Questdata

Volume 1 Issue #6

Images and Patterns for Tomorrow

FISH gotta fly, birds gotta swim. Eventually, given human intervention into things, this artistic arrangement is inevitable. With the advent of the microcomputer age, graphics and art are likely to be sliced and served in every conceivable way. What will be the new forms of art, design, architectural drawings, schematics, photographic images, animation, and graphics?

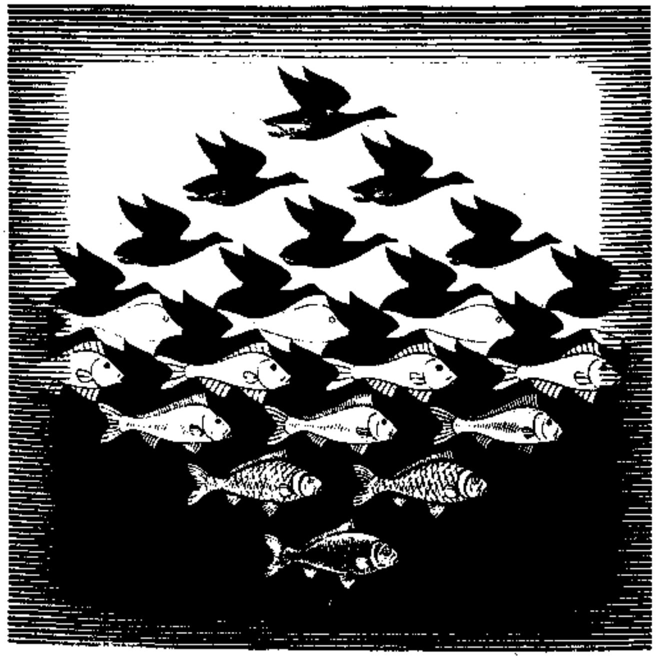
One of the first video art works was "Anti-Gravity Video." This particular piece consists of twenty TV sets hung face down from the ceiling. In order to view the show the viewer has to lie down—that is if he wants to see all the fish swimming across the screens. Such experimentation is not only playful fun, it marks the cutting of a new multifaceted diamond. Video art is here.

The flying-fish artwork is the creation of the foremost video artist, Nam June Paik. Paik is one of the first to venture forth into the new image-making process, and his views carry a lot of weight. In an interview in the recent Winter issue of Video he comments, "Home computers and synthesizers are an imaginative use of the TV screen. After Gutenberg invented the printing machine, he printed the Bible. Now that we have home video equipment, we have to create a purpose for it."

Some of the best works of computer art are destined to be done by computer hobbyists, "just for the fun and art of it." Wouldn't it be fun to take a Rube Goldberg cartoon and animate it. You would actually get to see A push B, and the rats running in the cages, and the ball rolling down the platform to . . . This project hasn't been tackled yet. True, there are obstacles in the way of accomplishing video art, but part of the fun of being a computer hobbyist has to be in overcoming obstacles.

One of the things blocking the way to computer art is that it requires a lot of memory. If you want really complex images you will have to have memory—4K makes a good start. Good things have been done with only 256 bytes, however. Paul Moews has shown in his booklet on graphics that there are infinite kaleidoscopic images and billboard images to be made. One thing you don't have to worry about in computer arts is the plunking down of a lot of money for canvas, paint and brushes.

And you sure don't have to worry about drawing a straight line any more. Or circle, ellipse or polygon. Just plot it out on graph paper and it will magically and perfectly appear on the TV screen, when fed into your willing COSMAC. Another interesting way to accomplish the task is to plot a function. An example of this ingenious technique is given by Michael Tyborski in **PATTERNS** on page 9 of this QUESTDATA. Today, the prophecy of the matchbook cover is at last true, "Even you can become an artist."



Sky and Water I, **woodcut by M. C. Escher**

So you are an artist. What are you going to do with your new found talents? You are freed of the handicap of not being able to draw a straight line, but you will soon discover that the techniques and details an artist must pay attention to are as demanding as the art of programming. Perhaps you always suspected they don't just dash out Disney cartoons. Planning, strategy and above all, patience are required in an artist.

