes*—The Accumulator; the X and Y Registers; The Processor Status Register; The Stack Pointer Register; Addressing, Modes; Summary; Exercises; Answers. *Branching Out*—Examples Using Forward Branches; Examples Using Backward Branches; Using the Carry Flag; Using the Zero Flag; Using the Negative Flag; The Overflow Flag; Summary; Exercises; Answers. *Assembler Review*—Source Program Format; Methods to Use Operands; The Assembler Writer/Editor Mode; The Debug Mode; Exercises; Answers. *Designing a Program*—Absolute Indexed Addressing; Using the Add Five Pairs of Numbers Program; Using the Add Ten Program; A Variation of the Add Ten Program; Yet Another Variation; Summary; Exercises; Answers. *Addition and Subtraction*—Two-Byte Addition; Two Programs in Memory; Two-Byte Subtraction; Negative Numbers; Multiple-Byte Addition and Subtraction; Decimal Arithmetic; Summary; Exercises; Answers. *Shift and Rotate*—Arithmetic Shift Left; Logical Shift Right; Rotate Left; Rotate Right; Summary; Exercises; Answers. *Multiplication, Division, and Subroutines*—Eight-Bit Multiplication; Using the 8-Bit Multiplication Program; Eight-Bit Division; Subroutines; Using a Subroutine; Summary; Exercises; Answers. *Programming Practice*—Using a Logic Function; Entering the Subroutine; Program to Sound Off; Play Notes Program; Program to Shape Sound; Program to Print on the Screen; You're On Your Own. *Appendix A*-6502 Instructions—Flags Affected. *Appendix B*—6502 Instructions—Addressing Modes. *Appendix C*—Frequency Values for Three-Octave Scale. *Appendix D*—Atari Assembler Error Codes. *Appendix E*—Atari Operating System Errors. *Appendix F*—ATASCII Character Set. *Index.*

AIM

The Take AIM Manual, Volume 1 by James Hoyt Clark. Matrix Publishers, Inc. (11000 S.W. 11th, Beaverton, Oregon 97005). 1981, xii, 388 pages, diagrams, drawings, listings, 8½ × 11 inches, paperbound.
ISBN: 0-916460-29-0 $16.95

This manual is designed as an addition to the AIM 65 documentation that is enclosed with the AIM 65. To use this manual successfully, a reader must first be able to use the AIM 65 documentation.

CONTENTS: *How To Use This Manual. The Formal Introduction*—The AIM 65 Hardware; The PERSON; Some Useful Steps—Software Example. *In The Beginning*—A Short History; The Sixteen Commandments of Microcomputers; 0 0000 CAUTION; 1 0001 POWER; 2 0010 WIRING; 3 0011 The Foundation; 4 0100 INSIGHT/OUTSIGHT; 5 0101 & 6 0110 Info Sources; 7 0111 Micro Chauvinist; 8 1000 NOP; 9 1001 Other Programs—the LAW; A 1010 Checking with the Neighbor; B 1011 & C 1100 Q & A's; D 1101 Storage; E 1110 The Every Half Hour Be Carefuls; F 1111 An Understanding. *The Language of the AIM 65*—The Hex Format; The Mnemonic Format; The ASCII Text Format; The EDITOR and ASSEMBLER; The Cost of Assembling; How to Input the TAKE AIM Programs. *Microcomputer Basics*—Memory; Some Programming Information; The Brains—the 6502 Microprocessor; The Heart—Clocks and Timing. *AIM 65 Documentation Explained*—Manuals, Cards, and a Chart; The Chicken or the Egg; User's Guide; The Monitor Program Listing; 6500 Microprocessor Programming Reference Card; The AIM 65 Wall Chart; The Monitor and Editor Subroutines. *The AIM 65 Documentation Index. The AIM 65 Display*—The Display Hardware; DISPLAYING; *The AIM 65 Keyboard*—The Keyboard Hardware; KEYING; KBINT Program; ASCII Program; DEMCU Program. *Versatile Interface Adaptor (VIA)*—The 6522 Homologous Homuncular Warehouse; Diagram of the VIA 6522; VIA Data Output Register Schematics; Summary of VIA Control Registers; Summary of VIA Commands. *Glossary. The GAIMS Programs*—BINARY TO HEXADECIMAL CONVERSION Program—BINHX; CARDS Program—CARDS; REACTION TIMER Program—REACT; GOLLUM'S CAVERNS Program—GC; ESP Program—ESP; BAGELS Program—BAGEL; BRICKS Program—BRICK; HANGMAN Program—HANGM; TIC TAC TOE Program—TIC; STARWAY 090 Program—STAR9. *The UTILITY Programs*—ROTATING BILLBOARD—ROTBB; PRINTER WAVES Program—PRTWV; ADDITION & SUBTRACTION—ADDSB; TOTAL Program—TOTAL; TIMER Program—TIMER; Printer Paper Programs; MEMORY TEST Program—MTEST; Hexadecimal Input/Output Programs; EDITOR RESTORE Program—ESTOR; SUPER SIGNS Program—SIGNS; CONVERT DECIMAL TO HEX Program—CNVRT; SYMBOL TABLE—SYMTB; FIELD SORT Program—FSORT; RELOCATE MEMORY Program—RLOC; DISASSEMBLY 1-STEP Program—K1STP; FIBBONACCI NUMBER SERIES Program—FIBBN. *The Appendix—Contents*—ROCKWELL Specification Sheets; Questions for the TAKE AIM Manual; Worksheets and Memory Page Samples; Reply Form.

Pascal

Pascal Programs for Scientists and Engineers by Alan R. Miller. Sybex Inc. (2344 Sixth Street, Berkeley, California 94710), 1981, xxii, 378 pages, 134 listings and illustrations, 7 × 9 inches, paperbound.
ISBN: 0-89588-058-X $16.95

This book was written to help readers gain a proficiency in Pascal and to pro-

(Continued on next page)

New Publications

(Continued from page 45)

vide a library of programs useful for solving problems frequently encountered in science and engineering. It contains over 60 of the most frequently used scientific algorithms, along with their program implementation in Pascal. The book is designed not only for the practicing scientist or engineer but is also suitable for a junior- or senior-level engineering course in numerical methods. Users need a working knowledge of an applications language (Pascal, FORTRAN, or BASIC). Experience with vector operations and differential and integral calculus is also recommended by the authors.

CONTENTS: *Evaluation of a Pascal Compiler*—Introduction; Precision and Range of Floating-Point Operations; Pascal Program: A Test of the Floating-Point Operations; Pascal SIN and COS Functions; Pascal Program: Testing the SIN Function; Other Pascal Functions; External Files; A Power-of-10 Function; Pascal Program: Calculating Powers of 10; Summary. *Mean and Standard Deviation*—Introduction; The Mean; The Standard Deviation; Pascal Program: Mean and Standard Deviation; Random Numbers; Pascal Function: A Random Number Generator; Pascal Program: Evaluation of a Random Number Generator; Pascal Function: Gaussian Random Number Generator; Pascal Program: Evaluating RANDG; Summary. *Vector and Matrix Operations*—Introduction; Scalars and Arrays; Vectors; Matrices; Pascal Program: Matrix Multiplication; Determinants; Pascal Program: Determinants; Inverse Matrices and Matrix Division; Summary. *Simultaneous Solution of Linear Equations*—Introduction; Linear Equations and Simultaneous Equations; Solution by Cramer's Rule; Pascal Program: A More Elegant Use of Cramer's Rule; Solution by Gauss Elimination; Pascal Program: The Gauss Elimination Method; Solution by Gauss-Jordan Elimination; Pascal Program: Gauss-Jordan Elimination; Multiple Constant Vectors and Matrix Inversion; Pascal Program: Gauss-Jordan Elimination, Version Two; Ill-Conditioned Equations; Pascal Program: Solving Hilbert Matrices; A Simultaneous Best Fit; Pascal Program: The Best Fit Solution; Equations with Complex Coefficients; Pascal Program: Simultaneous Equations with Complex Coefficients; The Gauss-Seidel Iterative Method; Pascal Program: The Gauss-Seidel Method; Summary. *Development of a Curve-Fitting Program*—Introduction; The Main Program; A Printer Plotter Routine; A Simulated Curve Fit; The Curve-Fitting Algorithm; The Correlation Coefficient; Pascal Program: Least-Squares Curve Fitting for Simulated Data; Summary. *Sorting*—Introduction; Handling Experimental Data; A Bubble Sort; Pascal Program: The Bubble Sort and TSTSORT; Pascal Procedure: Bubble Sort with SWAP; A Shell Sort; Pascal Procedure: The Shell-Metzner Sort; The Quick Sort; Pascal Procedure: A Recursive Quick Sort; Pascal Procedure: A Nonrecursive Quick Sort; Incorporating Sort into the Curve-Fitting Program; Summary. *General Least-Squares Curve Fitting*—Introduction; A Parabolic Curve Fit; Pascal Program: Least-Squares Curve Fit for a Parabola; Curve Fits for Other Equations; Pascal Program: The Matrix Approach to Curve Fitting; Pascal Program: Adjusting the Order of the Polynomial; Pascal Program: The Heat-Capacity Equation; Pascal Program: The Vapor Pressure Equation; A Three-Variable Equation; Pascal Program: An Equation of State for Steam; Summary. *Solution of Equations by Newton's Method*—Introduction; Formulating Newton's Method; Pascal Program: A First Attempt at Newton's Method; Pascal Programs: Solving Other Equations; Pascal Program: The Vapor Pressure Equation; Summary. *Numerical Integration*—Introduction; The Definite Integral; The Trapezoidal Rule; Pascal Program: The Trapezoidal Rule with User Input for the Number of Panels; Pascal Program: An Improved Trapezoidal Rule; Pascal Program: Trapezoidal Rule with End Correction; Pascal Program: Simpson's Integration Method; Pascal Program: The Simpson Method with End Correction; The Romberg Method; Pascal Program: Integration by the Romberg Method; Functions that Become Infinite at One Limit; Pascal Program: Adjustable Panels for an Infinite Function; Summary. *Nonlinear Curve-Fitting Equations*—Introduction; Linearizing the Rational Function; Pascal Program: The Clausing Factor Fitted to the Rational Function; Linearizing the Exponential Equation; Pascal Program: An Exponential Curve Fit for the Diffusion of Zinc in Copper; Direct Solution of the Exponential Equation; Pascal Program: A Nonlinearized Exponential Curve Fit; Summary. *Advanced Applications: The Normal Curve, the Gaussian Error Function, the Gamma Function, and the Bessel Function*—Introduction; The Normal and Cumulative Distribution Functions; The Gaussian Error Function; Pascal Program: Evaluating the Gaussian Error Function Using Simpson's Rule; Pascal Program: Evaluating the Gaussian Error Function Using an Infinite Series Expansion; The Complement of the Error Function; Pascal Program: Evaluating the Complement of the Error Function; Pascal Program: A Faster Implementation of the Error Function; The Gamma Function; Pascal Program: Evaluation of the Gamma Function; Bessel Functions; Pascal Program: Bessel Functions of the First Kind; Pascal Program: Bessel Functions of the Second Kind; Summary. *Appendix A: Reserved Words and Functions. Appendix B: Summary of Pascal*—Minimum Standard Character Set; Variable Names; Numbers; Comments; Operations; Syntax; Conditional Statements; Iterative Statements; Transfer-of-Control Statements; Input and Output; Data Types. *Bibliography. Index.*

MICRO™

Apple Graphics

This month's Apple bonus section features a special concentration on graphics. The versatile graphical capabilities of the Apple lend themselves easily to many useful and unusual applications. These applications can range from rather ordinary ones, like graph plotting, to some very sophisticated uses like solid area shading and hidden surface removal. In this section, the MICRO staff has collected five graphics-oriented articles, each of which highlights a different use of the Apple's graphical capabilities.

"SHAPER," by C. Osborne, is an easy-to-use, powerful utility designed to create and maintain Applesoft shape tables. While several shape table utilities have appeared before, both in the pages of MICRO and in other magazines, none has worked quite as quickly and easily as SHAPER. If you have not yet explored the possibilities offered by shape tables, SHAPER is the perfect place to start.

"Lo-Res Graphics and Pascal," by C.D. Heth, unlocks the power of the Apple's low resolution graphics from within the Pascal environment. One of the most common complaints about Apple Pascal has been that there are no Lo-Res graphics instructions on capabilities. With the routines explained in this article, the Apple Pascal user can install these instructions and take advantage of the 16-color graphics for which the Apple is famous. With low resolution graphics installed, the structure and versatility of Apple Pascal will become even more alluring than it already is.

"Paddle Hi-Res Graphics," by K. Woodward, interfaces Applesoft high resolution graphics to the game paddle control. Designed to enable drawing of backgrounds on the high resolution screen, the programs provided in this article demonstrate the power of interactive graphic cursor control, and show how easily such control is implemented on the Apple. Additionally, the article explains some of the graphical transformations used in the program — transformations which are universally essential to any computer graphics system.

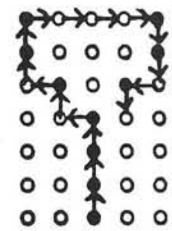
"True 3-D Images on the Apple II," by A. Radcliffe, illustrates how 3-dimensional views can be generated on the Apple Hi-Res screen by the use of stereoscopic pairs. The blue Hi-Res "roller-coaster" depicted on this month's cover represents one such pair and many others can be generated by the "noisy coaster" routine explained in the article. Besides providing a lucid description of the theory and techniques underlying 3-D view generation, this article and its accompanying programs should provide hours of fun and amusement. (They did for the MICRO staff.)

"Apple Bits," by R. Vile, discusses techniques for displaying patterns in low resolution graphics mode. The first part of this three-part article, presented in this month's issue, describes a fast, machine language routine which converts compact, numeric data files into low resolution pictures. A demonstration program, also described, illustrates how the routine is used to produce animation on the Lo-Res screen. The next two parts of the article, which will appear in October and November, will illustrate methods of generating and using the numeric data files. Together, the three parts of the series will enable more effective use of the Apple's low resolution graphics.

Each of these graphics articles tackles a different capability of Apple graphics. By reading through them, and studying the program material provided, it should be an easy matter to unlock the hidden power of your Apple's video display.

The graphics capability is, without doubt, one of the most powerful of the Apple, and is certainly one of the most interesting areas of computer science. We hope this special section helps to stimulate exploration of this exciting area by all MICRO readers.

MICRO



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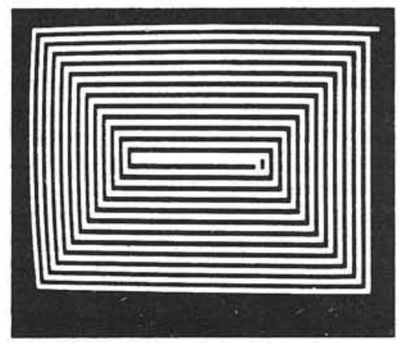
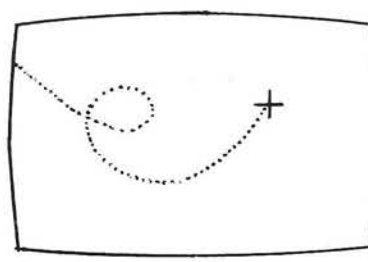
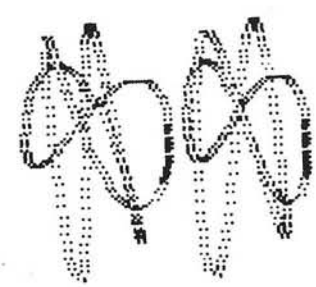


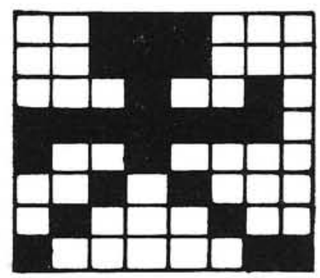
Lo-Res and Pascal — P. 62



Paddle Hi-Res — P. 68



3-D Images — P. 71



Apple Bits — P. 75

SHAPER: A Utility Program for Managing Shape Tables

"Shaper" describes a utility program for building and managing shape tables for the Apple II computer. The program allows the user to build shape tables by vector input, and view the shape while it is being built. The user can then change shapes, add shapes, delete shapes, review a shape table, and save or load a shape table.

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Shape tables are a very valuable tool of the Applesoft language. Programmers are allowed to define their own shapes, and then by implementing the Applesoft commands DRAW, XDRAW, ROT, SCALE, and SHLOAD, the shapes can be drawn, erased, rotated, enlarged, and loaded from tape. The shape tables can be used in programs to create dynamic effects on the high resolution graphics screen. Animating, displaying game objects, and mixing text and graphics on the high resolution graphics screen create only a subset of the possible uses of shape tables. The real problem of utilizing shape tables is the creation of the table. This program relieves the programmer of the tedious task of defining the shapes and setting up the table.

SHAPER is a complete program for building and modifying shape tables. The first function, BUILD, allows shape tables to be constructed. All details are handled for creating the index portion and shape definition portion of the table. The user types in vector definitions by using the keys 0 through 7. By hitting the ESC key the high resolution screen will display the shape as it is being typed in. The ADD function allows more shapes to be added to an already existing table. All new shape definitions are added at the end of the table, and the indexes are added in the index portion of the table. The function CHANGE allows the user to replace existing shapes in a table with a new shape definition. The actual shape definition is added at the end of the table, the old shape definition is removed, and the indexes are updated to point to the proper locations.

DELETE allows the user to remove unwanted shapes from a shape table. After the shapes are removed, the table is compressed. The remaining shapes will then have different numbers when referring to them with the DRAW and XDRAW commands. The REVIEW function displays information about a shape table and allows the user to view the shapes in the table. The SAVE/LOAD function allows shape tables to be loaded from tape and saved or loaded to and from disk. Creating shape tables with SHAPER is an enjoyable process, and using the shapes in Applesoft programs adds a new dimension to programming the Apple II computer.

To use the shape table in Applesoft programs requires two steps. The first step is loading the shape table into memory. SHLOAD can be used to read the table in from tape, or the code in line 7110 can be implemented to read the table in from disk. The second step is to store the lower two digits of the starting location of the table in $E8 (248), and the upper two digits in $E9 (249).

The code presented is full of REMarks to aid in the understanding of how the algorithms work. Each function is logically grouped into a set of lines. Please contact the author if there are any problems, suggestions, or questions about SHAPER. The text and example shape tables are available on cassette or disk. Contact the author for details.

The remainder of the article is presented in a "user's manual" format, so it can easily be referred to while learning to use the program. After running the program once or twice, the user's manual will seldom be needed.

Shape tables are a unique feature of the Apple II. However, the method of building shape tables described in chapter 9 of the Applesoft manual is time consuming, prone to error, and difficult to master. SHAPER utilizes an automated approach which provides the same sophisticated results in a shorter time with less chance of error.

SHAPER not only allows the user to build tables, but also to add shapes to the table, change shapes in the table, delete them from the table, display them from a table, and save shape tables to disk or load from disk or tape.

Executing SHAPER

SHAPER 2 is written in Applesoft BASIC. The program takes up about 6.5K and uses HGR2. SHAPER can be run in a 32K Apple, but 48K is recommended. Once SHAPER is loaded, type RUN to execute.

While running SHAPER a "Yes/No" question can be answered with any word beginning with a "Y" or "N." If an answer begins with any other letter, then the question is re-asked.

An "APPLESOFT ERROR" is an error caused by Applesoft. SHAPER intercepts the error and prints "APPLESOFT ERROR xx," where xx is the error code as listed on page 81 of the Applesoft Manual. To restart SHAPER hit any key. Each cause of an "APPLESOFT ERROR" is discussed under the function in which it can occur.

A "DOS ERROR xx" is an error that occurs when a table is being saved or loaded using the disk. The xx is the DOS error code as listed on page 114 of the DOS 3.3 manual.

Warning: Do not hit "Reset" during the operation of any of the functions of SHAPER, or the table could be destroyed.

Selecting the Starting Location

Selecting the correct starting location for the table is very important, and because of the importance, SHAPER makes the user double check it. In selecting a starting location, the amount of memory available in the computer and the length of the shape table being manipulated must be considered.

SHAPER 2 overwrites part of HGR1 and uses HGR2, so the logical location for the table is immediately above HGR2 at memory location 24576 (6000 hex). Using this location will allow a table length of 24476 bytes without DOS booted and 13724 bytes with DOS. Both these lengths allow for 100 bytes of character strings stored after HIMEM.

Question: What is the starting location of the table (in decimal)?

Response:	*Action of SHAPER:*
n	Set n as the starting location of the table.
0	Set starting location of the table to 24576.

If n is greater than the highest memory location in the Apple or lower than LOMEM an "APPLESOFT ERROR" will occur. Hit any key to restart SHAPER, and select a different starting location. After selecting the starting location a menu will appear:

Functions available:

0. Exit from SHAPER
1. Build shape table
2. Add shapes to table
3. Change shape in table
4. Delete shapes from table
5. Review shape table
6. SAVE/LOAD shape table

Question: Function?

Response:	*Action of SHAPER:*
0 - 6	Execute the desired function.
> 6	Re-ask question.

If a shape table is not in memory, trying to execute the Add, Change, Delete or Review function will give unpredictable results and usually end with an "APPLESOFT ERROR." Each function is described in the rest of the article.

Build

Build is used to construct a shape table. SHAPER-BUILD will configure the table in the proper format needed to utilize the Applesoft shape table commands. SHAPER-BUILD builds the index portion of the table along with the shape definition portion.

Question: Number of shapes going into table?

Response:	*Action of SHAPER-BUILD:*
0	Return to menu.
1 - 255	Set table for number of shapes.
> 255	Re-ask question. (Maximum number of shapes is 255.)

SHAPER-BUILD is now ready to accept vector definition numbers to define shapes that are going into the table.

Definition of Vectors:

- 0 - move up
- 1 - move right
- 2 - move down
- 3 - move left
- 4 - plot and move up
- 5 - plot and move right
- 6 - plot and move down
- 7 - plot and move left

Question: (Will repeat until shape definition is completed.) Vector 1 – 1 =

Response:	*Action of SHAPER-BUILD:*
0 - 7	Use as vector definition in shape.
8 - 9	Display definition of vectors.
ESC	Switch from TEXT to HGR2 and *vice versa.*
X	Erase last vector input.

Anything else is ignored.

To end a shape definition type in three vectors of zero. Because of how Applesoft handles a shape definition, a shape cannot be defined to move up three times in a row, or move up twice and use a plotting vector. Example (Vector n, Vector n + 1, Vector n + 2):

n	n+1	n+2	
0	0	0	Will end the shape definition.
0	0	(4-7)	Will end the shape definition.
0	0	(1-3)	Move up twice and move the last vector direction.

After the shape has been defined it will be displayed on high-resolution graphics page two at the coordinates: X = 139, Y = 79. These coordinates can be changed by altering line one of SHAPER, which also changes the point that the REVIEW function uses.

The "ESC" key will switch the display between TEXT and high-resolution graphics page two, so the shape can be viewed while it is being built. If a move vector is used to go over a point that has been plotted, the point will disappear, but the point still exists in the shape definition and it will be displayed when the shape is completed.

The "X" key can be used to erase the last vector input. The input buffer will only hold 100 inputs. This allows for 100 vectors to be erased per shape. If more than 100 mistakes are made on a shape, then the shape can be ended and restarted.

When the shape is completed, the shape will be displayed on HGR2, and the bell will sound. SHAPER is waiting for a "Y" or "N" for approval or disapproval of the shape. The question will not be seen and the ESC key is inoperative at this time.

Question: Is shape OK?

Response:	*Action of SHAPER-BUILD:*
Y	Allow user to define the next shape.
N	Allow the user to redefine the last shape.

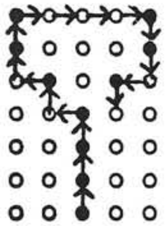
Warning: Do not start a shape definition with 0 0 0 or 0 0 (4-7). This will put one byte of zero in the table to define the shape. Applesoft will ignore this zero and use the next bytes in the table to define the shape until another byte of zero is reached. Later, when using Delete and Change functions, more problems could arise. An "APPLESOFT ERROR" will occur if one attempts to build a long table past the end of memory available in the computer.

Example of Build Function

Suppose one wishes to build a shape table of one shape. The shape looks like a "Y" in a 5 × 7 format. For starting location reply: 0 (sets starting location to 24576 — 6000 hex). The shape looks like this:

```
● O O O ●
● O O O ●
O ● O ● O
O O ● O O
O O ● O O
O O ● O O
O O ● O O
```

The shape is then drawn with direction vectors:



The vectors would be laid out as shown in figure 1. Type in the vector definition numbers followed by three zeros. Location 6000 hex will show the table as in figure 2.

Figure 1

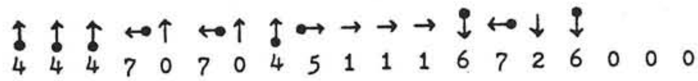


Figure 2

```
6000  01  00  04  00  24  3C  38  20  4D  31  17  06  00
      Number of   Index        Shape Definition        End Byte
      Shapes in
      Table
```

Add

Add allows one to add shapes at the end of an already existing shape table. The number of shapes added cannot make the total shape count in the table go over 255.

Question: Number of shapes adding to table?

Response:	*Action of SHAPER-ADD:*
0	Return to menu.
1 - n	Allow n number of shapes to be added to the table.
NS + n>255	Re-ask question.

(n is the number of shapes adding. NS is the number of shapes in table. NS + n is the number of shapes in the table after the add.)

After telling SHAPER-ADD how many shapes are being added, the vector definitions are typed in as in SHAPER-BUILD.

Change

Change allows a shape definition to be redefined. The new shape is defined as in SHAPER-BUILD and it replaces the one being changed.

Question: Shape to be changed?

Response:	*Action of SHAPER-CHANGE:*
0	Return to menu.
1 - NS	The requested numbered shape is changed.
> NS	Re-ask question.

(NS is the number of shapes in the table.)

After telling SHAPER-CHANGE what shape is to be changed, the vector definitions are typed in as in SHAPER-BUILD.

Delete

Delete allows unwanted shapes to be removed from the table. SHAPER-DELETE removes the shape definition, removes the index, and compresses the table. This compression causes all shapes after the deleted shape to have a smaller definition number in the table.

Example: Suppose shape number 3 is to be deleted.

Before

Shape Number	Shape
1	A
2	B
3	C
4	D
5	E

After

Shape Number	Shape
1	A
2	B
3	D
4	E

Notice after shape 3 is deleted, that shape 3 now defines D, and shape 4 is now E.

Question: (Will repeat until function is completed.) Shape to be deleted?

Response:	*Action of SHAPER-DELETE:*
0	Return to menu if no shapes have been deleted. Compress table and return to menu if shapes have been deleted.
1 - NS	Delete that shape from the table.
>NS	Give error message and re-ask question.
PS	Give error message and re-ask question.

(NS is number of shapes in the table.)
(PS is a previous deleted shape in this execution of SHAPER-DELETE.)

Many shapes may be deleted in one execution of SHAPER-DELETE. The table is not compressed until 0 is typed to end the function. So, in the above example if shape 2 and shape 4 were to be deleted, then 2, 4, and 0 would be typed in to answer the questions. B and D would be deleted.

If there is only one shape in the table, the Delete function cannot be used. Trying this will result in an error message and the question being re-asked. Type in zero to exit from SHAPER-DELETE.

Depending on the size of the table, there will be a delay when typing in zero to end the function. This is when the table is being compressed.

Review

Review will give information about the table and allow the shape table to be displayed. Information given: 1. The starting location of the table; 2. The ending location of the table; 3. The length of the table; 4. How many shapes are in the table.

Question: Shape number (first, last)?

Response:	*Action of SHAPER-REVIEW:*
0 ,L	Return to menu.
F,L (F = L)	Display shape.
F,L (F<L)	Display shape F through shape L.
F,L (F >L)	Re-ask question.

(F is the first shape to be displayed.)
(L is the last shape to be displayed.)

If L is greater than the number of shapes in the table then the shapes from F to the end of the table will be displayed.

If an "APPLESOFT ERROR" occurs when the function is being executed for the first time, then a table does not exist at the given starting location. Insure there was a table at the starting location.

If the table was read in from tape, make sure there was not an I/O error during the read, and that the length of the table was correct.

The point that the shape is drawn at is: X = 139, Y = 79. This point can be changed by altering line one in the program. Altering the coordinates also changes them for the Build function.

While a series of shapes is being displayed, a zero can be typed in to exit the function.

Save/Load

Save/Load allows a shape table to be loaded from cassette tape, loaded from disk, or saved to disk. A function menu will appear:

0. Exit
1. Load from tape
2. Save to disk
3. Load from disk
4. List catalog

Question: Function?

Response:	*Action of SHAPER-SAVE/LOAD:*
0	Return to menu.
1	(See cassette function below.)
2,3	(See disk function below.)
4	Display Catalog from the disk.

Cassette Tape:

Question: How long is table (in decimal)?

Response:	*Action of SHAPER: (Load from tape)*
0	Return to menu.
n	Use as length of table.

Next, the tape should be started. Hit any key to start SHLOAD command, which reads the tape.

If the wrong length is given, then the table will not be loaded at the starting location given. This will cause an "APPLESOFT ERROR" later in the execution of another function. Reload the table using the correct length.

If "ERR" appears on the screen, then an I/O error has occurred during the read. An "APPLESOFT ERROR" will occur. Hit any key to restart the program. Check the tape and recorder for problems.

Disk:

Question: What is the (input/output) file name?

Response:	*Action of SHAPER (Disk):*
Legal File Name	Perform the save or load function.

An illegal file name as defined in the DOS manual will result in a "DOS ERROR" or an "APPLESOFT ERROR." A "DOS ERROR" will return to the Save/Load menu and the function can be retried. An "APPLESOFT ERROR" will return to the beginning of the program. The shape table is not lost. Use the same starting location and the table is recovered.

SHAPER Listing

```
0  DIM BF%(100)
1 X = 139:Y = 79
10  ONERR  GOTO 9000
14  REM  : COMMENTS SHOULD NOT
15  REM  : BE INCLUDED IN THE
16  REM  : EXECUTABLE MODULE.
18  REM
19  REM : SET CONSTANTS
20 X1 = X:Y1 = Y:TW = 2:OE = 1:TF
      = 256:ZE = 0:TR = 3: GOTO 6
     000
1000 KB = BF%(B3):B3 = B3 + OE: IF
     B3 = 101 THEN B3 = ZE
1010  IF B1 = TW THEN  RETURN
1020  GOSUB 1030: RETURN
1027  REM : * SUBROUTINE FOR   *
1028  REM : * VECTOR INPUT     *
1030 N = N + OE
1040  PRINT "VECTOR ";SN;"-";N;"
     = ";
1049  REM :  GET KEYBOARD INPUT
     AND DETERMINE ACTION
1050  HCOLOR= TR: HPLOT X1,Y1:KI =
      PEEK ( - 16384) - 176: HCOLOR=
     ZE: HPLOT X1,Y1: IF (KI < ZE
      AND KI <  >  - 21) OR (KI >
     9 AND KI <  > 40) GOTO 1050
1060  POKE  - 16368,ZE: IF KI = 4
     0 GOTO 1190
1070  IF KI =  - 21 GOTO 1170
1080  IF KI > 7 GOTO 1330
1090  PRINT KI: IF KI > TR
     THEN  HCOLOR= TR: HPLOT X1,Y1
1099  REM : PLOT NEW VECTOR POINT
1100 T6 = KI:B4 = OE: GOSUB 1240
1110 BF%(BP) = KI:BP = BP + OE: IF
     KI = ZE THEN B2 = B2 + OE
1120  IF B2 = TR OR (KI > TR AND
     B2 = TW) THEN B1 = TW: RETURN
1130  IF BP = 100 THEN B1 = OE
1140  IF BP = 101 THEN BP = ZE
1150  IF KI <  > ZE THEN B2 = ZE
1160  RETURN
1169  REM : SWITCH SCREEN MODE
1170  IF S = OE THEN  POKE  - 162
     99,ZE: POKE  - 16297,ZE: POKE
      - 16304,ZE:S = ZE: GOTO 105
     0
1180  TEXT :S = OE: GOTO 1050
1189  REM : ERASE OLD VECTOR
1190 BP = BP - OE: IF BP = B3 - O
     E OR N = OE GOTO 1230
1200  IF BP < ZE THEN BP = 100
1210 T6 = BF%(BP):B4 =  - OE: GOSUB
     1240
1220  HPLOT X1,Y1:N = N - OE: PRINT
     "ERASED": GOTO 1040
1230 BP = BP + OE: PRINT "CAN'T E
     RASE": GOTO 1040
1239  REM : SET UP NEW X AND Y
     VALUES FOR PLOTTING
1240  IF T6 = ZE OR T6 = 4 THEN Y
     1 = Y1 - B4
1250  IF T6 = OE OR T6 = 5 THEN X
     1 = X1 + B4
1260  IF T6 = TW OR T6 = 6 THEN Y
     1 = Y1 + B4
1270  IF T6 = TR OR T6 = 7 THEN X
     1 = X1 - B4
1280  IF X1 < ZE THEN X1 = 279
1290  IF X1 > 279 THEN X1 = ZE
1300  IF Y1 < ZE THEN Y1 = 191
1310  IF Y1 > 191 THEN Y1 = ZE
1320  RETURN
1329  REM :     PRINT  VECTOR
     DEFINITIONS
1330  PRINT : PRINT "0 : MOVE UP
          4 : PLOT & MOVE UP": PRINT
```

(Continued)

```
      "1 : MOVE RIGHT     5 : PLOT
      & MOVE RIGHT": PRINT "2 : MO
      VE DOWN      6 : PLOT & MOVE
      DOWN": PRINT "3 : MOVE LEFT
         7 : PLOT & MOVE LEFT";: GOTO 1050
1338  REM : * BUILD ROUTINE      *
1340  PRINT "**  BUILD  **": PRINT
      : INPUT "NUMBER OF SHAPES GO
      ING INTO TABLE ? ";NS: IF NS
       < OE GOTO 6050
1350  IF NS > = TF GOTO 1340
1359  REM : SET UP BEGINNING OF
     SHAPE TABLE
1360  VTAB 24: POKE PP,NS:PP = PP
      + OE: POKE PP,ZE:PP = PP +
     OE:SS = NS * TW + TW + SL:R =
     ZE
1369  REM : SET UP INDEXES INTO
     TABLE
1370 T2 =  INT ((SS - SL) / TF):T
     1 =  INT (SS - SL - T2 * TF)

1380 PP = SN * TW + SL: POKE PP,T
     1:PP = PP + OE: POKE PP,T2:P
     P = SS
1390  VTAB 24:BP = ZE:B3 = ZE:B1 =
     ZE
1400  IF B1 = ZE THEN  GOSUB 1030
     : GOTO 1400
1408  REM : ALL SHAPES ARE BUILT
      AFTER RECEIVING 3 VECTORS
1409  REM : GET 1 OF 3 VECTOR
1410  GOSUB 1000:T1 = KB
1419  REM : GET 2 OF 3 VECTOR
1420  GOSUB 1000:T2 = KB
1430 PE = T1 + T2 * 8
1439  REM : GET 3 OF 3 VECTOR
1440  GOSUB 1000: IF PE = ZE AND
     (KB > TR OR KB = ZE) GOTO 15
     10
1449  REM : CONVERT VECTORS FOR
     EACH BYTE IN THE TABLE
1450 T1 = KB: IF KB > TR GOTO 149
     0
1460 PE = PE + KB * 64: POKE PP,P
     E:PP = PP + OE: IF T1 = ZE AND
     T2 = ZE GOTO 1430
1470  IF T1 = ZE GOTO 1420
1480  GOTO 1410
1490  POKE PP,PE:PP = PP + OE: IF
     T2 = ZE THEN T2 = T1:T1 = ZE
     : GOTO 1430
1500  GOTO 1420
1509  REM : REVIEW THE SHAPE
1510  POKE PP,ZE:PP = PP + OE:N =
     ZE: HGR2 :S = ZE: HCOLOR= TR
     : ROT= ZE: SCALE= OE: DRAW S
     N AT X,Y
1520 BP = ZE:B3 = ZE:B1 = ZE:X1 =
     X:Y1 = Y:B2 = ZE
1530  VTAB 24: INPUT "IS SHAPE OK
      ? ";A$: IF  LEFT$ (A$,OE) =
     "Y" GOTO 1560
1540  IF  LEFT$ (A$,OE) <  > "N" GOTO
     1530
1550  CALL 62450:N = ZE:PP = SS: GOTO
     1400
1560  IF SN = NS GOTO 1580
1570  CALL 62450: PRINT :SS = PP:
     SN = SN + OE: GOTO 1370
1580  IF R <  > ZE THEN  TEXT : PRINT
     "$$ TABLE IS BEING CHANGED $
     $": GOTO 3080
1590  GOTO 6050
1998  REM : * ADD ROUTINE        *
2000  PRINT "**  ADD  **": PRINT

2010  INPUT "NUMBER OF SHAPES ADD
     ING TO TABLE ? ";ND: IF ND <
     OE GOTO 6050
2020 NS =  PEEK (SL):SN = NS + ND
     : IF SN > 255 GOTO 2010
2030  POKE SL,SN:PP = SL
2039  REM : RECOMPUTE INDEXES AND
      MAKE ROOM FOR NEW INDEXES
2040  FOR I = OE TO NS:PP = PP +
     TW:T1 =  PEEK (PP) +  PEEK (
     PP + OE) * TF:T2 = T1 + ND *
     TW:T3 =  INT (T2 / TF):T2 =
      INT (T2 - T3 * TF): POKE PP
     ,T2: POKE PP + OE,T3: NEXT
2050 EF = PP + TW:T2 = T1 + SL
2060 T2 = T2 + OE: IF  PEEK (T2) <
      > ZE GOTO 2060
2070 PP = T2 + ND * TW:SS = PP +
     OE
2080  POKE PP, PEEK (T2):T2 = T2 -
     OE:PP = PP - OE: IF T2 > =
     EF GOTO 2080
2089  REM : SET UP VARIABLES FOR
     TRANSFER TO BUILD
2090 SN = NS + OE:NS =  PEEK (SL)
     : GOTO 1370
2998  REM : * CHANGE ROUTINE     *

3000  PRINT "**  CHANGE  **": PRINT
     :NS =  PEEK (SL):T1 = NS * T
     W + SL:PP =  PEEK (T1) +  PEEK
     (T1 + OE) * TF + SL
3010  INPUT "SHAPE TO BE CHANGED
     ? ";ND: IF ND < OE GOTO 6050

3020  IF ND > NS GOTO 3010
3029  REM :   REPLACE THE LAST
     SHAPE IN THE TABLE
3030  IF ND = NS THEN R = ZE: GOTO
     3070
3040 PP = PP + OE: IF ND = NS THEN
     R = ZE: GOTO 3070
3049  REM : AN INTERNAL SHAPE IS
     BEING CHANGED
3050 PP = PP + OE: IF  PEEK (PP) <
      > ZE GOTO 3050
3060 PP = PP + OE:T2 = ND * TW +
     SL:T3 =  PEEK (T2) +  PEEK (
     T2 + OE) * TF:T4 =  PEEK (T2
      + TW) +  PEEK (T2 + TR) * T
     F:T5 = T4 - T3:SS = PP - SL:
     SN =  INT (SS / TF):SS =  INT
     (SS - SN * TF): POKE T2,SS: POKE
     T2 + OE,SN:EF = PP:R = OE
3069  REM : INITIALIZE VARIABLES
     SO BUILD CAN CREATE SHAPE
3070 SS = PP:SN = ND:NS = SN: GOTO
     1390
3079  REM : REMOVE OLD SHAPE AND
     ADJUST INDEXES
3080 R = ZE:T1 = PP - EF:T5 = T1 -
     T5:SN =  INT (T3 / TF):SS =
      INT (T3 - SN * TF):NS = ND *
     TW + SL: POKE NS,SS: POKE NS
      + OE,SN: IF T5 > ZE GOTO 31
     10
3090  IF T5 = ZE GOTO 3130
3100 T2 = PP - OE:PE = T4 + SL -
     OE:PP = T4 + SL + T5 - OE:SS
      = OE: GOTO 3120
3110 PE = PP:PP = PP + T5:SS =  -
     OE:T2 = T4 + SL
3120 PE = PE + SS:PP = PP + SS: POKE
     PP, PEEK (PE): IF PE <  > T2
     GOTO 3120
3130 PE = EF + T5:PP = SL + T3:T1
      = PP + T1
3140  POKE PP, PEEK (PE):PP = PP +
     OE:PE = PE + OE: IF PP < T1 GOTO
     3140
3150 PP = NS:EF =  PEEK (SL + TW)
      +  PEEK (SL + TR) * TF + SL - TW
3160 PP = PP + TW:T2 =  PEEK (PP)
      +  PEEK (PP + OE) * TF:T2 =
```

(Continued)

```
     T2 + T5:T1 =  INT (T2 / TF):
     T2 =  INT (T2 - T1 * TF): POKE
     PP,T2: POKE PP + OE,T1: IF P
     P <  > EF GOTO 3160
3170  GOTO 6050
3998  REM : * DELETE ROUTINE   *
4000  PRINT "**  DELETE  **": PRINT
     :EF =  PEEK (SL):PE = EF * T
     W + SL:PE =  PEEK (PE) +  PEEK
     (PE + OE) * TF + SL:NS = EF
4010  INPUT "SHAPE TO BE DELETED
     ? ";ND: IF ND <  = ZE THEN  PRINT
     "$$ TABLE IS BEING COMPRESSE
     D $$": GOTO 4080
4019  REM : ERROR CHECK SO TABLE
     WONT BE DESTROYED
4020  IF (ND > EF) OR ND < ZE GOTO  4220
4030  IF NS = OE GOTO 4220
4040 SN = SL + ND * TW:PP =  PEEK
     (SN) +  PEEK (SN + OE) * TF +
     SL: IF  PEEK (SN) = ZE GOTO  4220
4049  REM : ZERO INDEX TO SHAPE
4050  POKE SN,ZE: POKE SN + OE,ZE
4060  IF  PEEK (PP) = ZE GOTO 4210
4069  REM : ZERO SHAPE DEFINITION
4070  POKE PP,ZE:PP = PP + OE: GOTO  4060
4080 T1 = PE:PP = NS * TW + SL +
     TW:PE = SL + EF * TW + OE
4088  REM : COMPRESS ZEROS OUT OF TABLE
4089  REM : LEAVE A SINGLE BYTE
     OF ZEROS BETWEEN SHAPES
4090 T1 = T1 + OE: IF  PEEK (T1) <
      > ZE GOTO 4090
4100 PE = PE + OE: IF  PEEK (PE) =
     ZE GOTO 4100
4110  POKE PP, PEEK (PE):PP = PP +
     OE:PE = PE + OE: IF  PEEK (P
     E) <  > ZE GOTO 4110
4120  IF PE = T1 GOTO 4170
4130  IF  PEEK (PE + OE) <  > ZE GOTO
     4110
4140  POKE PP, PEEK (PE):PP = PP +
     OE
4150 PE = PE + OE: IF  PEEK (PE) =
     ZE GOTO 4150
4160  IF PE < T1 GOTO 4110
4170  POKE PP,ZE: POKE SL,NS:EF =
     ZE:PP = SL + TW:T2 = ZE:T3 =
     NS * TW + TW:T1 = T3 + SL
4180 T4 = T3 + T2:T5 =  INT (T4 /
     TF):T4 =  INT (T4 - T5 * TF)
     : POKE PP,T4: POKE PP + OE,T
     5:PP = PP + TW:EF = EF + OE:
      IF EF = NS GOTO 6050
4190 T1 = T1 + OE:T2 = T2 + OE: IF
      PEEK (T1) <  > ZE GOTO 4190
4200 T1 = T1 + OE:T2 = T2 + OE: GOTO 4180
4210  PRINT "SHAPE DELETED": PRINT
     :NS = NS - OE: GOTO 4010
4220  PRINT "** ERROR ** INVALID
     SHAPE NUMBER": PRINT : GOTO  4010
4998  REM : * DISPLAY ROUTINE *
5000 NS =  PEEK (SL):T1 = NS * TW
      + SL:T2 =  PEEK (T1 + OE):T
     1 =  PEEK (T1):T1 = T2 * TF +
     T1 + SL
5009  REM : FIND THE END OF THE
     TABLE
5010 T1 = T1 + OE: IF  PEEK (T1) <
      > ZE GOTO 5010
5019  REM : COMPUTE ENDING ADDRS
     (T1), AND LENGTH (T2)
5020 T1 = T1 + OE:T2 = T1 - SL
5030  HOME : TEXT : VTAB TR: PRINT
     "  *****  SHAPE TABLE REVI
     EW  *****": PRINT : PRINT "
     TABLE STARTING LOCATION -> "
     ;SL;" DECIMAL": PRINT : PRINT
     "TABLE ENDING LOCATION --->
     ";T1;" DECIMAL"
5040  PRINT : PRINT "LENGTH  OF T
     ABLE  -------> ";T2;" BYTES"
     : PRINT : PRINT : PRINT "NUM
     BER OF SHAPES IN TABLE-> ";N
     S
5050  VTAB 22: INPUT "SHAPE NUMBE
     RS (FIRST,LAST) ? ";SN,T5: IF
     SN > NS OR SN > T5 GOTO 5050
5060  IF SN = 0 GOTO 6050
5070  IF T5 > NS THEN T5 = NS
5079  REM : DRAW SHAPE (I) FROM
     THE TABLE
5080  FOR I = SN TO T5: HGR2 :S =
     ZE: COLOR= TR: SCALE= OE: ROT=
     ZE: DRAW I AT X,Y: VTAB 23: PRINT
     "SHAPE NUMBER ";I
5089  REM  : CHECK FOR "0" TO QUIT
5090  FOR T4 = OE TO 150: IF  PEEK
     ( - 16384) = 176 GOTO 5110
5100  NEXT : NEXT
5110  POKE  - 16368,ZE:S = OE: GOTO
     5030
5997  REM : ********************
5998  REM : * MAIN PROGRAM      *
5999  REM : ********************
6000 S = OE: HGR2 : HOME : TEXT :
     VTAB 2: PRINT "**********
      S H A P E R  2  ***********
     ": VTAB 3: PRINT  TAB( 2);"*
     "; TAB( 39);"*": PRINT  TAB(
     3);"*"; TAB( 38);"*": PRINT
      TAB( 4);"*"; TAB( 12);"A UT
     ILITY PROGRAM"; TAB( 37);"*"
6010  PRINT  TAB( 5);"*"; TAB( 14
     );"FOR MANAGING"; TAB( 36);"
     *": PRINT  TAB( 4);"*"; TAB(
     14);"SHAPE TABLES"; TAB( 37)
     ;"*": PRINT  TAB( 3);"*"; TAB(
     38);"*": PRINT  TAB( 2);"*";
     " COPYRIGHT 1980  CLEMENT D.
     OSBORNE"; TAB( 39);"*"
6020  FOR I = OE TO 40: VTAB 10: HTAB
     I: PRINT "*": NEXT
6028  REM : GET STARTING LOCATION
     AND POKE FOR DRAW COMMANDS
6029  REM : GET STARTING LOCATION
6030  PRINT : PRINT "WHAT IS STAR
     TING LOCATION": INPUT "OF TH
     E TABLE (IN DECIMAL) ? ";SL:
      PRINT : PRINT "DOUBLE CHECK
      STARTING LOCATION !": PRINT
     : INPUT "IS IT CORRECT ? ";A
     $: IF  LEFT$ (A$,OE) <  > "Y
     " GOTO 6030
6035  IF SL = 0 THEN SL = 24576
6040 PP =  INT (SL / TF): POKE 23
     3,PP:PP =  INT (SL - PP * TF
     ): POKE 232,PP
6049  REM : MAIN MENU
6050  TEXT : HOME : VTAB 3: PRINT
     "FUNCTIONS AVAILABLE:": PRINT
     : PRINT "  0. EXIT FROM SHAP
     ER": PRINT : PRINT "  1. BUI
     LD SHAPE TABLE": PRINT : PRINT
     "  2. ADD SHAPES TO TABLE": PRINT
     : PRINT "  3. CHANGE SHAPE I
     N TABLE"
6060  PRINT : PRINT "  4. DELETE
     SHAPES FROM TABLE": PRINT : PRINT
     "  5. REVIEW SHAPE TABLE": PRINT
     : PRINT "  6. SAVE/LOAD SHAP
     E TABLE": PRINT : VTAB 20: INPUT
```

(Continued)

```
      "FUNCTION ? ";T1: IF T1 < ZE
       OR T1 > 6 GOTO 6050
6070   CALL 62450:PP = SL:SN = OE:
       HOME : ON T1 GOTO 1340,2000
      ,3000,4000,5000,7000: GOTO 9
      999
6997   REM : *******************
6998   REM : *   I/O ROUTINE     *
6999   REM : *******************
7000   VTAB 2: PRINT "**  SAVE/LOA
      D  **": PRINT : PRINT " 0. E
      XIT": PRINT : PRINT " 1. LOA
      D FROM TAPE": PRINT : PRINT
      " 2. SAVE TO DISK": PRINT : PRINT
      " 3. LOAD FROM DISK": PRINT

7010   PRINT " 4. LIST CATALOG": PRINT
7020  D4$ =  CHR$ (4): INPUT " FUN
      CTION ? ";T2: IF T2 < ZE OR
      T2 > 4 GOTO 7000
7030   HOME : ON T2 GOTO 7040,7060
      ,7100,7120: GOTO 6050
7040   PRINT : INPUT "HOW LONG IS
      THE TABLE (IN DECIMAL) ?";T1
      : IF T1 = ZE GOTO 6050:
7050  T3 =  PEEK (116) * TF +  PEEK
      (115): HIMEM: T1 + SL + OE: PRINT
      : PRINT "START TAPE, WHEN RE
      ADY HIT ANY KEY": GET A$: SHLOAD
      : PRINT : INPUT "HIT RETURN
      TO RETURN TO MENU";A$: HIMEM:
      T3: GOTO 6050
7060   PRINT : PRINT "WHAT IS THE
      OUTPUT FILE NAME ? ": INPUT
      A$:T1 =  PEEK (SL) * TW + SL
      :T2 =  PEEK (T1 + OE):T1 =  PEEK
      (T1):T1 = T2 * TF + T1 + SL
7070  T1 = T1 + OE: IF  PEEK (T1) <
       > ZE GOTO 7070
7080  T2 = T1 + OE - SL
7090   PRINT D4$;"BSAVE ";A$;",A";
      SL;",L";T2: PRINT : PRINT A$
      : PRINT "  HAS BEEN WRITTEN
      TO DISK": PRINT : PRINT "STA
      RTING LOCATION : ";SL,"LENGT
      H : ";T2: GOTO 7140
7100   PRINT : PRINT "WHAT IS THE
      INPUT FILE NAME ?": INPUT A$

7110   PRINT D4$;"BLOAD ";A$;",A";
      SL: PRINT : PRINT A$: PRINT
      "  HAS BEEN LOADED AT ";SL: GOTO
      7140
7120   HOME : PRINT D4$;"CATALOG":
       PRINT D4$
7130   PRINT : PRINT "HIT ANY KEY
      TO CONTINUE": GET A$: HOME :
       GOTO 7000
7140   PRINT : PRINT "HIT ANY KEY
      TO CONTINUE": GET A$: GOTO 6
      050
8998   REM : * ERROR ROUTINES *
9000   IF  PEEK (222) = 254 THEN  RESUME
9005   IF  PEEK (222) > 0 AND  PEEK
      (222) < 16 GOTO 9040
9010   PRINT : PRINT "** APPLESOFT
       ERROR ** "; PEEK (222): PRINT
      : PRINT "HIT ANY KEY TO CONT
      INUE": GET A$: GOTO 1
9040   PRINT : PRINT "** DOS ERROR
       ** "; PEEK (222): GOTO 7130

9999   END
```

MICRO™

List Controller

LIST CONTROLLER provides flexibility and ease of operation when using the LIST command in Applesoft and Integer BASIC and the TRACE command when using the Apple II System Monitor. The programmer can control the speed of the output to the text screen using the game paddle. As an added bonus those programmers using Integer BASIC and the Monitor can interrupt output to the text screen without pressing the RESET key.