There are many kinds of art begging to come to life on the TV screen. M. C. Escher makes a good starting point. The **Sky and Water I** woodcut is compelling. The images of bird and fish could blend into all kinds of new patterns if actually flying and swimming. What would happen if the school of fish switched directions? What kind of pattern will the birds make when they flap their wings? Perhaps this woodcut might lend itself to animated Moiré patterns. Note: Moiré patterns are a really interesting special effect which occurs when many thin lines are brought close together—the eye gets all caught up in them. If, even as stills, Escher's work can show the depth and fabric of life, think what they can do when given animation.

Recomended reading for M. C. Escher insight is *The Magic Mirror of M. C. Escher* by Bruno Ernst. Escher's art explores mathematical themes, such as Moebius strip and other concepts. About Escher's image experimentation, Ernst says, "To see an Escher print is to discover the infinite possibilities of the human imagination."

Escher's work, with its almost mathematical relationships, makes particularly fine material for video experimentation. Salvador Dali, and others, have produced artwork which might make an interesting starting point in this new art form. What if the limp Dali clocks were to actually tell time?

Experimentation and patience are definitely necessary in order to come up with new and interesting video images. We are playing with tomorrow's technology and the price of our graphics is measured in time and effort. Sure, there are easier ways already available for getting your graphics into a computer than plotting functions and using graph paper for memory mapping, but such methods are costly.

Metacolor Systems (855 Samsome St., San Francisco) rents time on its computer graphics system at $150 an hour. What you can do, if you live in the vicinity of their studio, is take them a black-and-white or color photo or slide, even a 35mm film or videotape of the subject you wish to have the computer reshape. Once a video camera has digitized the picture it can then be made to overlap itself, turn in any direction, and do other interesting tricks. The new image can expand or diminish, or blur to give the illusion of depth. You have, no doubt, noticed that the MOVIE OF THE WEEK on ABC uses overlapping, expanding, and wonderous graphics.

Television networks are using more and more computer generated logos and attention getters. It is a good bet that you will shortly see these computer effects on TV commercials. Computer renderings also have interesting possibilities for the printed page when they are made into photographs.

Genigraphics, a division of General Electric, offers a higher resolution computer graphics system. This system is not as popular with the graphics consumer. Why? Because an image must be mathematicallly described to the computer, and this, of course, means a lot of time spent by a "computer image specialist." This new video image mainipulator no doubt commands a tidy sum for this work.

Enough examples for a moment, the point is that there are computers out in the real world doing interesting graphics, but we are not a part of this computer action. Must we stand on the sidelines and watch the real action? Are our machines that different from the expensive corporate computers? This is a question which you should decide for yourself. QUESTDATA would like to see reader inputs of interesting software that will make image manipulation possible for COSMACians. Perhaps we can achieve blurring effects by exposing part of the TV image for more or less time than other parts? Interesting effects can be achieved by switching images (areas mapped in memory) at a fast rate.

What kinds of software does it take to rotate and diminish an object at the same instant? QUESTDATA is grateful to its authors who have been generous enough to share their knowledge with others. There is so much to be done in computer graphics that it is difficult to pick a starting point. One interesting, and probably difficult software area, is the shaping and trueing of images made with a light pen. Could a light pen image of a circle be drawn rough and trued up in software? Could a triangle be made true and then blurred and rotated? Knowledge in these areas, gained through persistence and hard work, just might have commercial value to some graphics studio. We hope you choose to share such knowledge with fellow COSMAC hobbyists.

Interesting graphics ideas abound in the new scanachrome technique. Imagine taking a computerized airbrush with the three primary colors linked to N-line COSMAC control. By scanning the airbrush in a pattern similar to the TV electron beam sweep, you could create interesting paintings. Is there some way we might make fantastic 14 foot murals like the 3M people who use this new system commercially? Drive your van right up and let me paint a memory mapped Star Wars scene on it, the 3M people might say some day very soon.