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The process of debugging a program is particularly tedious on the Apple, since there is limited control of the LIST and TRACE functions. Applesoft allows the TRACE and LIST speed to be changed, and the screen output can be interrupted with 'CTRL-C'. However, both Integer BASIC and the monitor lack even these primitive capabilities.

While Applesoft does provide the programmer with these useful debugging aids, there is little flexibility in the system. Once a particular speed is set in Applesoft, there is no way to alter the speed without interrupting the listing and starting over again. In addition, Applesoft does not provide any means by which the programmer can interrupt the output of his listing for his perusal and then continue in a simple fashion. A program which would give the programmer the debugging aids of Applesoft in Integer BASIC and in the Apple monitor, and also provide all three langauges with the flexibility mentioned above would be very useful.

LIST CONTROLLER is a short assembly language program which does this. LIST CONTROLLER uses the Apple game paddles to control the speed of output to the text screen. The programmer thus has the ability to change his output speed from the equivalent of SPEED = 0 to SPEED = 255 at any time during his output. The programmer can therefore speed over those portions of his program which have been debugged, and then slow down to concentrate on those portions of the program with which he is having difficulty. LIST CONTROLLER also allows the programmer the option to output his listing to the text screen one line at a time, or an entire page (i.e. one full screen) at once. All of this can be done without interrupting the LISTing or the TRACE.

LIST CONTROLLER also allows the programmer using Integer BASIC and the Apple monitor to interrupt his listing at any time without the necessity of pressing the RESET key.

How it Works

LIST CONTROLLER consists of four interconnected routines. The first of these is PDDLRD, which controls output speed, using paddle #0 as the controller. The Apple game paddles are analog inputs connected to 150K ohm variable resistors. The variable resistance between each input and the +5 volt power supply can be used as a timing circuit. As the resistance of the input varies, the timing characteristics of its corresponding time circuit changes accordingly. When the timing loops of the paddles are reset, all the paddle locations (-16284 ($C064) to -16281 ($C067)) become greater than 128 (that is, their high order bit is set). The time for these values to drop below 128 is directly proportional to the setting of the game paddle associated with that location. By polling the game paddle location and counting until it goes below 128, we can get a number relative to the setting of the game paddle.

The good old Apple monitor provides us with a routine which does exactly what we want. PREAD (located at $FB1E) polls the paddle pointed to by the x-register, and returns a value from 0 to 255 in the y-register, depending upon the setting of the paddle. The value in the y-register can then be used to initiate the accumulator before jumping to the monitor WAIT ($FCA8) subroutine. This is another useful subroutine which will initiate a delay of a specific amount of time, depending upon the value of the accumulator when this routine is called. The delay, in microseconds, is given by the equation

$$DELAY = 13 + 13.5*A + 2.5*A^2$$

where A is the contents of the accumulator. By interrelating the PREAD subroutine and the WAIT subroutine, output speed is controlled by the game paddle.

The second routine in LIST CONTROLLER is the PAGE routine. This routine outputs the listing one text screen page at a time. The text screen is first cleared by using the HOME subroutine in the Apple monitor. The listing is then output to the text screen. When the screen has been filled, the listing stops until another command is given. To understand how it is determined that the text screen has been filled, one must understand how characters are output to the screen.

Pages 14-17 of the *Apple II Reference Manual* tell us that the text screen occupies pages four through seven of memory. If we examine the diagram on page 16, we see that the lines of the text screen are not ordered sequentially. However, this is not important since this diagram also shows us that the last line of the text screen is at $7D0. And by further knowing that the address of the next line to be used for outputting to the text screen is calculated in BASCALC ($FBC1) and is then stored in BASL($28) and BASH($29), we can poll these addresses until the end of the text screen is reached (i.e. BASL = $D0 and BASH = $07). We then wait for the next command.

The STEP routine is a very simple routine which polls the output to the text screen until a 'carriage return' is detected, indicating the end of a line of output. We then go to the DELAY routine which waits for another command.

The final routine in this program is the DONE routine. When this routine is called, the output hooks at CSWL($36) and CSWH($37) are reset to the original monitor output routine at COUT1. It then determines which language the user is using by polling PROMPT($33), the address at which the monitor holds the prompt character. A jump to the warm start of the particular language is then executed.

The well-documented program which is listed should be self explanatory and should help the interested programmer to fully understand the routines. The program can be relocated with a few changes.

How to Use 'LIST CONTROLLER'

Because of the idiosyncracies of the three languages in the standard Apple II, I have had to use three different methods for using this program—one for each language. The program is first BLOADed from disk. If you are in Applesoft, type '&:LIST' to activate LIST CONTROLLER. The colon is necessary for proper handling of the command. In Integer BASIC typing 'CALL 768' will activate LIST CONTROLLER and begin listing your program automatically. To use LIST CONTROLLER from the monitor type (CTRL-Y)xxxxT where xxxx is the address with which you wish to begin tracing. The way the program is written, game paddle #0 is used to control output speed. To change to paddle #1, change the 'LDX #$0' in the PDDLRD routine to 'LDX $#1'.

When I'm not programming or playing with My Apple II, I am a research fellow in the Department of Surgery at the Brigham and Women's Hospital in Boston. I have had my Apple for two years and have taught myself assembly language over the last twelve months. Although I use my Apple primarily for personal entertainment, I have had occasion to use it in my research projects.

Listing 1

```
                ; **************************************
                ; *                                    *
                ; *        LIST CONTROLLER             *
                ; *              BY                    *
                ; *        PRESTON R BLACK             *
                ; *                                    *
                ; *                                    *
                ; *      TO USE 'BLOAD' FROM THE       *
                ; *      DISK. THEN ACTIVATE BY        *
                ; *      USING THE FOLLOWING           *
                ; *      COMMANDS:                     *
                ; *                                    *
                ; *      APPLESOFT--'&:LIST'           *
                ; *      INTEGER BASIC--'CALL 768'     *
                ; *      MONITOR--'(CTRL-Y)XXXX'       *
                ; *        WHERE XXXX IS THE ADD-      *
                ; *        RESS FROM WHICH YOU         *
                ; *        WOULD LIKE TO START         *
                ; *        TRACING                     *
                ; *                                    *
                ; **************************************
                ;
                ;
                BASL   EPZ $28
                BASH   EPZ $29
                PROMPT EPZ $33
                CSWL   EPZ $36
                CSWH   EPZ $37
                RETURN EQU $8D
                ESCAPE EQU $9B
                SPACE  EQU $A0
                IPRMPT EQU $BE
                PGBTM  EQU $D7
                APRMPT EQU $DD
                KBRD   EQU $C000
                STRB   EQU $C010
                ABASIC EQU $D43C
                IBASIC EQU $E003
                INLIST EQU $E04B
                PREAD  EQU $FB1E
                HOME   EQU $FC58
                WAIT   EQU $FCA8
                COUT1  EQU $FDF0
                RSTORE EQU $FF3F
                SAVE   EQU $FF4A
                MON    EQU $FF69
                ;
                ; SET AMPERSAND (&) JUMP VECTOR FOR APPLESOFT
                ;
03F5                   ORG $3F5
03F5            AMPRSD:
03F5 4C0003            JMP BEGIN
03F8            ;
03F8            ; SET CONTROL-Y JMP VECTOR FOR THE MONITOR
03F8            ;
03F8                   ORG $3F8
03F8            CTRLY:
03F8 4C0003            JMP BEGIN
03FB            ;
03FB            ;
03FB            ; ********* LIST CONTROLLER *********
03FB            ;
03FB            ;
0300                   ORG $300
0300            ;
0300            BEGIN:
0300 A912              LDA #PDDLRD        ; RESET OUTPUT HOOKS
0302 8536              STA CSWL           ; TO ROUTINE AT PDDLRD
0304 A903              LDA /PDDLRD
0306 8537              STA CSWH
0308 A533              LDA PROMPT
030A C9BE              CMP #IPRMPT        ; IS PROMPT '>'?
030C D003              BNE RETRN          ; NO--CONTINUE
030E 4C4BE0            JMP INLIST         ; YES--TO INTEGER BASIC LIST
0311            RETRN:
0311 60                RTS
0312            ; *
0312            ; *
0312            ; * PADDLE READING ROUTINE
0312            ; *
0312            ; *
0312            PDDLRD:
0312 204AFF            JSR SAVE           ; SAVE REGISTERS
0315 A200              LDX #$00           ; SELECT PADDLE #0
0317 201EFB            JSR PREAD          ; READ PADDLE VALUE IN Y REGISTER
031A 98                TYA                ; MOVE VALUE TO ACC
031B 20A8FC            JSR WAIT           ; TO MONITOR DELAY ROUTINE
031E 203FFF            JSR RSTORE         ; RESTORE REGISTERS
0321 20F0FD            JSR COUT1          ; OUTPUT CHARACTER
0324 AD00C0            LDA KBRD           ; POLL KEYBOARD
0327 C99B              CMP #ESCAPE        ; ? 'ESCAPE'
0329 F050              BEQ DONE           ; YES--FINISHED
032B C9A0              CMP #SPACE         ; ? 'SPACE'
032D F06B              BEQ STEPS          ; YES--OUTPUT ONE LINE
032F C98D              CMP #RETURN        ; ? 'CR'
0331 F004              BEQ PAGE           ; YES--OUTPUT ONE PAGE
```

(Continued)

Listing 1 *(Continued)*

```
0333 2C10C0          BIT STRB          ; CLEAR KEYBOARD
0336 60              RTS               ; REJOIN OUTPUT
0337            ; *
0337            ; *
0337            ; * ROUTINE TO OUTPUT ONE PAGE TO THE SCREEN
0337            ; *
0337            ; *
0337            PAGE:
0337 2C10C0          BIT STRB
033A A94C            LDA #PAGE1        ; RESET OUTPUT HOOKS
033C 8536            STA CSWL          ; TO ROUTINE AT PAGE
033E A903            LDA /PAGE1
0340 8537            STA CSWH
0342 204AFF          JSR SAVE          ; SAVE REGISTERS
0345 2058FC          JSR HOME          ; CLEAR SCREEN
0348 203FFF          JSR RSTORE        ; RESTORE REGISTERS
034B 60              RTS               ; REJOIN OUTPUT
034C            PAGE1:
034C 20F0FD          JSR COUT1         ; OUTPUT A CHARACTER
034F A528            LDA BASL          ; ARE WE AT THE END
0351 4529            EOR BASH          ; OF THE SCREEN PAGE?
0353 C9D7            CMP #PGBTM
0355 F001            BEQ DELAY         ; YES--WAIT FOR ANOTHER INSTRUCTION
0357 60              RTS               ; ELSE REJOIN OUTPUT
0358            ; *
0358            ; *
0358            ; * DELAY ROUTINE AND KEYBOARD SERVICING ROUTINE
0358            ; *
0358            ; *
0358            DELAY:
0358 AD00C0          LDA KBRD          ; ?KEY PRESSED
035B 10FB            BPL DELAY         ; NO--WAIT
035D C9A0            CMP #SPACE        ; ? 'SPACE'
035F F039            BEQ STEPS         ; YES--OUTPUT ONE LINE
0361 C98D            CMP #RETURN       ; ? 'CR'
0363 D006            BNE DELAY1
0365 2C10C0          BIT STRB          ; YES--OUTPUT ONE PAGE
0368 4C3703          JMP PAGE
036B            DELAY1:
036B C99B            CMP #ESCAPE       ; ?'ESCAPE'
036D F00C            BEQ DONE          ; YES--FINISHED
036F 2C10C0          BIT STRB          ; IF ANY OTHER KEY
0372 A912            LDA #PDDLRD       ; IS PRESSED THEN
0374 8536            STA CSWL          ; RESET OUTPUT HOOKS
0376 A903            LDA /PDDLRD       ; TO ROUTINE AT PDDLRD
0378 8537            STA CSWH
037A 60              RTS               ; REJOIN OUTPUT
037B            ; *
037B            ; *
037B            ; * LIST CONTROLLER EXIT ROUTINE
037B            ; *
037B            ; *
037B            DONE:
037B 2C10C0          BIT STRB
037E A9F0            LDA #COUT1        ; RESET OUTPUT HOOKS
0380 8536            STA CSWL          ; TO REGULAR OUTPUT ROUTINE AT COUT1
0382 A9FD            LDA /COUT1
0384 8537            STA CSWH
0386 A533            LDA PROMPT
0388 C9BE            CMP #IPRMPT       ; IS PROMPT '>'
038A D003            BNE DONE2
038C 4C03E0          JMP IBASIC        ; YES--WARMSTART INTEGER BASIC
038F            DONE2:
038F C9DD            CMP #APRMPT       ; IS PROMPT ']'
0391 D003            BNE DONE3
0393 4C3CD4          JMP ABASIC        ; YES--WARMSTART APPLESOFT
0396            DONE3:
0396 4C69FF          JMP MON           ; DEFAULT TO MONITOR WARMSTART
0399 60              RTS
039A            ; *
039A            ; *
039A            ; * ROUTINE TO OUTPUT ONE LINE
039A            ; *
039A            ; *
039A            STEPS:
039A 2C10C0          BIT STRB
039D A9A6            LDA #STEP         ; RESET OUTPUT HOOKS
039F 8536            STA CSWL          ; TO STEP ROUTINE
03A1 A903            LDA /STEP
03A3 8537            STA CSWH
03A5 60              RTS               ; REJOIN OUTPUT
03A6            STEP:
03A6 C98D            CMP #$8D          ; ?CARRIAGE RETURN
03A8 F004            BEQ STEP1
03AA 20F0FD          JSR COUT1         ; NO--CONTINUE OUTPUT
03AD 60              RTS               ; REJOIN OUTPUT
03AE            STEP1:
03AE 20F0FD          JSR COUT1         ; YES--OUTPUT CARRIAGE RETURN
03B1 D0A5            BNE DELAY         ; THEN TO DELAY ROUTINE
03B3 60              RTS               ; REJOIN OUTPUT
                END
```

MICRO™

Lo-Res Graphics and Pascal

The Apple language card precludes the use of the normal low resolution plotting routines. This article offers a library of assembly language procedures that allows you to plot low resolution graphics using Pascal.

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One of the principal attractions of the Apple II is its capacity for expansion. Not only can the Apple owner add a plethora of peripheral devices, but he can also change the very "personality" of his machine. Perhaps the most significant development in this latter connection was the Apple II Language Card. With it, the Apple owner can turn a hobbyist machine into a sophisticated computer system using one of the foremost languages of the computer industry, Pascal. As discussed by John Mulligan (MICRO, 29:59), Pascal provides the programmer with a very powerful set of programming tools. The Apple II owner interested in serious applications of his machine will find Pascal well worth considering.

However, he may find one feature disappointing. Because the Language Card functionally replaces the Apple monitor, it gates out many of Apple's intrinsic features. The feature that the new Pascal owner is likely to miss is the Apple's low resolution graphics capability. While Pascal has an excellent graphics handler, it is restricted to the standard high resolution color set. There are no defined procedures to produce the rainbow of colors for which the unmodified Apple is famous. So, while the Pascal user will undoubtedly conclude that Pascal's power is worth the sacrifice, its lack of low resolution graphics is likely to keep him forever nostalgic, or turn him into a closet BASIC user.

To help advance the Pascal movement, I'd like to report on one way I have found to generate low resolution graphics from Apple Pascal. It permits plotting on either page of the low resolution screen.

As readers of the *Apple Reference Manual* know, low resolution graphics in the BASIC Apple are generated from RAM data in the range $400 to $BFF, with the first $400 hex locations designated as "page one" and the second as "page two." This is also the area which contains text data when the Apple is displaying text. Whether text or data are displayed is determined by whether location $C054 or $C055 was last referred to.

This same memory range is reserved in Pascal to display text. The old page one contains the first 40 columns of text; the old page two contains the second. Hitting "Ctrl-A" from the keyboard simply switches between the two pages. But, despite the use of this range for text, the soft switches controlling the display of text or graphics are still functional. To verify this, perform the following experiment.

Type in the program of listing 1. This is a series of assembly language instructions that refer to the soft switches controlling the display of text

Listing 1

```
;-------------------------------------------------;
;                                                 ;
; THE FOLLOWING PROCEDURES "THROW" THE            ;
; APPROPRIATE SOFT SWITCHES TO EFFECT THEIR       ;
; RESPECTIVE FUNCTIONS. "COLOR1" AND "COLOR2"     ;
; DISPLAY LOW RESOLUTION GRAPHICS ON THE FULL     ;
; SCREEN OF THE PRIMARY AND SECONDARY PAGE,       ;
; RESPECTIVELY. "TEXT1" DISPLAYS ALL TEXT ON      ;
; THE PRIMARY PAGE.  OTHER COMBINATIONS OF        ;
; SWITCHES COULD BE USED TO DISPLAY MIXED TEXT    ;
; AND GRAPHICS ( SEE PAGE 13 OF THE APPLE ][      ;
; REFERENCE MANUAL ).                             ;
;                                                 ;
;-------------------------------------------------;

          .PROC COLOR1
          LDA 0C050
          LDA 0C052
          LDA 0C054
          LDA 0C056
          RTS

          .PROC COLOR2
          LDA 0C050
          LDA 0C052
          LDA 0C055
          LDA 0C056
          RTS

          .PROC TEXT1
          LDA 0C051
          LDA 0C054
          RTS


          .END
```

or graphics. The instructions under the heading .PROC COLOR1 turn on the graphics of page one; those under .PROC COLOR2 and .PROC TEXT1 turn on page two graphics and page one text, respectively. For those readers who have not yet used the assembly langauge capabilities of Pascal, these routines will ultimately be integrated into the main Pascal program and called as procedures.

After you have typed listing 1, save it in a disk file (e.g., under the name ASMDEMO). Then type in listing 2, which is the Pascal program to use these routines. Notice that there are procedure declarations corresponding to each assembly language routine. These procedures are then called in the main body of the program. Listing 2 should likewise be saved in a disk file.

Now you must use the system assembler, compiler, and linker to integrate the two programs. Follow the instructions given for the example in section 1.9.1.1 of the *Pascal Reference Manual*. Run the linked program. The system responds with its usual "RUNNING..." message. Hit carriage return, and you should see an immediate switch to the bar pattern of a non-cleared low resolution screen. The irregular colors in the upper left, of course, are the color translations of the message characters. The next carriage return switches to page two; the pattern in the upper left disappears. Finally, the next carriage return will return you to text mode and end the program.

Listing 2

```
PROGRAM SWITCHDEMO;

VAR
  RESPONSE : CHAR;

PROCEDURE COLOR1; EXTERNAL;

PROCEDURE COLOR2; EXTERNAL;

PROCEDURE TEXT1; EXTERNAL;


BEGIN

  READLN(RESPONSE);
  COLOR1;
  READLN(RESPONSE);
  COLOR2;
  READLN(RESPONSE);
  TEXT1;

END.
```

Listing 3

```
PROGRAM COLORDEMO;

VAR
  RESPONSE : CHAR;
  X : 0..39;
  Y : 0..47;
  COLOR : 0..15;

PROCEDURE COLOR1; EXTERNAL;

PROCEDURE COLOR2; EXTERNAL;

PROCEDURE TEXT1; EXTERNAL;

PROCEDURE PLOT2(X,Y,COLOR: INTEGER); EXTERNAL;

BEGIN

  COLOR2;

  FOR X := 0 TO 39 DO
    FOR Y := 0 TO 47 DO
      PLOT2(X,Y,0);

  TEXT1;

  REPEAT
    GOTOXY(0,3);
    WRITELN('                 ');
    GOTOXY(0,1);
    WRITELN('ENTER X, Y, AND COLOR');
    WRITELN('HIT <CR> TO DISPLAY PLOT; <CR> TO RETURN');
    READLN(X,Y,COLOR);
    COLOR2;
    PLOT2(X,Y,COLOR);
    READLN(KEYBOARD,RESPONSE);
    TEXT1;
    WRITELN('TYPE ''Q'' TO QUIT; SPACE TO CONTINUE');
    WRITELN('THEN HIT <CR>');
    READLN(RESPONSE);
  UNTIL RESPONSE = 'Q';

END.
```

So, Apple Pascal can generate low resolution colors—if we can put the right data into the right locations of the low resolution pages. Normally, this computation is performed by the Apple monitor, but again, it has been disabled by the Language Card.

The solution I suggest is an assembly language routine like the ones used to switch the colors on and off. Listing 3 contains such a procedure, labeled as PLOT2. It is set up to accept the X and Y coordinates, and the color to be plotted, as parameters. This gives the user closer

Listing 4

```
          .MACRO POP      ; SAMPLE MACRO TO POP 16 BIT
          PLA             ; WORD FROM TOP OF STACK.
          STA %1
          PLA
          STA %1+1
          .ENDM

          .PROC PLOT2,3

;--------------------------------------------------;
;                                                  ;
;                    PLOT2                         ;
;                                                  ;
; THIS PROCEDURE TAKES AS ITS PARAMETERS AN X      ;
; COORDINATE (0..39), A Y COORDINATE (0..47),      ;
; AND A COLOR (0..15) AND PLOTS A LOW RESOLU-      ;
; TION BLOCK ON THE SECONDARY PAGE ( SEE PAGES     ;
; 17-18 OF THE APPLE ][ REFERENCE MANUAL FOR       ;
; COLOR AND COORDINATE ASSIGNMENTS ).              ;
;                                                  ;
```

(Continued)

Listing 4 *(Continued)*

```
; THE ROUTINE CAN BE USED TO PLOT ON THE PRI-   ;
; MARY PAGE BY ALTERING THE INSTRUCTION         ;
; LABELED "PAGENUMB" TO READ "ORA #04".         ;
;                                               ;
; LOCATIONS 0005 AND 0006 ARE USED FOR          ;
; TEMPORARY STORAGE.                            ;
;                                               ;
;-----------------------------------------------;

RETURN    .EQU 0         ; USE LOCATION 0000 TO
          POP RETURN     ; STORE RETURN ADDRESS.

          PLA            ; PUT LOWER-ORDER BYTE OF
          STA CLR        ; COLOR ARGUMENT IN CLR,
          PLA            ; AND DISCARD HIGH BYTE.

          LDA #0F0       ; SET UP BINARY MASK
          STA MASK       ; AT MASK.

          PLA            ; GET LOWER-ORDER BYTE
          PHA            ; OF Y COORDINATE AND
          PHA            ; DUPLICATE ON STACK.
          AND #30        ; STRIP BITS 0-3 AND 6-7.
          LSR A          ; TRANSFER BITS 4-5 TO
          STA 5          ; POSITIONS 3-4.
          ASL A          ; THEN DUPLICATE PATTERN
          ASL A          ; IN POSITIONS 5-6,
          ORA 5          ; AND STORE IN 0005.
          STA 5

          PLA            ; GET LOW BYTE OF Y COOR.
          AND #0E        ; STRIP BITS 0 AND 4-7.
          ROR A          ; TRANSFER RESULT TO
          ROR A          ; CARRY AND BITS 0-1.
PAGENUMB  ORA #08        ; COMBINE WITH PAGE LIMIT
          STA 6          ; AND STORE IN 0006.

          ROR A          ; TRANSFER ORIGINAL BIT 1
          AND #80        ; TO POSITION 7 AND
          ORA 5          ; COMBINE WITH CONTENTS
          STA 5          ; OF 0005.
          PLA            ; GET LOW BYTE OF Y COOR.
          AND #01
          BEQ SKIP       ; IF ODD,
          ASL CLR        ; THEN SHIFT COLOR CODE
          ASL CLR        ; TO POSITIONS 4-7
          ASL CLR        ; OF CLR,
          ASL CLR
          LDA #0F        ; AND CHANGE MASK.
          STA MASK

SKIP      PLA            ; DISCARD HIGH BYTE OF Y.
          TYA            ; SAVE Y REGISTER.
          STA YSTOR
          PLA            ; GET LOW BYTE OF X COOR,
          TAY            ; TRANSFER TO Y REGISTER,
          PLA            ; AND DISCARD HIGH BYTE.

          LDA @5,Y       ; GET BYTE ON SCREEN.
          AND MASK       ; ERASE OLD COLOR.
          ORA CLR        ; COMBINE NEW COLOR
          STA @5,Y       ; AND PLOT.
          LDA YSTOR      ; RETURN Y REGISTER.
          TAY
          LDA RETURN+1   ; GET RETURN ADDRESS
          PHA
          LDA RETURN
          PHA
          RTS            ; AND RETURN.

CLR       .BYTE
MASK      .BYTE
YSTOR     .BYTE

          .END
```

control over the color than that afforded by the routine which comes with Applesoft. I won't go into the details of listing 3, except to note that, through bit manipulations, it transforms the parameters passed to it by the host program into the appropriate addresses in the page two memory range. If you'd like to plot on page one, change the line labeled PAGENUMB to ORA #04. You could even rewrite listing 3 with the modification and put it under the heading .PROC PLOT1. Then you could plot a point on either page by executing PLOT2 or PLOT2.

Save and assemble listing 3 under some name. It can now be linked, along with listing 1, into a Pascal program which uses the procedure PLOT2 (X,Y,COLOR). I've written listing 4 as an example. To use it, type, save, and compile it, and then link it (as the "host file") to the assembled versions of listings 1 and 3 (as the "lib files"). When you run it, it will begin by visibly clearing the screen. Then it will switch back to text to ask for the coordinates and color of the point you wish to plot. Type the X coordinate, Y coordinate, and color number, each separated by spaces. Hit carriage return, and the program will plot the low resolution point on the screen. The next carriage return will bring you back to text to plot another point. The Pascal program isn't very elegant, but it should help to demonstrate how these routines can be used.

Hitting "Ctrl-A" during the program seems to interfere with the plot; I haven't located the reason yet. Also, the plotting routine could be written in such a way that the color of the point is determined by a global variable in the Pascal host program, rather than by a procedure parameter. This would be similar to the way plotting routines are handled in Applesoft. This could be done by the assembler directive .PUBLIC, which allows communication between the assembler and Pascal programs through common variables. Finally, I suggest that listing 3 be adapted as BASIC routine. Using it, one could plot on page two directly, without having to move chunks of data from page one. Just how it could be adapted is left as an exercise for the reader.

I've found Pascal to be an extremely attractive language. Before I developed these routines, however, I occasionally missed the low resolution graphics of Applesoft. Now, it's nice to know you can have your Apple and eat it too.

Donald Heth is an Assistant Professor at the University of Alberta. He is interested in microcomputers as tools for psychological research.

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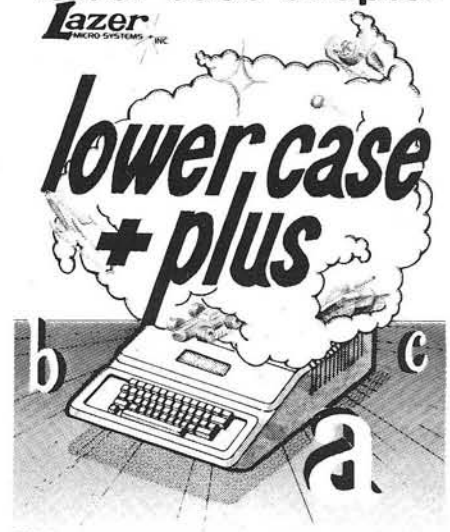

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for the Apple II

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by Randy Hyde

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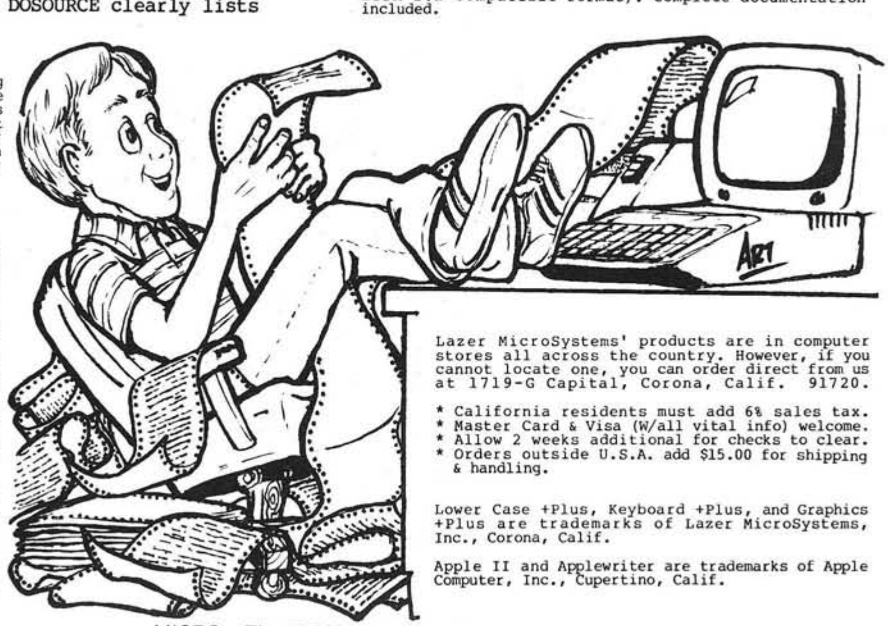

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Dollars & Sense Revisited

This article describes print formatting in Applesoft BASIC using a MID$ statement.

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One of the great joys of programming in BASIC is the way that one can solve the same problem in many different ways. Sometimes the thinking set one brings to the problem dictates the kind of solution one seeks. One often finds the simple solution to a problem while working on something quite different. I have been writing a program to act as a ski race secretary — shuffling, sorting, and printing the various lists of names and times generated during the course of a two-day ski race. One of the problems which I had to address was the output of times to the hundredth's decimal place, a problem similar to that discussed by Barton M. Bauers in his article "Business Dollars and Sense in Applesoft" which appeared in the August 1980 issue of MICRO (27:65). I was surprised to find how dissimilar our solutions were.

The problem, you will remember, is two-fold. First, in Applesoft one does not have a PRINT USING command or a print formatting capacity. Zeros trailing a decimal point, and the decimal point itself, will be omitted where no value follows the decimal. Both of our solutions involve tailoring an alphanumeric variable to suit our needs. Second, the tendency of rounding errors to crop up in the seventh significant digit must be overcome in handling cents. It would never do to output .2999997, rounded to .29 when the answer was really .30.

Bauers chose to handle this problem at input, converting and carrying his variables as integers. They must, of course, be reconverted at output. I chose to eliminate this step, and put the correction in as I set up the alphanumeric-tailored variable.

My solution is, where N is the number to manipulate, and N$ is the tailored alphanumeric to be printed:

```
10 N$ = STR$(N + 1.005 -
   SGN(N) * INT(ABS(N)))
20 N$ = STR$(SGN(N) *
   INT(ABS(N)))          +
   MID$(N$,2,3)
```

The Applesoft BASIC will return a 5E-03 when 0 + .005 is used, and this will be carried into the string. To protect against this I use a 1.005 adder for correction, then ignore the first digit. It is also advisable to use a fix-rounding situation rather than depend on the INT() function which will round *down* with negative values.

Listing 1 is a simple program which illustrates the above two lines as used in a program.

Dave Delli Quadri works as a contractor in the summer and a micro-programmer in the winter. Specializing in computer applications for ski competition, his programs have been used by the U.S. and Canadian Ski Associations for both jumping and alpine tournaments.

Listing 1

```
10  REM    A CHECKBOOK BALANCING
20  REM    PROGRAM TO ILLUSTRATE
30  REM    A SOLUTION TO A PRINT
40  REM    FORMATTING PROBLEM...
50  REM
60  HOME
70  INPUT "ENTER CURRENT BALANCE  ";BALANCE
80  PRINT : PRINT "ENTER CHECK AS    -NN.NN"
90  PRINT : PRINT "ENTER DEPOSIT AS   NN.NN"
100  PRINT : HTAB 20: INPUT "";CHECK
105 BALANCE = BALANCE + CHECK
110 BA$ =  STR$ (BALANCE + 1.005 -  SGN (BALAN
CE) *  INT ( ABS (BALANCE)))
120 BA$ =  STR$ ( SGN (BALANCE) *  INT ( ABS (
BALANCE))) +  MID$ (BA$,2,3)
130  PRINT : PRINT "NEW BALANCE IS  $ ";BA$
140  PRINT : INPUT "ANOTHER ENTRY?  ";AN$
150  IF  LEFT$ (AN$,1) = "Y" THEN 80
160  END

]RUN
ENTER CURRENT BALANCE  156.89

ENTER CHECK AS    -NN.NN

ENTER DEPOSIT AS   NN.NN
```

MICRO

Paddle Hi-Res Graphics

This program lets you draw a background scene on the Apple Hi-Res Graphics display using paddles. Data points are gathered according to the user-definable coordinate space. A series of DATA statements are created on a disk text file which can then be EXECed into any program.

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Apple owners are continually searching for shape maker programs. With a shape maker, you can define a shape to meet the needs of your program and then XDRAW the shape on a landscape background, creating exciting games. There has been a myrid of programs to create shapes, but few to create the backgrounds. This program allows you to create that background.

Paddle 0 controls the *X* movement, and paddle 1 controls the *Y* movement. The *X*-, *Y* coordinates from the paddles, in the user's coordinate system, are displayed as well as the status of the "pen." As the movement of the paddles draws a picture on the screen, the coordinates and the pen status are maintained in a vector array. At the conclusion of the background drawing the Apple will respond with a request for a starting line number and a text file name, in which data statements will be stored. In this data statement mode the Apple will create a series of DATA statements starting with the given line number and increment and place them onto the given text file. From the text file the statements may then be EXECd into any program to provide a permanent storage of the required background.

This program makes use of the windowing transform which takes a series of points in a defined "window" and transforms them into a series of points on a defined "viewport." For example, if I have a series of points from a plot whose *X* axis goes from 10 to 20 and whose *Y* axis goes from −15 to +35, this is my defined "window." If I wish to plot them on the upper right portion of the Apple's screen, in a defined "viewport" whose *X* axis goes from 140 to 279 and whose *Y* axis goes from 80 to 0, then I would use the windowing transform:

$$X' = 13.90 * X + 1$$
$$Y' = -1.60 * Y + 56$$

The transform is defined as follows:

```
WV2   .________.  VV2  .________.
      I        I       I        I
      I .      I       I .      I
      I X,Y    I       I X',Y'  I
      I        I       I        I
WV1   I        I  VV1  I        I
      WH1  WH2         VH1   VH2
       window          viewport
```

$$X' = A * X + B$$
$$Y' = C * Y + D$$

where:

$$A = (VH2 - VH1) / (WH2 - WH1)$$
$$B = VH1 - A * WH1$$
$$C = (VV2 - VV1) / (WV2 - WV1)$$
$$D = VV1 - C * WV1$$

The windowing transform is used to go from a user's coordinate system, the "window," to a device's (plotter, graphics screen, etc.) coordinate system, the "viewport." As you can see from the example, it is not necessary to fill the entire device; the example uses one-fourth of the screen. As a matter of fact, the windowing transform can be used to "zoom" in on a particular area, using clipping to get rid of unplottable lines.

Listing 1

```
10  REM  ENTER X(I),Y(I),P(I),I=1..N
20  REM  X(I) IS X COMPONENT
30  REM  Y(I) IS Y COMPONENT
40  REM  P(I)=1 PEN UP BEFORE MOVE
50  REM  P(I)=0 PEN DOWN BEFORE MOVE
60  POKE 232,192: POKE 233,3
70  FOR I = 960 TO 970: READ Z: POKE I,Z: NEXT I
80  DATA  1,0,4,0,54,196,111,32,86,53,0
90  DIM X(200),Y(200),P$(200)
100  REM  DRAW SCREEN FROM PADDLE
110  TEXT : HOME : ROT= 0: SCALE= 1: HCOLOR= 3
120  INPUT "XMIN VALUE (LEFT SIDE)? ";X1
130  INPUT "XMAX VALUE (RIGHT SIDE)? ";X2
140  INPUT "YMIN VALUE (BOTTOM)? ";Y1
150  INPUT "YMAX VALUE (TOP)? ";Y2
160 AZ = (X2 - X1) / 279:BZ = X1:CZ = (Y2 - Y1) / ( - 159
    ):DZ = Y1 - 159 * CZ
170  HGR :F = 0
180  VTAB 22: HTAB 1: PRINT "PEN IS UP"
190  GOSUB 870: REM  GET PADDLE POSITION
200  XDRAW 1 AT X,Y
210 XL = X:YL = Y
220 N = 0:G = 0
230  REM  REPEAT START
240  GOSUB 870: REM  GET PADDLE POSITION
250  XDRAW 1 AT XL,YL: XDRAW 1 AT X,Y:XL = X:YL = Y
260  IF  PEEK ( - 16384) <  = 127 THEN 840: REM  WAS KEY
    PRESSED?
```

(Continued)

The Program

The program begins by POKEing the "plus" cursor shape into locations starting at $3C0 which are above most page 3 utility routines and out of the way. The program then requests the user's min/max user screen values. If the values entered are 0, 279, 159 and 0, then the data recorded are the screen values themselves. However, if you are entering only one-fourth of an actual background then these numbers must change. The heart of the program is a REPEAT-UNTIL loop; the ESC key is the trigger to leave. Within the loop, as long as no keys on the keyboard are pressed, the loop continuously reads the current paddle cursor position, XDRAWS the cursor over the old cursor position, and XDRAWS the cursor at the new position. In this way the cursor appears to move over the entire screen without disrupting anything that has already been drawn.

The subroutine at the bottom of the program listing reads the cursor position from the paddles. Note that the paddles normally read from 0 to 255, clockwise. The subroutine reads each paddle and converts it through the windowing transform to appropriate screen coordinates.

Note that paddle 1 values are reversed so that with a clockwise rotation the cursor goes "up" instead of "down." The program locks out all but three keys. The space bar changes the "pen" status: if the "pen" is up, no lines are drawn; if it is "down," lines are drawn and data is taken. If the "pen" is down and the return is pressed, then the current cursor position is taken as the data point. If the "pen" was "up," and is now down previous to pressing the return key, then data is stored with an indicator, P%(), of 1, indicating to move to this point, i.e. HPLOT X,Y. If the "pen" was "down," and is now "down" previous to pressing the return key, then data is stored with an indicator, P%(), of 0 indicating to draw a line to this point, i.e. HPLOT TO X,Y. To start taking data, the space bar must be pressed until the "pen" is down and then the return key is pressed. When the ESC key is pressed, further recording of data ceases and the creation of DATA statements begins.

Kim G. Woodward works as an electronic engineer for the U.S. Coast Guard in Washington, D.C. He has been in the computer field for ten years. Woodward's current interests include software engineering and utility type programs.

MICRO

```
270 K =  PEEK ( - 16384) - 128: POKE  - 16368,0
280  IF K <  > 32 THEN 340: REM  KEY IS SPACE?
290  CALL  - 1059: REM  BEEP SPEAKER
300  IF F = 0 THEN F = 1: VTAB 22: HTAB 1: PRINT "PEN IS
    DOWN": GOTO 320
310  IF F = 1 THEN F = 0: VTAB 22: HTAB 1: PRINT "PEN IS
    UP  ":G = 0
320  REM  CONT.
330  GOTO 840
340  REM  CONT.
350  IF K <  > 27 THEN 640: REM  KEY IS ESC?
360  TEXT : HOME
370  INPUT "NAME OF FILE? ";A$
380  PRINT  CHR$ (4);"OPEN ";A$
390  PRINT  CHR$ (4);"DELETE ";A$
400  PRINT  CHR$ (4);"OPEN ";A$
410  INPUT "STARTING LINE NUMBER? ";I1
420  INPUT "INCREMENT? ";I2
430  PRINT  CHR$ (4);"WRITE ";A$
440  PRINT I1;" REM ";A$
450 I1 = I1 + I2
460  PRINT I1;" DATA ";N;",";X1;",";X2;",";Y1;",";Y2:I1 =
     I1 + I2
470 B$ = " DATA "
480 ZZ = 1
490  FOR I = 1 TO N
500 N1 = I - 1
510  IF ZZ <  > 4 OR I = 1 THEN 570
520 ZZ = 1
530  PRINT I1; LEFT$ (B$, LEN (B$) - 1)
540 I1 = I1 + I2
550 B$ = " DATA "
570 B$ = B$ +  STR$ (X(I)) + "," +  STR$ (Y(I)) + "," +
    STR$ (P%(I)) + ","
580 ZZ = ZZ + 1
590  REM  CONT.
600  NEXT I
610  PRINT I1; LEFT$ (B$, LEN (B$) - 1)
620  PRINT  CHR$ (4);"CLOSE ";A$
630  GOTO 840
640  REM  CONT.
650  IF K <  > 13 THEN 830: REM  KEY IS CR?
660  CALL  - 1059: REM  BEEP SPEAKER
670 N = N + 1:X(N) = AZ * X + BZ:Y(N) = CZ * Y + DZ
680  IF F = 0 THEN 810
690  IF G <  > 0 THEN 750
700  XDRAW 1 AT X,Y
710 G = 1: HPLOT X,Y:XZ = X:YZ = Y
720 P%(N) = 1
730  XDRAW 1 AT X,Y
740  GOTO 800
750  XDRAW 1 AT X,Y
760  HPLOT XZ,YZ TO X,Y:XZ = X:YZ = Y
770 P%(N) = 0
780  XDRAW 1 AT X,Y
790 G = 1
800  REM  CONT.
810  REM  CONT.
820  GOTO 840
830  REM  CONT.
840  REM  CONT.
850  IF K <  > 27 THEN 230
860  END
870  REM  CURSER SUBROUTINE
880 X =  PDL (0) * (279 / 255)
890 Y = 159 - ( PDL (1) * (159 / 255))
900 XP = AZ * X + BZ:YP = CZ * Y + DZ
910  VTAB 22: HTAB 20: PRINT  INT (XP + .5);"      ": VTAB
     23: HTAB 20: PRINT  INT (YP + .5);"      "
920  RETURN
```

Software for the Apple II and Apple II Plus*

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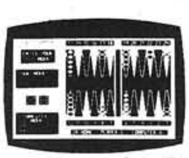

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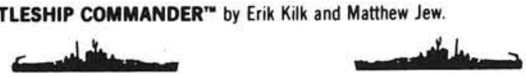

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True 3-D Images on Apple II

This article describes a program which creates stereo-pair images for viewing without accessory devices. The pair of images can be fused into a three dimensional pattern by placing a piece of paper between the viewer's eyes and the viewing screen so that each eye sees only the appropriate image. With practice the paper is no longer needed. The object used for demonstration is a three dimensional Lissajous figure.

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What we are talking about here is a genuine three-dimensional image such as seen through my grandparents' stereoptican or through more recent systems, such as require colored eye filters or polarizing filters for viewing. The present technique involves not a single projection of the object, a perspective view, but a pair of images which can be fused into one 3-D image without auxiliary contrivances.

The *Scientific American* has published articles accompanied by stereo-pair images, which can be fused into a stereo scene with a little practice. This program was inspired by success with such viewing. Some eye training is required, and some eye strain may be felt initially. What is required is that you stare off into the distance (eyeball axes essentially parallel) while focussing nearby. The muscles which direct your eyeball and the muscles which focus your lens are accustomed to working in a coordinated way for distant or for nearby objects; this muscular habit can readily be broken. It is not at all difficult for me now to glance at a pair of images on the screen from anywhere in the room, and see the 3-D pattern.

Listing 1

```
0  REM NOISY COASTER BY ART RADCLIFFE
10  HOME : POKE 36,12: PRINT "NOISY COASTER"
20  DIM A%(299): DIM B%(299): DIM H%(299): DIM S(299)
30 A = B = C = D = E = F = G = H = I = J = 0
40 K = L = M = N = O = P = Q = T = U = V = 0
50 W = X = Y = Z = 0:R =  - 16336:S = .5:LL = 0
60  GOTO 630
65  REM -------------------------
70  PRINT  CHR$ (7): PRINT  CHR$ (7): FOR A = 0 TO 1000:
 NEXT : PRINT  CHR$ (7)
80  FOR P = 0 TO 299
90 A =  PEEK (R)
100  HCOLOR= 3: REM  FRONT OF TRAIN
110 B = A%(P):C = B%(P):D = H%(P)
120 E = B + 1:F = C + 1:G = D + 1
130  HPLOT B,F: HPLOT E,C: HPLOT E,F
140  HPLOT D,F: HPLOT G,C: HPLOT G,F
150 Q = P - 10
160 A =  PEEK (R)
170  IF Q < 0 THEN Q = P + 289: REM 0<=Q<=360DEG
180  HCOLOR= 0: REM END OF TRAIN
190 B = A%(Q):C = B%(Q):D = H%(Q)
200 E = B + 1:F = C + 1:G = D + 1
210  HPLOT B,F: HPLOT E,C: HPLOT E,F
220  HPLOT D,F: HPLOT G,C: HPLOT G,F
230 A =  PEEK (R): REM REPLOT TRACK ->
240  HCOLOR= 3: HPLOT B,C: HPLOT D,C
250 A =  PEEK (R)
260  FOR Z = 0 TO LL - B%(P): NEXT : REM  TRAIN SPEED
270 A =  PEEK (R)
280  NEXT P
290  PRINT  CHR$ (7)
300  RETURN
305  REM -----------------------
310  FOR P = 0 TO 299: REM ESTABLISH PATTERN
320 X = S(I) + L:Y = 2 * S(J) + T:Z = S(K)
330 M = (C - Z) / (G - Z)
340 A =  INT (S + X + M * (E - X)):A%(P) = A: REM  LEFT X
350 B =  INT (S + Y + M * (F - Y)) - 50:B%(P) = B: REM Y
360 H =  INT (S + X + M * (D - X)):H%(P) = H: REM  RIGHT X
370  HPLOT A,B: HPLOT A + 2,B: HPLOT H,B: HPLOT H + 2,B
380  IF LL < B THEN LL = B
390 I = I + U: IF I > 299 THEN I = 0
400 J = J + V: IF J > 299 THEN J = 0
410 K = K + W: IF K > 299 THEN K = 0
420  NEXT P
430  RETURN
```

(Continued)

The viewing images are produced by running rays from each defined point of the object to points which correspond to eye locations, with the object being behind the screen and the eyes in typical viewing positions. Points are plotted where these rays intercept the display plane.