The Center for Professional Advancement (P.O. Box H, East Brunswick, New Jersey 08816) will be giving a three day intensive course for those interested in computer aided mechanical design and drafting. The cost of the course for, "technical personnel working with, or interested in, mechanical design, drafting, and engineering graphics, including 2D and 3D graphics design, drawing and documentation," is $450. This course is to be given in East Brunswick, New Jersey, on March 26-28. The course is primarily concerned with plotters and other equipment which is outside the budget of computer hobbyists. Is it possible to produce an X-Y type plotter, a pen mechanism that can be motorized along two coordinates, for less than $1,500? If so, QUESTDATA would like to hear about your homebrew system.

The Institute of Electrical and Electronics Engineers will be sponsoring a tutorial on Computer Graphics along with other sessions of interest to computer personnel. Student rates for tutorials are $25, member rates $50, and non-member rates $65. Quoting from the literature on the session for graphics, "This tutorial is an introductory course in computer graphics. It will address fundamental issues in hardware and software, with an emphasis on decision-making in the acquisition, implementation, and use of these systems. Topics will include hardware for plotters, line-drawing

CRTs, master video, and input devices; software for communications, display primitives, transformations, clipping, perspectives, data structures, and hidden-line/hidden-surface removal. Also discussed will be commercial and turn-key systems, and graphics standards. Examples will be given of applications in engineering, research, education, and the film making business." Compcon 79 will be held in San Francisco on February 26-March 1. If you cannot attend the sessions, digests of the material will be made available. More Compcon information is available from: IEEE Computer Society, 5855 Naples Plaza, Suite 301, Long Beach, CA 90803.

Here are some words on electronic media from Alan Watts, a man perhaps best remembered for his interpretations of Zen Buddhist philosophy. He wrote the following as the forward to a catalogue for an exhibition of electronic art organized by Oliver Andrews, Professor of Sculpture at the University of California, Los Angeles:

"By reason of electronics and automation we are moving—to the consternation of the Protestant conscience—into an age when there will hardly be any distinction between work and play. Mankind has to face the moral shock of realizing that masochistic work will be obsolete, for the slaves will no longer be people but machines, watched and tended by swinging and fascinated engineers. Art will therefore cease to be a propaganda calling attention to misery. It will use all the facilities of electronic technology to create and exuberant splendor which has not been seen since the days of Persian miniatures and arabesques, medieval stained glass, the illuminated manuscripts of the Celts, the enamels of Limoges, and the jewelry of Cellini."

"The wheel extends the foot. Brush, chisel, hammer, and saw extend the hand. But electric circuitry extends the brain itself as an externalization of the nervous system, and will therefore perform wonders of art (that is, of playful patterns of energy) which have not heretofore been seen."

BAY AREA COSMAC GROUP

A group of COSMAC users is now forming in the San Francisco Bay Area. The person to contact if you live in the Bay Area is Eugene E. Jackson, 3637 Snell Avenue, Sp. 385, San Jose, CA 95136. Eugene's phone number is (408) 224-0837. Eugene has an abiding interest in hardware, and is also the author of "Elf Talk" in QUESTDATA No. 5. He would like to get as many people together as possible to talk about hardware, software and schedule guest speakers. If you live in the Bay Area, he would very much like to have you write or call him.

1K GRAPHICS

By Alan Wallace

This program allows you to display 1K bytes of memory on an expanded memory COSMAC system for more detailed graphics. If the byte at location 001F is 01, the program itself will not appear on the screen. With the display program off the screen, you can produce and manipulate pure graphics in a 64 x 128 display using the RCA 1861 graphics chip.