The object is defined near the origin of an *X, Y, Z* coordinate system, behind the screen plane. We can define object points using the notation: $(X1,Y1,Z1)$, define screen points with: $(X2,Y2,Z2)$ and define the eye locations using: $(X3,Y3,Z3)$. $Z2$, the screen distance from the origin, is set at 200 in the program and $Z3$, the eye distance from the origin, is set at 300. $Y3$ is the same for each eye: 40; and the $X3$ values for the two eyes are 40 and 120. The direction from which the object is viewed can be altered by offsetting $X1$ and $Y1$.

Use of proportions leads us to the conclusion that $(X2-X1)/(Z2-Z1) = (X3-X1)/(Z3-Z1)$ and similarly, $(Y2-Y1)/(Z2-Z1) = (Y3-Y1)/(Z3-Z1)$. From these equations we can derive $X2 = X1 + M(X3-X1)$ and $Y2 + Y1 + M(Y3-Y1)$ where $M = (Z2-Z1)/(Z3-Z1)$.

Listing 1 is an embellishment, with sound effects, of the program as originally written, which appears in listing 2.

Within the program there are variable substitutions: $(X,Y,Z) = (X1,Y1,Z1)$, $(A,B,C) = (X2,Y2,Z2)$ and $(D,F,G),(E,F,G) = (X3,Y3,Z3)$. A Lissajous pattern was chosen for viewing because it has the convenient property of being restricted to a rectangular area, derived from the property of the sine function, being bounded by 1 and -1. In the program a raised sine is used by adding 1 (line 64) to avoid negative values. Thus, the *X*-coordinates of the object vary according to one sine function, the *Y*-coordinates of the object vary in a coordinated manner according to a second sine function, and the *Z*-coordinate varies according to a third sine function.

Random numbers are used to achieve an almost infinite variety of patterns. It is fun to watch the pattern take shape; the eye can go on a roller-coaster ride with the leading edge of the pattern as it develops on the screen.

There is an inherent limitation to this method in that the display area is limited to the space between the primary pair of images. Use of prismatic glasses might increase the available object size. The program is written for viewing on a twelve inch diagonal screen. Users with other size displays may want to alter program parameters, first increasing or decreasing the *X* dimension for eye position by altering

Listing 1 *(Continued)*

```
435  REM -------------------------
440 O = 8 *  ATN (1) / 300: REM 360DEG/300
450 N = 40: REM OBJECT SCALE FACTOR
460  FOR A = 0 TO 299
470 S(A) = N * (1 +  SIN (A * O)): REM SINE+1>0
480  NEXT A
490 C = 200: REM X COOR'S OF EYES
500 D = 120
510 E = 40: REM Y COOR'S OF EYES
520 F = 40
530 L = 150: REM  X,Y,Z COOR'S OF OBJECT
540 T = 250
550 G = 300: REM # CYCLES IN X,Y,Z ->
560 U =  INT (1 + 5 *  RND (1))
570 V =  INT (1 + 5 *  RND (1)): IF V = U THEN 570
580 W =  INT (1 + 5 *  RND (1)): IF W = V OR W = U THEN
580
590 I =  INT (300 *  RND (1)): REM START POINTS
600 J =  INT (300 *  RND (1))
610 K =  INT (300 *  RND (1))
620  RETURN
625  REM -------------------------
630  PRINT : PRINT : PRINT "  CREATED BY ART RADCLIFFE,
ANN ARBOR    ": PRINT
640  PRINT : PRINT "PLACE 8 INCH BY 12 INCH CARDBOARD
  "
650  PRINT "BETWEEN SCREEN AND TIP OF NOSE SO EACH  "
660  PRINT "EYE SEES ONLY IT'S IMAGE.  SOME EYE     "
670  PRINT "TRAINING IS NECESSARY.            "
680  PRINT : PRINT : PRINT : PRINT : PRINT
690  PRINT "PLEASE BE PATIENT WHILE I MEDITATE TO   "
700  PRINT "GET MYSELF READY FOR THIS.............."
705  REM -------------------------
710  GOSUB 440 REM INITIALIZE
720  HOME : HGR : HCOLOR= 3
730 LL = 0: REM LOWEST POINT
740  GOSUB 310 REM LAY TRACK
750  FOR A = 0 TO 999: NEXT
760  GOSUB 70 REM HOLD TIGHT!
770  FOR A = 0 TO 3000: NEXT
780  GOSUB 490 REM REINITIALIZE
790  GOTO 720 REM START OVER
800  END
```

Listing 2

```
0  REM LISSAJOUS FIGURES IN TRUE 3D FOR APPLE-II.
2  REM  PLEASE SHARE YOUR COMMENTS WITH:
4  REM  ART RADCLIFFE
6  REM  1612 FERNDALE
8  REM  ANN ARBOR, MICHIGAN 48104
10  REM  (313)-995-2485
12  REM  SEE REMARKS AT END OF PROGRAM.
14  HGR : HCOLOR= 3: PRINT : PRINT : PRINT "WAIT"
16  DIM S(199)
18 A = B = C = D = E = F = G = H = I = S = 0
20 J = K = L = M = N = O = P = X = Y = Z = 0
22  GOTO 56
24  FOR P = 0 TO 199
26 X = S(I) + L
28 Y = S(J) + T
30 Z = S(K)
32 M = (C - Z) / (G - Z)
34 A =  INT (S + X + M * (E - X))
36 B =  INT (S + Y + M * (F - Y))
38 H =  INT (S + X + M * (D - X))
40  HPLOT A,B: HPLOT H,B
```

(Continued)

Listing 2 *(Continued)*

```
 42 I = I + U: IF I > 199 THEN I = 0
 44 J = J + V: IF J > 199 THEN J = 0
 46 K = K + W: IF K > 199 THEN K = 0
 48  NEXT P
 50  FOR Z = 0 TO 5000: NEXT Z
 52  HGR
 54  GOTO 22
 56 O = .04 *  ATN (1)
 58 N = 40
 60  FOR A = 0 TO 199
 62 B = A * O
 64 S(A) = N * (1 +  SIN (B))
 66  NEXT A
 68 C = 200
 70 D = 120
 72 E = 40
 74 F = 40
 76 G = 300
 78 T = 250
 80 L = 150
 82 U =  INT (1 + 5 *  RND (1))
 84 V =  INT (1 + 5 *  RND (1)): IF V = U THEN 84
 86 W =  INT (1 + 5 *  RND (1)): IF W = V OR W = U THEN 86
 88 I =  INT (199 *  RND (1))
 90 J =  INT (199 *  RND (1))
 92 K =  INT (199 *  RND (1))
 94 S = .5
 96  POKE 49234,0
 98  GOTO 24
100  REM TO VIEW, SIT WITH FACE ABOUT A FOOT IN FRONT OF THE
SCREEN AND STARE THROUGH THE SCREEN OFF INTO THE DISTANCE.
102  REM THIS PROGRAM PLOTS A LEFT-EYE IMAGE AND A RIGHT-EYE
IMAGE WHICH MUST BE FUSED INTO A SINGLE IMAGE.
104  REM THIS TAKES PRACTICE, AS THE EYES ARE POINTED OFF INT
O THE DISTANCE WHILE THEY ARE FOCUSSED ON THE SCREEN.
106  REM WHEN THE IMAGES ARE FUSED YOU WILLSEE A THREE DIMENS
IONAL PATTERN IN THE CENTER WITH IRRELEVANT IMAGES ON EACH SIDE.
108  REM IN TIME YOU WILL BE ABLE TO GLANCE AT THE SCREEN FRO
M ANYHERE IN THE ROOM AND SEE A 3-D IMAGE.
110  REM PAY ATTENTION TO YOUR EYES; QUIT IF THEY FEEL STRAIN
ED.
112  REM THE PROGRAM GENERATES A 3-D PATTERN BEHIND THE SCREE
N AND RUNS A RAY FROM EACH POINT ON THE PATTERN TO EACH OF YOUR
     EYES IN FRONT OF THE SCREEN.
114  REM AT THE POINT WHERE EACH RAY INTERCEPTS THE SCREEN A
POINT IS PLOTTED.
116  REM THIS IS A SIMPLE MATTER OF PROPORTIONS; YOU MAY READ
 UP ON IT IN AN OPTICS TEXT.  YOU MIGHT ALSO READ ON DIRECTION C
     OSINES IN A SOLID ANALYTIC GEOMETRY TEXT
118  REM OBJECT IS AT ORIGIN; OBJECT IS ORIGINALLY DEFINED WI
TH (X1,Y1,Z1) AND IS REPRESENTED IN PROGRAM BY (X,Y,Z).
120 SIMILARLY FOR THESCREENPLANE:(X2,Y2,Z2) AND (A,B,C)
122  REM EYE LOCATIONS ORIGINALLY DEFINED BY (X3,Y3,Z3) AND B
Y (D,F,G) AND (E,F,G)IN PROGRAM.
124  REM THE OBJECT IS VIEWED FROM OFFSET POINT DEFINED BY T AND
L.
126  REM  THE OBJECT IS CREATED BY DEFINING THE X, Y, AND Z C
OORDINATES BY THREE SEPARATE SINE FUNCTIONS.
128  REM THE POINTS ARE PLOTTED AT ANGULAR INCREMENTS SET BY
'O', LINE 56.
130  REM  THE PROGRAM IS SPEEDED BY PRECALCULATIN A SINE TABL
E WITH SCALE FACTOR 'N' BUILT IN: LINES 60-66.
132  REM I, J, AND K START THE THREE SINE FUNCTIONS AT RANDOM
 PHASES IN THE SINE TABLE.
134  REM U, V, AND W ARE SMALL INTEGERS WHICH DEFINE THE PERI
OD (OR FREQUENCY) OF THE SINE FUNCTIONS.
```

one or both of parameters D and E. It may also be useful to alter the scale factor N.

Interesting 3-D motion displays could be written in machine language; I can also imagine game possibilities, including visual 3-D Tic Tac Toe. Please note the remarks appended to the program (written in Applesoft), which complement the explanatory remarks above.

I have experimented with more general systems using color filters for viewing, and may report on this at some future time. I hope that readers will experiment with this viewing system, perhaps altering parameters of the given program or substituting another object. Data points in three dimensions might be seen as a 3-D swarm of points in which local clusters or correlations could be detected. This is a new way of seeing things.

Art Radcliffe has worked 25 years for IT&T, Radiation-Inc., and Burroughs, during which time he has acquired 32 patents in computer and communciation circuits and systems. He has also worked in optics and holography, whence his interest in generating 3-D images. He has a 48K Apple with twin disks, Zenith color monitor and Silentype printer which he uses as a medium for creative and artistic expression.

MICRO

Apple Bits, Part I

This article describes several aids to faster and more efficient low resolution graphics programming, including machine language routines.

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This is the first in a series of articles dealing with the use of the Apple II low resolution graphics features. Some techniques will be described that use machine language to enhance the speed of graphics applications and reduce the amount of memory required in order to represent certain screen patterns.

The basic techniques to be described will enable display of patterns, each of which is 8 × 8 in size or smaller and consists of a single color. Larger patterns must be constructed from smaller pieces which fit these requirements. A modification of the machine language routine will allow multiple colors to be obtained by overlaying.

This article will describe the machine language display program which converts a numerically encoded picture into the low resolution display pattern. The next article will describe an Integer BASIC program which allows the user to interactively develop a series of patterns, store their corresponding numerical representations in memory, and save it all on disk or tape. Finally, each article in the series will present one or more applications of the techniques to the construction of animations in Lo-Res.

Bit-encoding a Picture

Consider the following eight hexadecimal numbers:

38,38,12,FE,90,28,44,83

Believe it or not, they contain a picture! To see how, let's first rewrite the numbers in binary, using the following table to convert each hex digit into a 4-bit binary "nibble:"

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

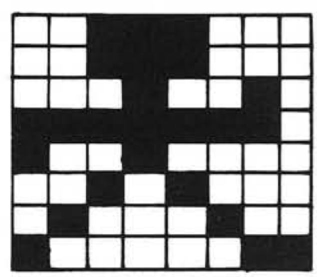
We arrive at the following numbers:

```
0 0 1 1 1 0 0 0
0 0 1 1 1 0 0 0
0 0 0 1 0 0 1 0
1 1 1 1 1 1 1 0
1 0 0 1 0 0 0 0
0 0 1 0 1 0 0 0
0 1 0 0 0 1 0 0
1 0 0 0 0 0 1 1
```

Do you see the picture yet? Just in case you don't, let's transform the pattern of 0's and 1's onto "graph paper" by superimposing a grid of squares on top of the above list, like so:

0	0	1	1	1	0	0	0
0	0	1	1	1	0	0	0
0	0	0	1	0	0	1	0
1	1	1	1	1	1	1	0
1	0	0	1	0	0	0	0
0	0	1	0	1	0	0	0
0	1	0	0	0	1	0	0
1	0	0	0	0	0	1	1

Now, erase all the 0's and completely blacken the squares containing the 1's. That gives the grid shown next:



Now, of course, you see the "picture." Erasing the grid lines should make the correspondence with the Lo-Res display pretty obvious as well. The question now becomes: "How do we turn the above process into a program?"

Shown in listing 1 is a machine language program which will carry out the process. It "assumes" that certain information has been set up for it. This information will be illustrated by listing 2 (in Integer BASIC). We discuss this further following that program.

Listing 1

```
*80ALL

080A-   A5 30     LDA   $30
080C-   8D 04 08  STA   $0804
080F-   AC 00 08  LDY   $0800
0812-   8C 03 08  STY   $0803
0815-   CE 03 08  DEC   $0803
0818-   30 31     BMI   $084B
081A-   AE 01 08  LDX   $0801
081D-   8E 02 08  STX   $0802
0820-   CA        DEX
0821-   30 F2     BMI   $0815
0823-   BD 50 08  LDA   $0850,X
0826-   AC 03 08  LDY   $0803
0829-   31 3C     AND   ($3C),Y
082B-   D0 04     BNE   $0831
082D-   A9 00     LDA   #$00
082F-   85 30     STA   $30
0831-   A5 24     LDA   $24
0833-   18        CLC
0834-   6D 03 08  ADC   $0803
0837-   A8        TAY
0838-   A5 25     LDA   $25
083A-   8E 02 08  STX   $0802
083D-   6D 02 08  ADC   $0802
0840-   20 00 F8  JSR   $F800
0843-   AD 04 08  LDA   $0804
0846-   85 30     STA   $30
0848-   4C 20 08  JMP   $0820
084B-   60        RTS
084C-   80        ???
084D-   10 10     BPL   $085F
084F-   F8        SED
0850-   01 02     ORA   ($02,X)
0852-   04        ???
0853-   08        PHP
0854-   10 20     BPL   $0876
0856-   40        RTI
0857-   80        ???
0858-   A8        TAY
0859-   B0 08     BCS   $0863
085B-   28        PLP
*
```

Machine Language Pattern Displayer

Listing 2

```
10 GR : PRINT : PRINT : PRINT
12 POKE 2048,7: POKE 2049,7
15 ROW=7+ RND (27)
20 COL=7+ RND (27)
25 COLOR= RND (15)+1
28 POKE 36,COL: POKE 37,ROW
30 FOR J=1 TO RND (10)
40 SPARK=1+ RND (20)
50 OFFSET=SPARK*7
60 POKE 60,(3072+OFFSET) MOD 256
65 POKE 61,(3072+OFFSET)/256
70 CALL 2058
72 FOR DE=1 TO RND (25): NEXT DE
75 NEXT J
80 COLOR=0: FOR J=0 TO 6: HLIN COL,
   COL+6 AT ROW+J: NEXT J
85 GOTO 15
```

Integer BASIC Fireworks Animation

The BASIC program does a series of POKEs which set up the machine language routine's information:

```
12 POKE 2048,7: POKE 2049,7
```

indicates the width and height of the patterns to be displayed.

```
28 POKE 36,COL: POKE 37,ROW
```

indicates the ROW and COLUMN of the Lo-Res screen at which the upper-left corner of the pattern to be displayed will be.

```
60 POKE 60,(3072 + OFFSET)
MOD 256

65 POKE 61,(3072 + OFFSET)
/256
```

stores the address in Apple II RAM at which the numerical codes for the pattern to be displayed begin.

The machine language program is invoked by the line:

```
70 CALL 2058
```

Running the Fireworks Animation

The numerical data which the program uses must first be entered into memory. This data resides at locations C00 to D27 (3072-3367) and has been listed on the next page. Once you have entered it (sorry about that) using the monitor, save it on tape (C00.D27W) or on disk:

```
*3DOG
>BSAVE SPARKS,A$C00,L$127
```

to avoid keying it in again later. Likewise, enter the machine language program using the monitor or the mini-assembler and save it:

```
*800.857W                (Tape)
```

or

```
*3DOG
>BSAVE APPLE-BITS,
A$800,L$57               (Disk)
```

(Continued)

In order to run the program, you should issue the command:

```
>LOMEM:4096
```

so that BASIC doesn't clobber the machine language program.

Assuming you are using a disk-based system, the entire sequence of commands needed to run the animation would be:

```
>BLOAD APPLE-BITS
>BLOAD SPARKS
>LOMEM:4096
>RUN FIREWORKS
```

(If you hate keying in long command sequences, cook up an EXEC file with the commands in it.)

Numerical Data for Fireworks Animation

```
*C00.D27

0C00- FF FF FF 15 1F 15 F5 00
0C08- 00 00 08 00 00 00 00 00
0C10- 14 00 14 00 00 00 22 00
0C18- 00 00 22 00 41 00 00 00
0C20- 00 00 41 00 00 14 08 14
0C28- 00 00 00 22 14 00 14 22
0C30- 00 41 22 00 00 00 22 41
0C38- 00 22 14 08 14 22 00 41
0C40- 22 14 00 14 22 41 41 22
0C48- 14 08 14 22 41 00 00 00
0C50- 08 00 00 00 00 00 08 14
0C58- 08 00 00 00 08 00 22 00
0C60- 08 00 08 00 00 41 00 00
0C68- 08 00 00 08 1C 08 00 00
0C70- 00 08 08 36 08 08 00 08
0C78- 08 00 63 00 08 08 00 08
0C80- 08 3E 08 08 00 08 08 08
0C88- 77 08 08 08 08 08 08 7F
0C90- 08 08 08 12 1F 10 19 15
0C98- 12 11 15 0A 06 1F 04 17
0CA0- 15 09 1F 15 1D 19 05 03
0CA8- 0A 15 0A 17 15 1F 00 0A
0CB0- 00 10 1A 00 FF FF FF 0A
0CB8- 0A 0A FF FF FF 01 15 07
0CC0- FF FF FF 1F 05 1F 1F 15
0CC8- 0A 1F 11 11 1F 11 0E 1F
0CD0- 15 11 1F 05 01 1F 11 19
0CD8- 1F 04 1F 11 1F 11 18 11
0CE0- 1F 1F 06 19 1F 10 10 1F
0CE8- 02 1F 1F 0E 1F 1F 11 1F
0CF0- 1F 05 07 1F 11 17 1F 05
0CF8- 1A 17 15 1D 01 1F 01 1F
0D00- 10 1F 0F 10 0F 1F 08 1F
0D08- 1B 04 1B 03 1C 03 19 15
0D10- 13 FF FF FF FF FF FF 00
0D18- 11 1F FF FF FF FF FF FF
0D20- FF FF FF FF FF FF FF FF
```

MICRO

Tracemark, An Apple II Debugging Aid

TRACEMARK is a debugging or study-tool utility, an extension of the Apple II Monitor TRACE command. A count of each traced instruction is kept in a separate memory block, and the trace display rate is controlled by a game paddle. Certain complex, highly convoluted problems can be better understood using this tool.

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During assembly language program development several debugging techniques are commonly employed, including single-step, trace and breakpoint. The Apple II Monitor provides the facilities for these techniques, although on a rudimentary level. Use of the TRACE function causes the program steps to scroll past at a dizzying speed, and the only way to stop the function is to hit the RESET key, which alters the stack pointer. Single-stepping allows more careful study of the program under test, but the manual requirements of typing the command 'S' for each step quickly become tedious.

TRACEMARK was developed to fill this spectrum of capability, and it also introduces an even more powerful tool for software detective work: 'footprinting' (herein called a 'mark'). How often have you wanted to know where a faulty program has gone to reach some (usually) faulty result? With single-stepping you can see the program flow, but making a record requires tedious hand-copying of the addresses. TRACEMARK not only makes a mark of the whereabouts of the processor for later evaluation, but keeps count of the number of times each instruction is executed (255 maximum). The only thing we sacrifice is knowing the order of instructions and why a certain branch occurred.

Specifically, TRACEMARK calls the Monitor single-step routine (not found in the Auto-start ROM — but if you are doing assembly language work you probably have the standard Monitor, or should). Each instruction is displayed as if in the free-running Trace mode, but the speed is controlled by the game paddle 0, from full speed (almost) to a complete stop. For the address of each instruction executed, an offset address is generated, which points to a free memory area (mark buffer) where the count of each instruction resides. This count is incremented up to a maximum of 255 ($FF). Multiple byte instructions have each byte marked identically, so any wild branches into the operand portion of an instruction will show differing mark counts.

The mark buffer resides "in parallel" with the program under test. That is, the offset of the address is only done to the high byte, greatly simplifying the mental work required when inspecting the mark buffer later. The program does not check to see if the mark buffer address is within the bounds of the actual mark buffer, so care must be exercised in selecting an offset value based on the expected range of the program under test. If extremely wide ranges are expected, it might be best to insert some boundary checking into TRACEMARK.

Program Operation

TRACEMARK, as shown in the assembly listing, resides at that popular spot, $300. It may be re-assembled to any convenient location. Similarly, page zero use may be adjusted to avoid conflicts (TPCL, TPCH, TA, TB, & TC). From the Monitor, preset values for the trace beginning point (TPCL, TPCH), the mark buffer low boundary (TA, TB) and the mark buffer high boundary high byte (TC). Then call $300. First the mark buffer is filled with zeros by CLEAR. The Monitor program counter is then loaded with the trace start ad-

Listing 1

```
LOC  CODE          LINE

0000               ; TRACEMARK
0000               ; REV B4 - 27 DEC 1980
0000               ; R WEISLING; SURAKARTA, INDONESIA
0000                     *=$300
0300               TPCL   = $00            ;TRACEMARK PGOGRAM COUNTER --
0300               TPCH   = $01            ;-- ALSO TRACE START ADDRESS
0300               TA     = $02            ;TRACEMARK BUFFER START (LO)
0300               TB     = $03            ;                       (HI)
0300               TC     = $04            ;BUFFER END (HI)
0300               LENGTH = $2F
0300               PCL    = $3A            ;MONITOR PC
0300               PCH    = $3B
0300               STEP   = $FA43          ;TRACE SINGLE STEP ROUTINE
0300               PREAD  = $FB1E          ;MONITOR - READ PADDLE VALUE
0300               ;
0300               ; TRACEMARK AND TRACE DISPLAY RATE UTILITY
0300               ;
0300 204E03 START   JSR CLEAR        ;ENTER HERE FROM MONITOR
0303 A500           LDA TPCL        ;UPDATE MONITOR PROGRAM COUNTER
0305 853A           STA PCL
0307 A501           LDA TPCH
0309 853B           STA PCH
030B 2043FA AGAIN   JSR STEP         ;DO ONE STEP IN MONITOR
030E A501           LDA TPCH        ;GET ADDRESS (PCL/H 1 STEP AHEAD)
0310 38             SEC
0311 E9D0           SBC #$D0        ;<-CHANGE THIS FOR OTHER OFFSETS
0313 8501           STA TPCH        ;OFFSET FOR MARKING
0315 A42F           LDY LENGTH      ;SIZE OF INSTRUCTION, 1-3 BYTES (0-2)
0317 B100           LDA (TPCL),Y    ;GET FORMER MARK VALUE
```

(Continued)

dress, and the single-step display loop begins. After the call to STEP, the mark buffer address is calculated from TPCL, TPCH values (the Monitor PC is already set for the next instruction).

LENGTH is a value representing the size of the last instruction disassembled (less one), and acts as an index to LOOP for marking each byte of multi-byte instructions. The previous mark count is first read and checked to prevent overflow, and then the incremented count is returned to the mark buffer. The paddle is read by a call to PREAD in the Monitor, and the returned value is used to set the repeat count of two nested timing loops. In addition, the value is tested to see if it is in the range of $FC to $FF, and if so, the paddle is read again (and again) until the value drops below $FC, effectively freezing the display. The paddle read-rate is slowed down by doing this value testing, after the inner loop, to eliminate errors caused from calling the PREAD routine too rapidly. (This caveat, mentioned in the Apple literature, is due to circuit peculiarities of this crude a/d converter.

Listing 1 *(Continued)*

```
0031 0319 AA              TAX
0032 031A E8              INX                  ;BUMP BY ONE
0033 031B F006            BEQ DONE             ;PREVENT MARK OVERFLOW BEYOND $FF
0034 031D 8A              TXA
0035 031E 9100     LOOP   STA (TPCL),Y          ;SAVE BUMPED MARK
0036 0320 88              DEY
0037 0321 10FB            BPL LOOP             ;REPEAT IF 2-3 BYTE INSTRUCTION
0038 0323 A53A     DONE   LDA PCL               ;READY LOCAL PC FOR NEXT STEP
0039 0325 8500            STA TPCL
0040 0327 A53B            LDA PCH
0041 0329 8501            STA TPCH             ;TRACEMARK PHASE DONE
0042 032B A200     RD     LDX #0                ;DISPLAY RATE PHASE BEGIN
0043 032D 201EFB          JSR PREAD            ;READ PADDLE 0 VALUE
0044 0330 8404            STY TC               ;SAVE FOR DELAY RESTORE USE
0045 0332 C8              INY                  ;ADJUST FOR DEC BEFORE TEST
0046 0333 8502            STA TA
0047 0335 8503            STA TB
0048 0337 C602     PLOP   DEC TA                ;INNER DELAY LOOP
0049 0339 D0FC            BNE PLOP
0050 033B A504            LDA TC               ;GET PADDLE VALUE AGAIN
0051 033D 8502            STA TA               ;RESTORE INNER LOOP
0052 033F A903            LDA #03              ;MAKE LOW 2 BITS HI
0053 0341 0504            ORA TC               ;OR WITH PADDLE VALUE (111111XX)
0054 0343 A8              TAY                  ;-- IF RESULT $FF AND --
0055 0344 C8              INY                  ;-- HERE MADE ZERO THEN --
0056 0345 F0E4            BEQ RD               ;GO BACK TO READ PADDLE (DISPLAY FREEZE)

LINE# LOC CODE     LINE

0057 0347 C603            DEC TB               ;OUTER DELAY LOOP
0058 0349 D0EC            BNE PLOP             ;DELAY TIME = PADDLE VALUE SQUARED
0059 034B 4C0B03          JMP AGAIN            ;DISPLAY RATE PHASE DONE - REPEAT
0060 034E          ;
0061 034E          ; CLEAR MARK BUFFER FROM $TBTA TO $TC00
0062 034E          ;    (THESE MUST BE PRELOADED FROM MONITOR
0063 034E          ;     EACH TIME PROGRAM IS CALLED - BEWARE)
0064 034E          ;
0065 034E A400     CLEAR  LDY $00               ;CLEAR MARK BUFFER, TA/TB = FIRST
0066 0350 98              TYA                  ;                      ADDRESS OF BUFFER
0067 0351 9102     CLOP   STA (TA),Y            ;ZERO MEMORY BYTE
0068 0353 E602            INC TA               ;BUMP ADDRESS LO
0069 0355 D0FA            BNE CLOP
0070 0357 E603            INC TB               ;CARRY - BUMP ADDRESS HI
0071 0359 A504            LDA TC               ;GET LAST ADDRESS LIMIT
0072 035B C503            CMP TB               ;CHECK LIMIT AGAINST HI PART
0073 035D D0EF            BNE CLEAR            ;MORE TO CLEAR
0074 035F 60              RTS                  ;DONE
0075 0360                 .END
```

Having the speed control is handy to use: slow down or stop the display for close inspection or let it run at full speed for those loops that work well. TRACEMARK will continue as long as possible — the only means of exit are encountering a BRK or hitting 'RESET.' Before calling the program again, be sure to reset the five bytes in page zero to the correct values for initializing the mark buffer and starting the trace. If more page zero space can be spent, these initial values could be made non-destructive (but the program will be slightly longer).

Example of Use

Let us see how TRACEMARK operates by running it to trace the Apple Integer BASIC program. This is a good example of a program which is highly convoluted and which cannot be debugged by conventional breakpoints, since it resides in ROM. The listing shows line 27 as being SBC #$D0, which is the offset for this example. Thus BASIC, running from $E000 to $FFFF (including display calls to within the Monitor) will be marked from $1000 to $2FFF (mark buffer). Now, preset the page zero registers as follows:

00:00 E0 00 10 30 'return'

This means to start the trace at $E000 (cold start), clearing the mark buffer from $1000 to $2FFF. Next, call TRACEMARK and watch the trace display, using the paddle for rate control. At some point hit 'reset' and then inspect the mark buffer. It will contain many zeros of course — those are places never reached by the program. But look at $2000-2022 (representing $F000-$F022) or around $2C62-2CA7 (the scroll routines in the Monitor) and you will see evidence that the program worked here for some time.

While this program seems pretty dependent on the Apple II firmware and hardware, it shows merit for study by those with other systems, since the concept of making a parallel counter or mark buffer is processor-independent. All that is necessary is a processor simulator trace program which can single-step and yield the address of each step and optionally the size of each instruction traced.

Limitations

Performing a TRACEMARK on a program with even a small amount of printing, via the Monitor display and scroll routines, will consume some considerable time while scrolling the text buffer. Worse still is the problem of a program which alters the two-byte output vector at $36-37 (CSWL), since one byte will be changed while the other remains unchanged, and everything will come to a grinding halt (when the trace program tries to output something to a half-baked jump vector). Additionally, some other Monitor routines may not be traceable, due to ambiguities relating to display status. The other limit is that of space, with no room for both the program under test and the mark buffer. Here some segmentation of the area to be marked, with mark buffer boundary checking, is called for.

TRACEMARK should enhance the set of debugging tools commonly employed for development of programs at the assembler level, and is also useful where coupled with a disassembler, for study of undocumented programs in native machine code. I hope that use of TRACEMARK will cut time from an oft-times painful and tedious chore as it has done for me.

Raymond Weisling has two degrees in music composition from California Institute of the Arts, where he also worked on software development in the Hybrid Computer Music Studio. He was a software and hardware designer for an industrial electronics manufacturer before resuming his artistic career. He uses the Apple II for design support in making acoustic and kinetic sculptures.

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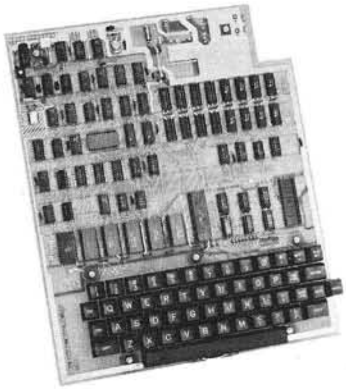

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MICROCRUNCH: An Ultra-fast Arithmetic Computing System

Part 2

This article describes software support for the fast mathematics hardware outlined in Part I (39:07). A detailed discussion of machine code routines necessary for communication between the arithmetic processing chip and BASIC is given, along with an overview of a BASIC home-brew compiler.

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Part I described a hardware floating point board and demonstrated that truly high speed computing is only possible with a microcomputer if the floating point chip is used in conjunction with a compiler. This is true where the overall program is written in direct machine code. In this case, the source code higher level language statements do not need to be interpreted or pseudo-interpreted (as in Pascal).

This article describes a compiler that is useful for fast arithmetic processing, but does not translate statement types that are rarely if ever used in mathematical problems. The fundamental idea is to use the normal Microsoft BASIC interpreter to do most of the non-mathematical work and to form the overall program structure. When a mathematical loop containing floating point operations needs to be done, a jump is made to a machine language subroutine via USR that executes the equations. It is only this machine language subroutine that is generated by the compiler.

Our system compiles as machine code subroutines, all the time consuming mathematical operations. The source code for these subroutines includes a limited subset of BASIC statements. Then the full BASIC language is used to input variables, set initial conditions, print results of calculations, and perform calculations that, because they are not iterated often, are not time consuming.

There are several problems that need to be discussed.

1. How to communicate between variables used by the mathematical subroutines and variables used in the BASIC main program. Since the C8231 floating point chip uses a non-standard floating point format (at least it is different from that used by Microsoft) it is necessary for floating point subroutines to have their own variable space. The alternative of converting all BASIC variables to APU (arithmetic processing unit) format upon entry to a subroutine, and then reconverting on exit, is extremely time consuming and wasteful since only a few of the variables used are actually input or output variables. In addition, any time a change is made in BASIC the variable table shifts its position, and BASIC array storage is cumbersome and inefficient.

2. How to get in and out of a large number of compiler-generated machine code mathematical subroutines. Clearly you would like the option of writing several different subroutines and calling them from different points in the main program. Thus some kind of directory management is necessary.

3. What BASIC statements and variable allocations do we allow in the source code for mathematical subroutines?

The Limited BASIC Source Statements

Variable allocation:

Somewhat like a Tiny BASIC, all mathematical subroutine variables are described by a single alphabetic name A-Z. Unlike Tiny BASIC, any variable (except I, J, K, L, M, N that are integer variables for use in FOR loops and indexing) can be either a single number, a vector (e.g. A(I)) or a two dimensional array (e.g. U(I,J)). The vector dimension and the second array dimension must be less than 65 and the first array dimension can be anything consistent with the memory map. Thus there are two types of arithmetic that can be done in a machine language mathematical subroutine: integer and floating point. The integer arithmetic, used mostly for array indexing (e.g. U(I−2+K, J+31)) is done by the 6502 and can only be subtraction or addition.

Statement List:

SUB#, where #=1 to 9 indicating one of 9 possible subroutines.

RETURN, return from subroutine.

GOSUB#, where #=1 to 9. GO to SUB# given.

GOTO#, where #=1 to 9. GO to LABEL# within current subroutine.

FOR I=1TOJ / NEXTI Same as BASIC except no expressions allowed in index setting part of statement.

IF A=0THENGOTO# Same as BASIC, except label referred to 1 to 9, Variable reference (e.g. A) must be simple variable, not vector, etc. Also less than 0 is OK. Only comparisons w.r.t. zero can be made.

LABEL# where #=1 to 9. Jump point for GOTO and IF...THEN.

I=J+K−25, etc. General integer arithmetic involving only integer variables and numbers less than 256. Only addition and subtraction since these operations are done with the 6502. Mostly used in vector and array indices.

END Denotes termination of a particular subroutine.

In addition to these statements, general mathematical expressions can be written exactly as in BASIC. Example:

```
X = 1.234*U(I-2,J + 1) + B(J)
*SIN(3.141592*Y)
```

This is a marked improvement over such primitive compilers as FLOPTRAN IV and BASEX that do not allow chained calculations or indexing.

It can be seen that this subset of statements is sufficient to implement almost any conceivable iterative and/or conditional calculation. The advantages of the restricted variable set and limited statement types are a shorter and faster compiler. You should note that the compiler must trap all possible source code errors during the compilation, or the machine code subroutines will crash (or give back garbage) and debugging will be extremely difficult. This error trapping is the most difficult part of language translation, and it is made easier by using the restricted language outlined above.

Source statements such as those required to do a long mathematical iteration or calculation, are entered into memory under control of an editor, and then are translated into machine code and placed in the upper end of memory. The compiler and editor are written in BASIC, but being essentially word processors and language translators, execute rapidly. The memory maps for the compilation and run modes are shown in figure 1. The APU variable space depends on the precise allocation of variables, dimensions of arrays, etc. The object code is tied to an initial object starting location OI that is set before compilation.

Variable Format and Exchange

Both Microsoft BASIC and the C8231 represent floating point numbers with four bytes. The first byte contains the exponent, and the next three contain the mantissa, with the most significant bit first. Of course here we are talking about a binary representation where a number is written as

$$\left(\frac{a}{2} + \frac{b}{4} + \frac{c}{8} + \ldots\right) \times 2^E$$

***Figure 1:* MEMORY MAP (typical). Addresses are decimal**

Compilation	Run
0	0
Microsoft Overhead	Microsoft Overhead (loc 0-127 swapped out for math. subroutine)
700	700
BASIC Compiler	BASIC: line 0-6 Overhead line 6-700 Main Program line 730-790 Overhead Routines
16000	4000 (typ)
Compiler Variables	BASIC variables
18500 (typ)	6000 (typ., depends on variable allocation)
Source Code	APU Variables
20480 (typ)	19768 (OI-200)
Object Code	Fixed Routines and Swap Storage
32768	20480 (OI+512)
	Object Code
	32768

***Figure 2:* Floating Point Formats**

	Bit		BASIC	APU
Byte 1	7		Exponent Sign	Mantissa Sign
	6		Exponent MSB	Exponent Sign
	5			Exponent MSB
	4			
	3			
	2			
	1			
	0		Exponent LSB	Exponent LSB
Byte 2	7	a	Mantissa Sign (a=1 inferred unless 0)	Mantissa a=1 unless 0
	6	b		
	5	c	,	
	4	d	,	
	3	e	MANTISSA (most significant bit = bit 6 byte 2)	
	2	.	,	
	1	.	,	
	0	.		
		.		
Byte 3	7	.		
	6	.		
	5	.		
	4	.		
	3	.		
	2	.		
	1	.		
	0	.		
Byte 4	7	.		
	6	.		
	5	.		
	4	.		
	3	.		
	2	u		
	1	v		
	0	w	Mantissa Least Significant Bit	

Here E is typically the exponent and a, b, c, and so forth, are the successive bits of the three byte mantissa, and are either 0 or 1. Figure 2 shows the representations for the two systems. In BASIC a 1 in bit 7 of byte 2 indicates a negative number. For the APU, a negative number is indicated by a 1 in bit 7 of byte 1! Also, bit 7 of byte 2 in APU space is always a 1, except if the number is identically zero. That is, $a=1$ unless the number is zero. Note that since the mantissa sign occurs in byte 1 for the APU variable, the exponent range is less by a factor of 2 than for the BASIC variable. Indeed the BASIC exponent range is $+127$ to -128, e.g. the exponent is biased by bit 7, or biased negative 128. However, the APU exponent is only biased negative 64 since the mantissa sign bit occupies bit 7. Thus bit 6 gives the exponent sign.

Machine code routines have been written to convert back and forth between these two formats. Whenever you want to input a variable to APU space, or print out such a number, one of these routines is called by USR from a set of BASIC statements that precede the overall program as shown in figure 1. This is discussed in more detail below. First we list a number of machine code routines that are useful in communicating between BASIC and the APU, and between the compiled code and the APU. These routines must be entered along with each object code, but unlike the object they do not change if either the BASIC source code or main program is altered.

Fixed Routines

Listing 1 is a BASIC program that will load all the fixed routines needed for execution. This program should be run after entering the initial object address OI. OI must be a multiple of 256. In the example discussed below it is 78*256. The decimal entry points and functions of the routines entered by this program are as follows:

Listing 1

```
600  REM  FIXED ROUTINES
601  DATA 32,166,255,216,181,0,157,128,255,202,16,248,162
602  DATA 127,189,0,255,149,0,202,16,248,32,56,255,162,127,181,0,157,0
603  DATA 255,202,16,248,162,127,189,128,255,149,0,202,16,248
604  DATA 173,6,255,41,30,240,3,76,116,162,96
606  FOR J = OI TO OI + 55: READ Z: POKE J,Z: NEXT J
607  DATA 165,5,240,14,56,233,255,16,9,56,255,48,5,169,30,76,153,255
608  FOR J = OI + 170 TO OI + 187: READ Z: POKE J,Z: NEXT J
609  POKE OI + 176,WL: POKE OI + 180,OI / 256 - 1: POKE OI + 187,OI / 256
610  DATA 173,1,251,173,6,251,145,4,200
612  FOR J = 1 TO 9: READ H(J): NEXT J
614  FOR J = OI + 188 TO OI + 218 STEP 9: FOR N = 1 TO 9: POKE J + N - 1,H(N): NEXT N: NEXT J
618  POKE OI + 223,96
620  DATA 177,4,141,6,251,136
622  FOR J = OI + 228 TO OI + 230: POKE J,200: NEXT J
624  FOR J = 1 TO 6: READ H(J): NEXT J
626  FOR J = OI + 231 TO OI + 249 STEP 6: FOR N = 1 TO 6: POKE J + N - 1,H(N): NEXT N: NEXT J
627  POKE OI + 254,96
630  DATA 173,0,251,173,6,251,48,248,41,30,208,1,96,133,6
632  DATA 104,133,7,104,133,8,76,25,255
634  FOR J = OI + 140 TO OI + 163: READ Z: POKE J,Z: NEXT J
640  DATA 8,16,39,31,47
642  FOR J = 1 TO 5: READ Z: POKE OI + Z,OI / 256 + 1: NEXT J
644  DATA 24,163
646  FOR J = 1 TO 2: READ Z: POKE OI + Z,OI / 256: NEXT J
650  DATA 160,3,177,123,72,9,128,160,1,145,1,200,177,123,56,233,128,41
652  DATA 127,136,136,145,1,104,41,128,17,1,145,1,160,5,177,123,136,136
653  DATA 145,1,200,177,123,136,136,145,1,96
654  FOR J = OI + 56 TO OI + 101: READ Z: POKE J,Z: NEXT J
656  DATA 160,3,169,0,145,1,136,48,251,96
658  FOR J = OI + 102 TO OI + 111: READ Z: POKE J,Z: NEXT J
660  DATA 160,1,177,1,48,12,200,169,0,145,123,200,152,73,6,208,246,96
661  DATA 76,210,255
662  FOR J = OI + 117 TO OI + 137: READ Z: POKE J,Z: NEXT J
663  POKE OI + 137,OI / 256 - 1: POKE OI + 2,OI / 256 - 1
665  DATA 160,5,162,6,181,0,153,3,211,232,200,200,224,17,208,244,96
667  FOR J = OI - 120 TO OI - 104: READ Z: POKE J,Z: NEXT J
670  DATA 41,127,200,200,145,123,160,0,177,1,72,41,128,160,3,17,123,145
672  DATA 123,104,41,127,24,10,48,2,56,234,106,136,145,123,177,1,200
673  DATA 200,145,123,136,177,1,200,200,145,123,96
674  FOR J = OI - 46 TO OI - 1: READ Z: POKE J,Z: NEXT J
676  DATA 165,1,141,224,255,165,2,141,225,255,173,226,255,133,1,173,227
678  DATA 255,133,2,32,57,255,173,224,255,133,1,173,225,255,133,2,96
679  GOTO 684
684  FOR J = OI - 256 + 176 TO OI - 256 + 209: READ Z: POKE J,Z: NEXT J
686  DATA 4,9,12,17,22,25,30
688  FOR J = 1 TO 7: READ Z: POKE OI - 256 + 176 + Z,OI / 256: NEXT J
690  DATA 162,127,169,0,141,6,255,96
692  FOR J = OI - 90 TO OI - 83: READ Z: POKE J,Z: NEXT J
694  POKE OI - 84,OI / 256 + 1: STOP
```

(Continued)

OI-80	Protect zero page address 1 and 2 for APU BASIC conversions, and jump to proper conversion routine.
OI-46	Convert APU variable whose start address is set in location 1 and 2 and place result in BASIC variable pointed to by location 123-124 (the BASIC variable X since this is the first variable called by the main program as given in LIST 2 below).
OI	Entry to object code. Swap lower half of page zero to upper memory, jump to routine called from main program, swap back page zero, check for address range error, and return (warm start if error set).
OI+56	Convert BASIC variable pointed to by 123-124 to APU variable and set in four locations starting with that pointed to by 1-2.
OI+117	APU to BASIC conversion entry. Check if APU =0, if so set X=0, otherwise jump to OI-46.
OI+140	Check APU for error and busy status. If there has been an error (see part I), pull program counter off stack and exit.
OI+170	Read APU floating point number on top of APU stack to memory starting with location pointed to by 4-5.
OI+228	Write memory floating point number starting at location pointed to by 4-5 to top of APU stack.

BASIC Fixed Routines

When a machine code mathematical subroutine is run a few BASIC statements must be included in the main program. These are given in list 2. The first line makes sure X is at the head of the variable table by setting it equal to zero. It also sets OI. Subroutines 730 and 735 set the variable address bases for the variable A,B,C,D,E,F,G,H,T,X,Y,Z. That is, NF contains the relative address on page zero (after swapping) for these variables. For example, A starts at location 20, B at 24, etc., X at 56, Y at 60, and Z at 64. These subroutines are called before the main program in lines 8-700.

The main program written out in list 2 is used to run the mathematical test loop described below. Line 8 identifies the APU variable X, sets BASIC X=1, and calls subroutine 770 which executes a USR jump to the fixed routine that converts between these variables. Similarly, line 9 causes APU variable A to be set equal to the constant 1.00013. Line 10 identifies a call to the subroutine J whose starting address is set in line 2 (the first subroutine always starts at location OI+512), then executes this jump. Finally, line 11 identifies a variable X that is converted, and then printed. In the conversion calls, first set Z$ equal to the desired variable name, then CALL 770 to go from BASIC to APU, or 780 for the inverse.

The fixed routines outlined above, and these BASIC overhead instructions, are sufficient to manage a large number of mathematical subroutines and APU variables. If there is a warm start after a mathematical subroutine call, a GOSUB750 will print out the error code and an object address of a place near where the error occurred.

An Example

Consider the multiplication test program discussed in part I. This called for consecutive multiplication of X by a specified constant A for 40,000 times. One program to do this would set A and X, and call the following mathematical subroutine.

```
SUB1
FORI=1TO200
FOR J=1TO200
X=X*A
NEXTJ
NEXTI
RETURN
END
```

Note that two nested FOR loops are needed to get 40,000 because integer variables are limited to a range of 0 to 255 each.

List 3 gives detailed description of the object code generated by the compiler when the above statements were entered as a source code. Note OI=19968 for this example.

By inspecting this program you can see that the 6502 is used for loop control. The variable table is the same as was set in statement 733-734 of list 2. A is at loc 20, X at 56. Note that some 6502 statements are executed concurrently while the C8231 is multiplying (20541-20549). Writing short mathematical expressions like X=X*A does not allow much co-processing because you are primarily reading and

Listing 2

```
1 X = 0: DIM S(20):OI = 78 * 256
2 S(1) = 20480
5  GOSUB 730: GOSUB 735
6  REM  END HEADER. MAIN PROGRAM, LINES 8-700.
8 Z$ = "X":X = 1: GOSUB 770: REM  BEGIN MAIN PROGRAM, SET SUBR. VARIABLE X=1.
9 Z$ = "A":X = 1.00013: GOSUB 770: REM   SET MATH SUBROUTINE CONSTANT A=1.00013
10 J = 1: PRINT "START": GOSUB 760: REM  ENTER MATH SUBROUTINE
11 Z$ = "X": GOSUB 780: PRINT X: REM   PRINT FINAL VALUE OF X AFTER 40,000 MULTS
20  STOP
730  REM   VARIABLE ADDRESS BASES--SINGLE VARIABLES ONLY
731  DIM NF(26)
733  FOR J = 1 TO 8:NF(J) = 16 + 4 * J: NEXT J:NF(20 = 52:NF(24) = 56:NF(25) = 60
734 NF(26) = 64: RETURN
735  REM  SET CONSTANTS FOR OVERHEAD ROUTINES
738 S(10) = OI + 226:S(11) = OI + 227:S(15) = 256
739 S(14) = OI / 256 - 1:S(16) = OI + 23:S(17) = OI + 24:S(18) = OI - 59: RETURN
750  REM  ERROR CHECK
751  PRINT "ERROR CODE="; PEEK (OI + 262) AND 30
752  PRINT "ADDRESS="; PEEK (OI + 263) +  PEEK (OI + 264) * 256: PRINT : RETURN
759  REM  760 IS SUB CALL ENTRY J=SUB#
760  IF J > 9 OR J < 1 OR S(J) = 0 THEN  PRINT "ILL SUB CALL TO #";J: STOP
761 X = S(J):XS =  INT (X / 256): POKE S(17),XS: POKE S(16),X - 256 * XS
763  POKE 11,0: POKE 12,OI / 256:X =  USR (0): RETURN
770  REM  BASIC TO APU CONV, Z$=CHAR, J=INDEX, I=PAGE INDEX
771 XS =  ASC (Z$) - 64: IF XS <  > 10 THEN  IF NF(XS) <  > 0 THEN I = 1:J = 1
772  POKE 11,176: POKE 12,S(14): POKE S(10),NF(XS)
773  POKE S(11),79: IF X = 0 THEN  POKE S(18),102
774  IF X <  > 0 THEN  POKE S(18),56
775 XS =  USR (0): RETURN
780  REM  APU TO BASIC
781 XS =  ASC (Z$) - 64: IF XS <  > 10 THEN  IF NF(XS) <  > 0 THEN I = 1:J = 1
782  POKE 11,176: POKE 12,S(14): POKE S(10),NF(XS)
783  POKE S(11),79: POKE S(18),117
784 XS =  USR (0): RETURN
```

List 3: **A sample object code (all addresses decimal).**

20480	162,1	LDX-IMM	1	
20482	202	DEX		
20483	134,10	STX-Z	10	initialize integer I (I at loc 10 page zero)
20485	166,10	LDX-Z	10	load I
20487	224,200	CPX-IM	200	I equal to 200?
20489	208,3	BNE	3	
20491	76,81,80	JMP	20561	If true jump out of For loop.
20494	232	INX		If I less than 200 increment.
20495	134,10	STX-Z	10	restore I
20497	162,1	LDX-IMM	1	
20499	202	DEX		
20500	134,11	STX-Z	11	initialize integer J (J at loc 11 page zero)
20502	166,11	LDX-Z	11	load J
20504	224,200	CPX-IM	200	J equal to 200?
20506	208,3	BNE	3	
20508	76,78,80	JMP	20558	If true jump out to next I
20511	232	INX		If J less than 200 increment J
20512	134,11	STX-Z	11	restore J
20514	169,56	LDA-IM	56	load address base for variable X (lo)
20516	133,4	STA-Z	4	put into zero page loc 4 (variable pointer)
20518	160,0	LDY-IM	0	
20520	132,5	STY-Z	5	put address base (hi) into loc 5
20522	32,228,78	JSR	20196	goto fixed routine to write X to top of APU stack
20525	169,20	LDA-IMM	20	load address base for variable A (loc 20, page 0)
20527	133,4	STY-Z	4	set address pointer
20529	160,0	LDY-IM	0	
20531	132,5	STY-Z	5	
20533	32,228,78	JSR	20196	write variable A to APU stack (to OI+228)
20536	169,18	LDA-IM	18	load op code for multiply
20538	141,7,251	STA-AB	64263	command APU to multiply top of stack by next on stack, result to top of stack
20541	169,56	LDA-IM	56	set address base for variable X (loc 56 page 0)
20543	133,4	STA-Z	4	
20545	160,0	LDA-IM	0	
20547	132,5	STY-Z	5	
20549	32,140,78	JSR	20108	APU busy-error check (to OI+140)
20552	32,170,78	JSR	20138	Read APU to memory (to OI+170)
20555	76,22,80	JMP	20502	J loop return
20558	76,5,80	JMP	20485	I loop return
20561	96	RTS		return from subroutine 1.

writing from the APU. However, in longer calculations involving arrays and complicated indexing, time saved by co-processing can amount to a factor of 2 or more.