The monitor in my system is located at F0 00 and the display program allows jumping to the monitor with C0 F0 00. The monitor listing given in *Popular Electronics* March 1978 put me onto the PROM monitor with tape I/O. I continued to use the transistor amplifier approach to taping until I relaized how easily it spoiled tapes. When I switched to the OP AMP method, I was able to record programs more quickly and accurately. Have fun exploring the 1K display capabilities of your extended memory Elf.

```
LOC.  OP CODE/DATA        COMMENTS
0000   30 03 C4           Can be used to jump to monitor
  03   90 B1 B2 B3 B4     Initialize registers
  08   F8 26 A3           R3.0=(MAIN)
  0B   F8 00 B2           R2=(STACK)
  0E   F8 3F A2
  11   F8 18 A1           R1.0=Interrupt
  14   D3                 SEP 3
  15   72 70     INTRET:  Restore D, X and P
  17   C4 22 78     INT:  Entry Point, Stack
  1A   22 52              Manipulation
  1C   E2 E2              NOP for timing
  1E   F8 00 B0           Can use F8 01 B0 if you
  21   F8 00 A0           wish display routine off screen
  24   30 15              Branch INTRET
  26   E2 69              X=2; turn TV on
  28   3F 28              Wait for INPUT
  2A   37 2A              to be depressed
  2C   6C B4              Input data to R4.1
  2E   3F 2E              Wait for INPUT
  30   37 30              to be depressed
  32   6C A4              Input goes to R4.0
  34   3F 34              Wait for INPUT
  36   37 36              to be depressed
  38   6C                 Input data
  39   54 14              and store via 4 and INC 4
  3B   30 34              Repeat storage process
  3D   00 00 00           Stack
  40   DISPLAY AREA 1K DISPLAYED
```

WHAT THE MACHINE IS THINKING

Part of the power of the 16 x 16 register matrix within the 1802 microprocessing unit (MPU) is its ability to store the addresses of all 65K of memory. In the basic Elf, the need for the upper registers is not readily apparent. In the basic 256 byte COSMAC, the upper protion of the registers make nice temporary holding places for data or timing loops. The timing loop for blinking the Q-LED at a visible rate, refer to QUESTDATA #3, depends upon decrementing all 16 bits of a register. Other methods of long delays, such as cascading registers, are also possible. But it is when you have extended the memory of your Elf past 265 bytes that you begin to see the need for having the registers 0 through F sixteen bits in length. The fact that you can store the numbers 00 00 through FF FF hex in these registers is put to real use when it comes to extended memory relocation.

The process of putting a number in the high portion of Register 1 is similar to placing data in the low part of that Register. To place the hex number 01 in the lower part of Register 1 we write the following code: F8 01 A1. That is, first we place the number in the D-Register, using the load immediate instruction, then we transfer the number to the low part of Register 1 using PLO (Put Low Register 1–A1). A good way to keep the machine code for Putting Low and Putting High seperate in your mind is to consider that A is lower down in the alphabet than B. This relationship similar to Get Low 8N and Get High 9N (where N is any of the 16 registers 0-F). When we want to put the address of something on page 01 of memory (the basic 256 bytes of the COSMAC being page 00), we write F8 01 B1. We then designate the lower portion of memory: F8 00 A1 (Thus Register 1 contains 01 00 and can be used to point to the address where we wish to start loading data).

When we want to move data or program on an extended memory COSMAC, even from one part of page 00 to another part of page 00, it is necessary to put 00 in the high part of the pointer register. There is garbage in the high part of registers, just as there is garbage (unwanted numbers) in the memory of your microcomputer when it is first turned on. There are certain registers which are automatically reset to zero upon pressing RESET and RUN. They are: I, N, X, P, Q (the one bit latch), and R(0)–this is why the program starts execution at 00 00 (upon startup the Program Counter is automatically Register 0).

If you wish to write a program on page 00 and move it to another page of memory (page 04 is used in the example) the extended memory mover below can be used. You could use this mover to change just part of a program written on a high page of memory. It is not necessary to change the locations after the 3X branch instructions when you move things to a different page of memory. This is because the 30 instructions are Short Jumps or jumps within the same page. This page relative feature is fine, as long as you remember to change long jumps or use coding tricks for making your long jumps relative jumps. One way to accomplish complete relativity of location, hence easily relocated programs, is by using a Pseudo Program Counter–a technique described in the RCA User Manual for the CDP1802 (MPM-201). Any program you write after location 19 and through 00 FF, as in this example, will run perfectly on the page to which it is transferred. To begin a program which has been moved to a new page, you can use the long jump C0 04 1A (the example relocates to page 04 1A but can be used to relocate anywhere in 65K).