The above listings, along with this example, should give the reader enough information to write machine code subroutines by hand. The 6502 just implements, writes, and reads to and from the APU, sends it commands and checks its status. Standard 6502 operations can be used for loop control, jumps between subroutines, etc. It should be possible, without undo effort, to write out such object codes for fairly straightforward calculations. If you want to try this particular program the DATA list in listing 4 should be helpful.

```
DATA 162,1,202,134,10,166,10,224,200,208
DATA 3,76,81,80,232,134,10,162,1,202
DATA 134,11,166,11,224,200,208,3,76,78
DATA 80,232,134,11,169,56,133,4,160,0
DATA  132,5,32,228,78,169,20,133,4,160
DATA 0,132,5,32,228,78,169,18,141,7
DATA 251,169,56,133,4,160,0,132,5,32
DATA 140,78,32,170,78,76,22,80,76,5
DATA 80,96
```

Of course, the ultimate situation is to have the compiler write out the object code as illustrated above. Clearly it takes each BASIC source statement and branches out to routines that parse through the line according to the fundamental operation (e.g. FOR, NEXT, a mathematical expression, etc.). The most complicated aspects of a compiler involve rewriting general mathematical expressions into a stack-processing type form suitable for the C8231, and in the process trapping any errors in the source code. The compiler is much too long to list here (16K of BASIC statements), or to describe in detail. However, I hope these two articles have illustrated how fast mathematical processing can be carried out on a simple micro at minimal cost. Enough material has been presented to write and execute simple mathematical subroutines. For further information (a complete manual and cassette tape) on the compiler please write the author.

Two years ago John Hart became interested in using a microcomputer to control laboratory experiments, and to do theoretical calculations involved with his research in meteorology and physical oceanography. The system described above has been used to solve a variety of problems concerned with flow over or around mountains and simple climate models.

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Updates and Microbes

Charles Schwarz of Bethesda, Maryland, sent this note:

I was very annoyed to discover that the assembly language program by Steve Emmett on pages 38-39 of your July, 1981 issue (38) has been cut off. I very much enjoy reading about well-tested assembly language programs in your magazine, but errors such as this one make the reading very difficult.

We regret our mistake. See Emmett's listing below:

Emmett Listing

```
08D1 8D1008          STA BUFHI
08D4 EE1208          INC RWS          ;RWS TO WRITE
08D7 AD0D08          LDA CTRK
08DA 8D1708          STA IBTRK
08DD AD0E08          LDA CSCT
08E0 8D1808          STA IBSECT
08E3 AD1008          LDA BUFHI
08E6 8D1C08          STA IBBUFH
08E9 AD1208          LDA RWS
08EC 8D1F08          STA IBCMD
08EF 60        RTN   RTS
08F0           ;
08F0 A901      END   LDA #$01         ;RESET TEMPORARY
08F2 8D0F08          STA CDIO         ;STORAGE AND
08F5 8D1108          STA NTRK         ;IOB TO
08F8 8D1208          STA RWS          ;INITIAL
08FB 8D1F08          STA IBCMD        ;CONDITIONS
08FE A903            LDA #$03
0900 8D0D08          STA CTRK
0903 8D1708          STA IBTRK
0906 AD0C08          LDA BUFAB
0909 8D1008          STA BUFHI
090C 8D1C08          STA IBBUFH
090F A900            LDA #$00
0911 8D0E08          STA CSCT
0914 8D1808          STA IBSECT
0917 8D2008          STA IBSTAT
091A A90F            LDA #$0F         ;SET END FLAG
091C 8D2808          STA FLAG
091F 60              RTS
                     END
```

John Martin of Cleveland Heights, Ohio, called to tell us of an omission we made from listing 1 of Monobyte Checksum Dumper for C1P *by Peter Broers in MICRO (38:68). The rest of the listing follows:*

Broers Listing

```
               ;
1EDF 20E71E    MONOUT JSR HEXOUT     ;SUBROUTINE TO DUMP A BYTE AS
1EE2 A90D             LDA #$0D       ;2 HEX DIGITS + CR, I.E.
1EE4 4CB1FC           JMP SAVBYT     ;"MONITOR LOADABLE FORMAT"
1EE7           ;
1EE7 48        HEXOUT PHA            ;SUBROUTINE TO PRINT (AND SAVE) BYTE
1EE8 4A               LSR            ;AS TWO HEX DIGITS
1EE9 4A               LSR
1EEA 4A               LSR
1EEB 4A               LSR
1EEC 20F01E           JSR DIGOUT
1EEF 68               PLA
1EF0           ;
1EF0 290F      DIGOUT AND #$0F       ;SUBROUTINE TO PRINT (AND SAVE)
1EF2 0930             ORA #$30       ;A HEX DIGIT
1EF4 C93A             CMP #$3A
1EF6 9002             BCC *+4
1EF8 6906             ADC #$06
1EFA 4CEEFF           JMP BYTOUT
                      END
```

Warren Ward of Alberta, Canada, sent another update to the Superboard article.

For C1P and Superboard owners who want to use Edward H. Carlson's mini-assembler (MICRO, March 1981), here are a few line changes that suit his program to the smaller screen format:

```
   1 FOR X=0 to 25:PRINT:NEXT
       X:GOTO 1990
  20 FOR Z=2 TO LEN(C$) : POKE
       N+Z, ASC(MID$(C$,Z,1)):
       NEXT:RETURN
  99 C$="No":N=Q+1:GOSUB 20:
 100 PRINT:PRINT AD;:INPUT C$:
       PRINT">":L$=LEFT$(C$,3):
       L=LEN(C$)
 106 IF L$="ASC"THEN M=ASC
       (C$):Z=1:GOSUB 2: GOTO 100
1995 Q=54084
4050 N=N+M*L:L=L/16:NEXT:C$=
       STR$(N):N=Q:GOSUB 20:
       GOTO 100
```

Line 1 is cosmetic — it scrolls the screen for a clean start. Line 1995 relocates assembler comments into the C1P video memory, and changes the other lines to reposition the comments so they'll all fit on the screen.

It's impossible to squeeze a full comment sequence legibly into the same 24-character line as the command input, so the third PRINT statement in 100 starts a new line, preceded by a "greater-than" sign, beneath the address line. The first PRINT in 100 puts a space between each pair of lines for greater readability: to fit more information on the screen, leave it out.

The display resulting from these changes is almost as easy to read as the original. Users will still have to keep a notebook handy, though, if they want to save the assembler's translation before it disappears off the top of the screen.

Cliff Harris of Anaheim, California, wrote about his update:

I was intrigued by Edward Carlson's *6502 Assembler in BASIC* in the March, 1981 issue of MICRO. I thought if he could adopt the program from PET BASIC to OSI, then I could transform it into something my Apple could understand. See listing 1.

Listing 1

```
   1 HOME: GOTO 1990
  99 C$="NO": N=Q+18: GOSUB 20
 100 PRINT AD;: INPUT C$: L$ =
     LEFT$ (C$,3): L = LEN(C$): Q =
     Q + 128: IF Q > 2000 THEN Q
     = Q - 984: IF PEEK (37) > 20
     THEN Q = 1888
 106 IF L$ = "ASC" then M = ASC
     (C$): Z = 18: GOSUB 2: GOTO
     100
 221 II = OP + 8 * (CA = 1)
 340 N = N - AD - 2: IF N <
     -128 OR N > 127 THEN PRINT
     "CAN'T BRANCH "; N; " -- TOO
     FAR": Q = Q + 128
1992 DEF FN H(D) = D + 48 - 57 *
     (D > 9)
1995 Q = 912
2029 Delete this line
2030 AD = 768: GOTO 100
4050 N = N + M * L: L = L/16:
     NEXT: C$ = STR$ (N): N = Q
     + 18: GOSUB 20: GOTO 100
```

Line 1 cleans up all the garbage on the screen and sets up the screen format. This is necessary since the hex addresses and commands are POKEd directly into the screen memory.

Lines 99, 106, and 4050 move the output from the assembler to result in a format that will fit on the Apple screen.

In line 100, the changes are required because of the way the screen locations are arranged in the Apple. Adding 128 to a screen location moves it down one line, unless you're on the 8th or 16th line. Then you must subtract 984 to move down one line. The Q = 1888 sets the screen into a scrolling mode once you reach the bottom of the screen.

Line 221 required a change in sign. The minus was changed to a plus. In line 34 I added "--TOO FAR" here to make the message more meaningful. The Q = Q + 128 moves the line position down one so that your next program line won't be printed in the middle of the "CAN'T BRANCH..." message.

In line 1992 I changed the 7 to 57 to get this line to work with the Apple. A side effect of this is that the hex portions of the program will be printed in the inverse mode. If you want to take the time to massage this function, you can get a display in the normal mode, or even flashing, if you're so inclined. I left it this way to minimize the number of changes in the program.

In line 1995 the number sets up the screen location where the output from the assembler will be printed on the screen. When 128 is added by line 100, you will be on the top line of the screen 16 spaces from the left (912 + 128 = 1040, which equals 1024 + 16).

Line 2029 can be deleted, as it seems to be left over from a decimal-to-hex conversion routine which is no longer part of the program.

In line 2030, AD = 768 sets the starting address of your program to \$0300. You have only 255 bytes available before you run into the screen memory at \$0400. If your programs are going to be longer than 255 bytes, change AD to 8192 (\$2000), or whatever address suits your needs, to get into an area of memory with no conflicts.

If you want to add a "user's manual" to the top three lines of the screen, change line 1995, and add lines 1996 through 1999 (listing 2).

Listing 2

Change the following lines to add a "menu:"

```
1995 Q = 1296: POKE 34,0: HOME
1996 INVERSE: PRINT "ADD";:
     NORMAL: PRINT "NEW
     ADDRESS";: INVERSE: PRINT
     "CON";: NORMAL: PRINT
     "STORE CONSTANT"
1997 INVERSE: PRINT "DIS";:
     NORMAL: PRINT "DISPLAY
     MEMORY";: INVERSE: PRINT
     "ASC";: NORMAL: PRINT "ASCII
     EQUIVALENT"
1998 INVERSE: PRINT "HEX";:
     NORMAL: PRINT "CONVERT
     FOUR DIGIT HEX TO DECIMAL"
1999 POKE 34,3
```

The POKEs set the text window so that you can clear the screen (line 1995) and so that you won't lose your mnemonics when you get to the bottom of the screen (line 1999).

Eric R. Bean of South Bend, Indiana, pointed out this omission:

My letter to the editor in July, 1981 on page 19, mentioned a figure 1, which was not printed. Here is another copy of the clock oscillator fix for the early KIM-1 uP board (see figure 1).

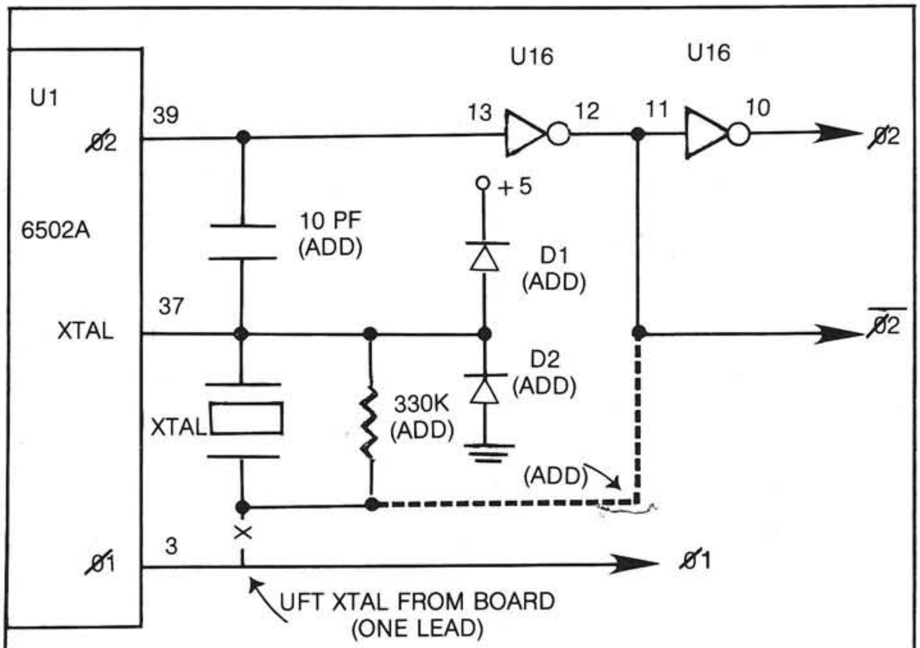

Figure 1: **Conversion of early KIM-1 XTAL oscillator to later production circuit to insure self starting.**

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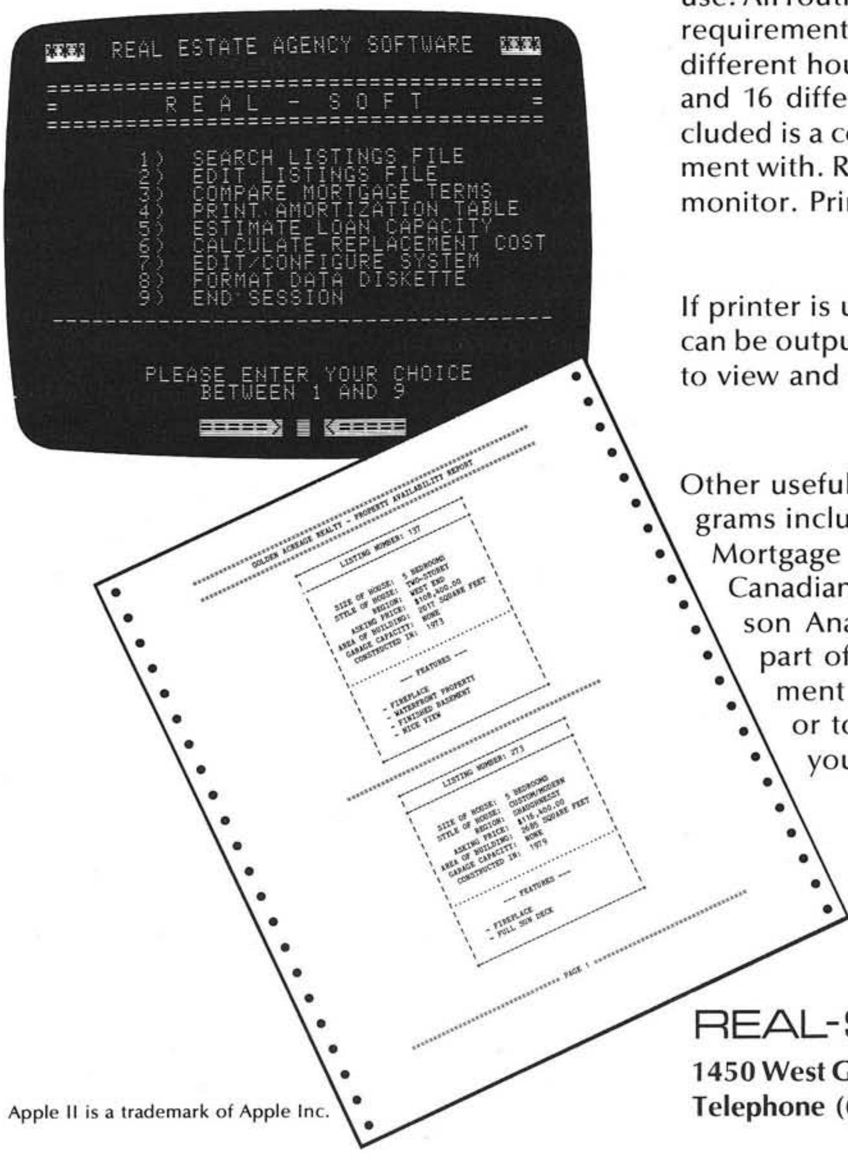

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Language: Applesoft in ROM or Language System
Hardware: Apple II, one or two disk drives, lower case adapter or 80-column video board, shift key modification, printer
Description: This is the ultimate word processor for the Apple II computer. Works with 40- or 80-column screens interchangeably, shows lower case, has real shift key. Other features: works at professional typing speeds; versatile page numbering and header printing on each page; file merge and unmerge; block operations — move, transfer, and delete; automatic insertion of full phrases for user-defined abbreviation (unlimited number); automatic envelope address; built-in card file system; interfaces with Data Factory™, On-Line Database, Information Master, and Visicalc™ files; file chaining and nesting; "if" and relational commands to allow conditional printing of information based on the contents of a database; insertion of data directly from database files (in lower case, if desired); permits keyboard input during print time; multi-level outline indentation; right and left justified tab stops; dynamic text reformatting; immediate mode configuration for display screen, number of disk drives, and printer (including Centronics 737 and IBM Selectric); interfaces with CCS clock board for time stamping of documents; embedded or external printer commands; character/word/line insert/replace/delete; selective or global search and replace; built-in interface to D.C. Hayes Micromodem II™; menu-driven operation; easel-bound, indexed manual; lesson-type instructions.
Price: $250.00
Available: Aurora Systems, Inc.
2040 E. Washington Ave.
Madison, WI 53704
(608) 249-5875

Name: **Business Plus**
System: Apple and Atari/800
Memory: 48K
Language: Applesoft & Binary (Apple)
BASIC & Binary (Atari)
Hardware: Any 80-column printer
Description: An all-in-one billing system. Handles invoices, statements, credit memos, purchase orders, payables, writes checks, account aging reports (30, 60, 90 and over 90 days), bar graphs of sales, income and expenses, mailing list with search, sales register and a whole lot more. Everything you need for daily business operations.
Price: $299.00 (or $25.00 for demo - credited towards purchase) includes 2 disks and documentation
Author: Advanced Data Systems
Available: Advanced Data Systems
7468 Maple Avenue
St. Louis, MO 63143

Name: **Micro-Telegram**
System: Apple II or Apple II Plus
Language: Integer BASIC or Applesoft
Hardware: Apple II or Apple II Plus
Description: Allows Apple owners to access Western Union Services worldwide, send and receive TWX™, Telex™ and international cables, and send mailgrams. Apple owners can also access continuously updated reports on news, stock, foreign exchange, gold, futures, sports reports and ski conditions through Infomaster®, the Western Union Data Base.
Price: $250.00 - suggested retail, FOB Boston, includes mini-floppy diskette and documentation
Author: Microcom, Inc.
Available: Microcom, Inc.
89 State St.
Boston, Massachusetts 02110

Name: **Super-Text II**
System: Apple II word processing program
Memory: 48K
Language: Assembly
Hardware: Apple II or Apple II +
Description: With Super-Text the basics of text editing are learned quickly, yet its advanced features will meet the user's expanding word processing requirements into the future. Add the Form Letter Module and Address Book Mailing List for the ultimate in professional or personal use word processing.
Price: $150.00 includes documentation, an unlimited time replacement policy, and dual disk
Author: Ed Zaron
Available: MUSE Software
330 N. Charles
Baltimore, MD 21201
(301) 659-7212

Name: **Eureka™ Learning System**
System: Apple II or Apple II +
Memory: 32K Cassette, 48K Diskette
Language: Applesoft with some machine language
Hardware: Cassette or diskette (DOS 3.3)
Description: An interactive, menu driven program that helps teachers create courseware. No programming is necessary. Any subject may be taught using symbols and line drawings (Hi-Res shapes). Courses are presented to students in three modes, with optional sound effects. May be used with any level of student, pre-school through adult. The material and its style is up to the teacher, not the computer.
Price: $995.00 for software license
Author: Eiconics, Inc.
Available: Eiconics, Inc.
200 Cruz Alta
Taos, New Mexico 87571

Name: **Sentence Diagramming**
System: Apple II
Memory: 48K
Language: Applesoft
Hardware: Apple II, Disk II (one or two drives)
Description: Teaches sentence diagramming, parts of speech, and usage, for individual student sessions. It is also an excellent tool for teachers to use for instruction in one, two, or all of these areas. Students may use the teacher-formatted disk for individual practice at 3 levels of difficulty. Each level has 20 separate sentences. Options include creating student record files, monitoring progress, reading records, omitting diagramming sections, etc. This is the best grammar disk available today. Grades 6-12.
Copies: Many
Price: $19.95 includes disk, manual, demo sheet
Available: Avant-Garde Creations
P.O. Box 30161 MCC
Eugene, OR 97403

Name: **Extended SYM-BASIC**
System: SYM-1
Memory: 16K
Language: 5½K machine language program
Hardware: Serial terminal and Synertek BASIC ROMs
Description: Extended SYM-BASIC adds over 30 new commands/functions to standard SYM-BASIC. Features include: a unique input line editor; pagination of program listings; hex arithmetic and arguments; built-in printer control; auto line number prompting; realtime clock; powerful trace/debug command; trigonometric patch; ultra renumber; powerful execute command; range delete command; and many others. List of commands follows: $, @HH, @MM, @SS, APPEND, AUTO, CA, CALL, CR, CHAIN, DEL, DR, EDIT, EXEC, GET, GOTO, IN=, LOADP, LOAD NUM, OUT=, PAGE, PRINTOFF, PRINTON, PRINTUSING, SAVEP, SAVEV, SAVEB, STIME, TRACE, VERIFY.
Copies: 50 copies (Note: over 200 copies of 8K version sold.)
Price: $85.00 U.S., $95.00 Canada, includes object on cassette and 90-page instruction manual complete with source listing
Author: John W. Brown
Available: Saturn Software Limited
8146 116A St.
Delta, B.C., V4C 5Y9, Canada

Name: **A.3. Frequency Analysis**
System: PET
Memory: 8K
Language: BASIC
Hardware: PET/CBM
Description: Using harmonic analysis techniques, a frequency scan is made of a time series, such as stock prices, which discloses frequencies of significant amplitudes. A harmonic analysis is then made at chosen frequencies. Included is a logical file input and modification to update and delete old data.
Price: $15.00 for cassette and documentation
Author: Claud E. Cleeton
Available: 122-109th Ave., S.E.
Bellevue, WA 98004

Name: **HSD Anova**
System: Apple II or Apple II Plus, DOS 3.2
Memory: 48K
Language: Applesoft
Hardware: Optional printer with serial or parallel interface
Description: HSD Anova is a powerful, flexible analysis of variance program suitable for scientific research and business analyses. This single program analyzes balanced designs of from one to eight independent variables. It can handle designs composed of between-subjects and/or within-subjects factors. Design specification and data entry are simple. Data entry is from keyboard or disk, with data editing. Output is an Anova table on CRT or printer.
Price: $74.95 includes disk, complete documentation, binder.
Author: Stephen Madigan, Ph.D.
Virginia Lawrence, Ph.D.
Available: Human Systems Dynamics
9249 Reseda Boulevard
Suite 107C
Northridge, California 91324

Name: **FORTH-79 Standard**
System: Apple II, Apple II +
Memory: 48K
Language: Machine Language and FORTH-79
Hardware: 1-14 disk drives (13 or 16 sector-compatible)
Description: FORTH-79 is a structured language suited for systems and applications programming with advantages where execution speed is important (i.e., data acquisition, process control, animation, and video games). Programs run faster than BASIC and are compact. The 32-bit integer arithmetic vocabulary is ideal for business applications and is also extensible. Package includes screen editor, macro-assembler and vocabularies for strings, double precision integers and Lo-Res graphics.
Price: $89.95 includes software and manual (including FORTH-79 and Fig-FORTH)
Author: Martin Tracy and Philip Wasson
Available: MicroMotion
12077 Wilshire Blvd. #506
Los Angeles, CA 90025
(213) 821-4340

Name: **S-FORTH**
System: OSI disk systems
Memory: 20-96K
Hardware: No extra hardware required
Description: S-FORTH is a full implementation of fig-FORTH including editor, a virtual memory disk subsystem, and compatibility with OS65D. All OS65D commands are still usable. You can exit from S-FORTH to OS65D and then return to S-FORTH. It is over 10 times faster than BASIC and is as fast as Pascal. The FORTH compiler uses less memory than Pascal and allows any user with at least 20K to have an excellent FORTH system.
Price: $34.95 for 5¼" or 8" disk (disk and source listing together are $49.95)
Author: Digital Systems
Available: Aurora Software Associates, P.O. Box 99553 Cleveland, Ohio 44199

Name: **Dental Insurance Form Writer**
System: Apple II with firmware card or Apple II Plus
Memory: 48K RAM
Language: Applesoft, DOS 3.2, 3.3
Hardware: Disk drive, 80-column printer
Description: You can prepare Universal American Dental Association Insurance Claim forms on your Apple. Each form can be prepared, saved to disk, reloaded, edited and printed as many times as you desire. Dental Insurance Form Writer allows rapid billing and claim submittal with a minimum of effort. A master form can be created for each family/patient and saved for later use. This master can be loaded, treatments entered, printed and sent as a pre-authorization or actual statement. Over 100 families per diskette.
Price: $100 includes manual
Author: J. McFarland
Available: Andent Inc. 1000 North Ave. Waukegan, Illinois 60085

Name: **Pulsar II**
System: Apple II or Apple II Plus
Memory: 48K
Language: Machine
Hardware: One disk drive, 13 or 16 sector controller card
Description: Two games — Pulsar II and Wormwall in a unique combination. Each game has eight levels of play and score can be transferred between the two. The object of Pulsar II is to destroy the spinning shields around the Pulsar and destroy it. Wormwall places you in one of the strangest mazes ever created. The walls do not connect and openings occur only temporarily as colored lines cross. Little creatures chase you in each part of the maze.
Price: $29.95 includes disk and documentation.
Author: NASIR — Presented by Sirius Software, Inc.
Available: Your local Apple dealer or software store.

Name: **The Dragon's Eye**
System: PET or Apple
Memory: 32K (PET) and 48K (Apple)
Language: PET BASIC, Applesoft BASIC
Hardware: PET, Apple II
Description: An overland fantasy game, where the player has 21 game days (approximately a half an hour playing time), to find the Dragon's Eye, a magical jewel hidden by an evil magician. The player chooses one of 16 characters, and gains a set of magical abilities. He also chooses among 13 commands. When he combats the vicious monsters, animated graphics display the action between player and beast.
Price: $24.95
Author: Automated Simulations, Inc.
Available: Automated Simulations, Inc. P.O. Box 4247 Mountain View, California 94040

Name: **Sneakers**
System: Apple II or Apple II+
Memory: 48K
Language: Machine
Hardware: Disk Drive
Description: Sneakers are little guys who appear to be friendly but will quickly stomp you out if you do not get them first. After the Sneakers come wave after wave of Cyclops, Saucers, Fangs, H-Wings, Meteors, Scrambles and Scrubs. The variety is incredible and the challenge unending. *Sneakers* is playable with keyboard or paddles.
Price: $29.95 includes disk, documentation and a T-shirt transfer
Author: Mark Turmell
Available: Your local computer software store

Name: **Olympic Decathlon**
System: CP/M or TRS-80
Memory: 48K for Apple II or II+; 32K for disk drive TRS-80 Model 1; 16K for cassette TRS-80 Model 1.
Language: Machine
Hardware: Apple II or II+; TRS-80 Model 1, disk or cassette
Description: Enjoy the excitement and skill of Olympic competition with this game which takes you through all 10 events of the real Decathlon. Each event is presented with animated graphics that put you into the action. Eight and six players can compete respectively with the TRS-80 and Apple versions. Repeat feature lets you practice any event as many times as you wish prior to beginning the actual competition. Your best times can be compared to actual recorded Olympic Decathlon times.
Price: $29.95 includes instruction manual and 5¼" disk (cassette for TRS-80 cassette version)
Author: Tim Smith
Available: Microsoft Consumer Products 400-108th Ave. NE Suite 200 Bellevue, WA 98004

Name: **Cavern of the Dwarves**
System: SYM with BAS-1 or KIM 8K BASIC at 2000 H
Memory: 16K
Language: BASIC
Hardware: Terminal using standard serial I/O ports on SYM or KIM
Description: An adventure game in which you wander a large cavern seeking treasure, fighting monsters, and trying to avoid getting killed by the many dwarves who inhabit the cavern. You communicate with the computer using one- and two-word commands.
Price: $10.00 on cassette tape, ppd. in U.S. only
Author: Lee Chapel
Available: Lee Associates 2349 Wiggins Ave. Springfield, IL 62704

MICRO

Dr. William R. Dial
438 Roslyn Avenue
Akron, Ohio 44320

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Lane, Eric T., "Microcomputing—At the Speed of Light," pg. 75-76, 136.
Graphics show what an object looks like at the speed of light, for the Apple.

Stotts, Gary A., "Amortization Schedule," pg. 90-91.
The Apple program to show you where your money goes when you are paying off a loan.

Schlarb, Keith N., "Information Source for Home and School," pg. 94-95, 138-140.
A random access file program for the Apple.

1046. Apple Cookbook 1, Issues 5/6 (February, 1981)

Maly, Frank, "Proper Program Design," pg. 1-2.
A tutorial on writing proper programs with the Apple.

Golding, Val J., "Applesoft from Bottom to Top," pg. 3-6.
A roadmap to Applesoft to help you understand programming.

Reynolds, Lee, "EXEC Files on the Apple II," pg. 6-7.
A short instructional article on the EXEC command.

Rivers, Jerry, "Sorting," pg. 7-10.
A discussion, with examples, of the various types of sorting routines.

Simpson, Rick, "Introduction to Assembly Language," pg. 10-13.
A tutorial on assembly and machine language for the Apple.

Tyro, A., "Pascal: Beginners Notes," pg. 13-14.
A Tab Demo program in Pascal.

Anon., "Apple Doodle," pg. 15.
An assortment of short routines and procedures for the Apple.

1047. 73 Magazine No. 245 (February, 1981)

Erdei, Steven G., "Under Software Control," pg. 94-98.
A repeater control system with minimal hardware, using a KIM-1.

1048. Byte 6, No. 2 (February, 1981)

Zimmermann, Mark, "A Beginner's Guide to Spectral Analysis," pg. 68-90.
An instructional article including listings for the PET.

Woteki, Thomas H., "A Pascal Library Unit for the Micromodem II," pg. 106-136.
Programs for the Micromodem on an Apple/Pascal system.

1049. L.A.U.G.H.S. 3, No. 1 (January, 1981)

Connelly, Pat, "A Disassembler for S-C Assembler," pg. 3-8.
A disassembler which dissembles into source code format is a definite asset to augment your S-C Assembler, for Apple.

1050. Southeastern Software Newsletter Issue 24 (February, 1981)

George McClelland, "Software Reviews," pg. 1-6.
A review of new games for the Apple.

1051. Dr. Dobb's Journal 6, No. 52, Issue 2 (February, 1981)

Caulkins, Dave and Harris, David C., "PAN — One Activity of the PCNET Project," pg. 17, 37.
Discussion and updates for PAN, a communication net implemented on the PET.

Gordon, H.T., "Byte-Count Routine," pg. 37.
Modifications to CNTBYT and BYTNUM routines for 6502 micros.

1052. The Transactor 2, No. 12 (ca. February, 1981)

Anon., "Exclusive OR on Your PET," pg. 2.
Add this useful function to the PET.

Anon., "Bits and Pieces," pg. 2-5.
Miscellaneous PET notes including discussion of logical operators; differences among BASIC 1.0, 2.0, and 4.0; screen loading; NEC Spinwriter; Card Print Utility, etc.

Hooks, Dave, "Card Print Utility," pg. 6-7.
Listing and cross references for the PET.

Hoogstraat, J., "PET BASIC Label Support Interface," pg. 8-13.
An interesting PET routine residing in the second cassette buffer allowing the use of labels in BASIC. For BASIC 2.0.

Anon, "BASIC 4.0, DOS 2.0 and the Relative Record System," pg. 14-21.
The new PET operating systems, discussion and tutorial with examples.

Higginbottom, Paul, "BASIC 2.0 to BASIC 4.0 Conversions (40 Column)," pg. 22-31.
All about converting several types of PET BASIC programs. With memory map, entry points, 6502 op codes, status variables, etc.

Troup, Henry, "The PET NMI Vector," pg. 32-33.
An instructional article on the non-maskable interrupt.

Butterfield, Jim, "A Few Entry Points, 1.0/2.0/4.0 ROM," pg. 34-35.
A useful tabulation for PET users.

Troup, Henry, "Fun with WAIT Statements," pg. 36-37.
All about PET Wait command.

Anon., "8032 Control Characters," pg. 38-40.
Discussion and tabular summary of control functions.

1053. T.A.R.T. 2, Issue 1 (February, 1981)

Smith, Eric, "String Art," pg. 3-5.
A graphics program for the Apple.

Sander-Cederlof, Bob and Koerin, Sid, "Hi-Res Crest Design," pg. 6-8.
A graphics program for the Apple.

Shipley, Jim, "Revision 7 and 7a Motherboards," pg. 12-13.
A description of the latest Apple motherboards and instructions for hardware modifications.

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Guest, Ronald A., "A Simple Securities Manager for the Apple," pg. 7-13.
An Apple program to manage your stocks.

Elm, Robert L. ,"Why WAIT?", pg. 15-16.
Interesting applications of the WAIT function on the OSI and PET systems.

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A simple one-pass assembler for the Atari.

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A program for the OSI C1P to save machine language routines as BASIC DATA statements.

Wells, George, "Improved Dual Tape Drive for SYM BASIC," pg. 23-28.
Utility routines for SYM to enhance the use of two cassettes, including a tape duplication feature.

Bongers, C., "In the Heart of Applesoft," pg. 31-47.
A tutorial on how to work with Applesoft.

Kollar, Larry, "One Dimensional Life on the AIM 65," pg. 50-52.
A Life game taking advantage of the AIM's 20-character display.

Tenny, Ralph, "Increase KIM-1 Versatility at Low Cost," pg. 57-59.
A hardware article for the KIM involving moving the primary address decoder off-board, making it possible to add other I/O devices.

Strasma, James, "PET String Flip," pg. 65-66.
A solution to the problem of upper and lower case inversion using CBM 2022 and 2023 printers with Old ROM PETs.

Wright, Loren, "PET Vet," pg. 68.
A modified routine to allow you to recover from a crash without losing memory; how to avoid accidental INPUT exit, etc.

Ell, David A., "A C1P Sound Idea," pg. 71-72.
A hardware addition creating a belltone for the C1P or Superboard II.

Sebra, Randy, "Does Anybody Really Know What Time It Is?", pg. 75-79.
Hardware and software for using the OKI Semiconductor MSM5832 CMOS clock chip on your 6502 system, with a BASIC listing for the SYM.

1055. Atari Computer Enthusiasts 2, Issue 2 (February, 1981)

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How to get more speed from your BASIC programs on the Atari.

Crawford, Chris, "Missile-Graphics Demo."
A BASIC listing for an Atari graphics routine.

Anon., "POKE Text Into Graphics 8!", pg. 7.
How to POKE alphanumeric graphics characters into the Atari graphics 8 mode.

1056. The Apple Peel 3, No. 2 (February, 1981)

Jenkins, Jerry, "Apple Program Conventions," pg. 6.
A routine to add credits, etc. to program listings for Apple software donated to a club library.

Brown, Thomas A., "Telephone Dialer," pg. 9-10.
Hardware and software listing for an Apple telephone dialer.

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A group of programs including Applesoft conversions.

Chapel, Lee, "Monster Combat," pg. 106-116.
A game written in BASIC for the KIM.

Stith, John E., "Lower-Case Display for Apple Writer," pg. 124-129.

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Blank, George, "Outpost: Atari," pg. 168-171.
Discussion of Atari graphics, listing for Decimal Dump, the PEEK function, etc.

Carpenter, Chuck, "Apple-Cart," pg. 172-180.
Discussion of programming languages for the Apple, including Mini PILOT; Mini-PILOT Interpreter, etc.

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Baker, Robert W., "Tape-To-Disk Data File Copy," pg. 15.
A basic program for the PET.

Chamberlin, Hal, "Simulation of Musical Instruments," pg. 142-148.
Part 2 of this series on music synthesis includes routines written for the KIM.

Kammer, David W., "Autoloader Program for the C1P and Superboard II," pg. 158-160.
Routines to load and save machine language programs on OSI systems.

1059. Personal Computing 5, No. 2 (February, 1981)

Miles, Kenneth, "Menu-Writer," pg. 38-42.
Let Apple write a menu for your Applesoft or Integer BASIC programs.

Karis, Robert, "Archimedes' Spiral," pg. 81-82.
A versatile graphics Hi-Res program for the Apple.

1060. CSRA Computer Club Newsletter (February, 1981)

Morse, Ken, "Permanent (?) Comment," pg. 1.
A program to convert Integer BASIC line numbers to 65535 to make them more resistant to undesired deletion.

Sikes, Randy, "DOS 3.3 Update," pg. 4.
A simple fix for the new Apple DOS 3.3.

1061. Softalk 1, No. 6 (February, 1981)

Wagner, Roger, "Assembly Lines," pg. 26-29.
Part 5 of the guide to assembly language covers branch instructions.

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Some notes for OSI owners who wish to use the Spinwriter.

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The first of a series of tutorial articles showing how to develop a budgeting program.

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Discussion of the use of Apple's Editor/Assembler, found in the DOS Toolkit. Also Neil Konzen's Program Line Editor and the INIT command.

Garvey, Michael, "Storing and Reading an Array on Disk," pg. 16-17.
A utility for the Apple.

Greene, Amos, "Sex and the Single Drive (Disk Version)," pg. 18-19.
An instructional article on the storage of data on the Apple Disk.

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An EXEC File Operator for the Program List Formatter in the Winter Orchard magazine.

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An Apple/Pascal program to plot circles, etc. on the Hi-Res screen.

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An instructional article with a BASIC Booter Routine in Apple/Pascal.

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A detailed guide to interfacing in Apple Pascal systems.

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A program for the Apple/Pascal library.

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A good source of information on how to POKE characters on the Hi-Res screen.

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A program to enter standard program labels into software items donated to club libraries, for the Apple.

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An instructional article on using Applesoft's SPC function.

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A utility for the PET to maintain PASCAL source language statements.

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Description and evaluation of a printer for the Atari systems.

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A routine for the AIM 65 micro.

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An 8K elementary arithmetic program written for the 16K PET with new ROMs.

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An article on inexpensive hardware and software for an accurate clock for the Apple.

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A horizontal scrolling message routine for the Atari.

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A tutorial on defining the character set of the Atari.

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A way to effectively increase the normal 24 × 24 format of the C1P to a 40 × 40 format for graphing functions.

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A program for the PET.

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Several reasons for crashes and how to avoid them.

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Notes on PET/CBM files.

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Hardware for small single board micros to make a simple communications terminal.

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A clock program that is a little different — for the 4K SYM-1.

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How many expansion boards can the unbuffered microprocessor bus drive before becoming overloaded?

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Can cousins marry and remain happy?

1068. Apple-Com-Post Issue 9 (ca. June, 1980)

Knuelle, Alfred, "Paddles, Joysticks undsoweiter," pg. 8.
How to use a 40K pot in place of a difficult-to-find 150K pot in constructing paddles or joysticks for the Apple.

Kniefel, J. and Goetze, Uwe, "Programmschutz," pg. 11-12.
How to add copyright statements to your basic pro-

(Continued on next page)

grams and make them more resistant to obliteration or alteration.

1069. From The Core (February, 1981)

Whittaker, Alec, "Lazer Lower Case Plus," pg. 4.
A review of new hardware for the Apple. Also some routines for text files.

Schroyer, Jeff, "Lazer Lowercase in Depth," pg. 5.
An evaluation of this new hardware mod in some detail.

Anon., "Dr. Apple: Some Uses for a Disassembler," pg. 5-7.
Use the disassembler to assist in Pascal/Apple programs.

Lingwood, David A., "Overlaying in Applesoft," pg. 6-7.
How to get a 20K program to run in 8K.

Budge, Joe, "The Locksmith," pg. 3.
Some notes on the use, ethics, etc. of this utility in 'unlocking' protected software disks.

1070. Mini'app'les 4, No. 2 (February, 1981)

Pinotti, Terry L., "DOS 3.2 and 3.3 on Single Controller," pg. 2-3.
Hardware modification to your Apple Disk II controller card to switch back and forth between the 13/16 sectors.

Hammond, Daryl, "Pondering Pascal: Run Time Errors," pg. 11-15.
A tutorial on Apple/Pascal and an example of how to debug Pascal programs.

Pinotti, Terry L., "Game Paddle Port Modification," pg. 15.
A simple hardware mod to make installing accessories on the Apple I/O ports.

1071. Spreadsheet (Visigroup — A Visicalc User Group) 1, No. 1 (November, 1980)

Staff, "Definitions," pg. 2.
Definitions to make communications amongst Visicalc/6502 users easier.

Staff, "Template," pg. 3.
Typical layout for a Visicalc sheet, reserving the first two columns for variables.

1072. Spreadsheet 1, No. 2 (January, 1981)

Mellon, Arthur Mellon, "Merging Templates," pg. 2.
A time-saving procedure for setting up sheets.

Anon., "Visilist," pg. 5-6.
An accessory utility for printing out the contents of Visicalc template formulas, valuable in diagnostics and planning improvements.

Ender, Philip, "Visitip #5: Flashing M."
How to avoid that flashing M by using more memory in your Apple.

Staff, "Visitip #6: Template Development Aid," pg. 6.
How to find out where the "to" print position has got to in a template under development.

1073. Printout 2, No. 2 (February/March, 1981)

Batey, Duncan, "Matrix Codes," pg. 11.
Useful table for PET users.

Valentine, Mark, "Tick Tock PET," pg. 11.
A 12-hour clock machine-language routine for PET.

Nuttall, John, "Visicalc: How and Why," pg. 18-19.
All about Visicalc for the PET.

Turnbull, Tommy, "Tommy's Tips," pg. 21, 47.
Automatic deletion of DATA statements; instant algebraic input; etc.

Anon., "Turnkey ROMs: Do they Open the Door?", pg. 22, 31.
How to implement turnkey operation on the PET.

Jarrett, Dennis, "PET Communications — State of the Art Report," pg. 24-29.
A special in-depth presentation on PET communication hardware, systems, etc.

Staff, "Colour Display Arrives for PET," pg. 33-35.
A review of the Chromadaptor for the PET system.

Sanders, Gavin, "Get Back in the Black," pg. 36-37.
How to recover and make reuseable those old printer ribbons.

Yob, Gregory, "Personal Electronic Transactions," pg. 43-45.
How to get lower case on the PET; a program for POKE-ing machine language into the PET memory; and several short machine language routines for the PET.

1074. FWAUG Newsletter 2, No. 2 (December, 1980)

McVay, Ray, "Disk Status Finder," pg. 2-10.
A machine language routine that can be run from either DOS 3.2/3.3 which will tell the current DOS version, Master/slave status, free sectors and auto-boot file name.

Meador, Lee, "Disassembly of DOS 3.2 — Part 10," pg. 12-18.
This section of DOS is nearly identical between 3.2, 3.2.1, and 3.3 — devoted to the DOS command decoder.

1075. Apple Assembly Line 1, Issue 5 (February, 1981)

Sander-Cederlof, Bob, "Apple Noises and Other Sounds," pg. 2-9.
Routines for Apple bell, machine-gun noise, laser swoop, inch-worm sounds, touch-tone simulator, morse code output, etc.

Boering, Brooke W., "Faster 16×16 Multiply," pg. 11-12.
A routine for rapid multiplication of two 16-bit values to get a 32-bit value.

Sander-Cederlof, Bob, "A String Swapper for Applesoft," pg. 14-15.
Rearrange data, sort alphanumerics, all the easy way.

1076. Softside 3, No. 5 (February, 1981)

Pelczarski, Mark, "Developing Data Base: Part 6," pg. 16-17, 82-83.
This month capabilities for print formatting are added to this utility for Apples and Ataris.

Truckenbrod, Joan, "Three Dimensional Rotation — Part III," pg. 22-25.
An Apple Hi-Res graphics program.

Schoenmeyer, Roger, Thompson, Robert and Mueller, Carl, "Apple One-Liners," pg. 45.
Three oneline programs for the Apple.

Case, Phillip, "Miner," pg. 48-52.
Atari and Apple versions of a program offering adventure deep in an abandoned gold mine.

Cross, Mark, "Famous Sayings Hangman," pg. 59-61.
A different type of Apple Hangman.

Ockers, Stan, "Changing Hearts," pg. 64-65.
An Atari graphics program.

Daoust, John, "Darts," pg. 84.
A paddle game for the Apple.

MICRO

Advertisers' Index

Next Month in MICRO

In addition to the usual, balanced coverage we strive for in MICRO, since June 1981 we have added pages devoted to special topics. We call these added pages BONUS sections.

Commodore Bonus Section

This section will include the following articles:

- **VIC Light Pen-manship —** evaluates several manufacturers' light pens which can be used with the VIC and offers demonstration programs for applying the pens as a scribe or color paint brush.
- **The PET from A to D —** Analog to digital conversion on the PET.
- **Speeding Up ASCII File Retrieval —** Machine language techniques to speed file retrieval in the PET and Apple.
- **Commodore ROM Genealogy —** An up-to-date list of all the combinations of Commodore's ROMs, keyboards, and screens.
- **Character Set Substitution —** Explains how PET characters are generated and discusses several alternate character sets that can be substituted for the largely redundant second character set.

Apple Bonus Section

Apple users will continue to receive extra material in October in the Apple Bonus Section. A sampling of articles follows.

A Booby Trap in Applesoft addresses "protection" schemes for Applesoft. *Random Numbers Generator in Machine Language* offers a simple subroutine to use in a machine language program whenever random numbers are needed. And *Taming the Wild Reset* tells how a user can easily modify an Apple keyboard to ignore normal resets. *Solar Simulation* provides a program for printing information and plotting positions (using hi-res graphics) of the first six planets of the Solar System.

Coming in November

November brings a double BONUS featuring Games and still more on the Apple — just in time for the upcoming, gift-giving holiday month of December.

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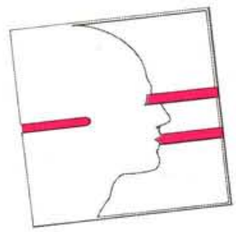

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Microcomputers, their peripherals, and software are a part of the most volatile industry in existence today.

Companies associated with this growing area come and go at a painful rate. Presently, good software is at a premium. The average computer owner is far more sophisticated than he was a year ago. He demands an ever increasing diet of faster high resolution games that can only be met by the best programmers. The day of the small businessman, who has the time to sweat through the debugging of his general ledger while on the line, is gone.

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