LOC.	CODE	MNEM.	COMMENTS
0000	F8	LDI	
0001	04 ←		HIGH move to start
0002	B1	PHI1	
0003	F8	LDI	
0004	1A ←		LOW move to start
0005	A1	PLO1	
0006	F8	LDI	
0007	00 ←		HIGH from address
0008	B2	PHI2	
0009	F8	LDI	
000A	1A ←		LOW from address
000B	A2	PLO2	
000C	42	LDA2	This part loads and
000D	51	STR5	deposits data in new
000E	11	INC1	loc. and inc. pointer
000F	91	GHI1	Puts R1.1 into D for
0010	FB	XRI	compare with STOP loc.
0011	04 ←		HIGH ending STOP loc.
0012	3A	BNZ	loop until 04; then cont.
0013	0C		
0014	81	GLO1	Puts R1.0 into D for
0015	FB	XRI	compare with STOP loc.
0016	FF ←		LOW ending STOP loc.
0017	3A	BNZ	loop until FF; then HLT
0018	0C		
0019	00	IDL	HALT

Next month it is back to the basic 256 byte Elf for some more experinents. The logic instructions and ways to manipulate them to make them do what you want them to do, will be our topic. Should be fun and interesting.

DIRECT DECIMAL WITH THE 1802

By F. L. Oats

There are bascially two ways in which decimal numbers may be treated in a microprocessor-based system. One widely used scheme is to convert input binary coded decimal to hex, treat the hex number internally, then convert the hex back to binary coded decimal for output. This method is usually restricted to low precision numbers (eight significant decimal digits or less) and gets very awkward when dealing with high precision or variable precision applications.

The other method bypasses the code conversion to and from hex, and pretty well keeps the numbers in decimal all the way through the calculation. This generally requires less command code, and puts high precision within the reach of everybody. In spite of the fact that the 1802 has no special flags or commands for handling decimal numbers, it is still possible and practical to work direct decimal with the 1802. We will now see how.

In order to work this scheme, decimal numbers must be represented in memory as shown in Figure 1. Each digit will occupy an entire byte of memory with the digit itself contained in the lower four bits (least significant), and a zero in the upper four bits (most significant). This representation has a fringe benefit when using ASCII code for input/output–it eliminates the digit pack and unpack operations required for two-digits-per byte environments.

The program presented here works with fifteen significant decimal digits, and has an extra byte reserved for sign, overflow and decomp purposes. Figure 2 shows an entire decimal quantity, or operand, as it would appear in memory. The addresses, hex 10 thru hex 1F, correspond to operand A on line 1 of Figure 3. The byte labelled 03 on line 1 of Figure 3, for example, would reside in memory address 001D. Note that the least significant digit resides in the highest memory address of the quantity. Later, we will see how to increase or decrease the number of significant digits (it's easy).

To work the direct decimal add and multiply operations, we will employ a two phase correction technique as shown in Figure 3. Phase I will be applied to one of the operands, and consists of adding hex F6 to each digit of the affected operand. In figure 3, line 1 shows the decimal number 1369 as it would appear in memory, line 2 shows phase I being applied to the number, and line 3 shows the result of phase I. Line 4 shows the number 2349 in memory as the second operand, and line 5 shows the result of adding lines 3 and 4 together in internal (hex) code.

Line 5 is obviously not ready to be output at this point, but we can salvage this number by applying phase II. Phase II looks for a carry out of the digit being treated into the next significant digit. If the carry takes place, it says that the digit does not need further correction and stores the digit, unaltered, into the answer. The carry is then propagated to the next column. If the carry does not take place, it says that the number is bad and needs phase II correction–hex F6 is subtracted from the digit and the result is placed in the answer. Carry to the next significant digit is inhibited.

The machine language code for the add algorithm is presented in Table I. Operand A is assigned memory locations 0010 thru 001F, operand B is assigned 0020 thru 002F, and the result goes into 0030 thru 003F. They are placed near the beginning of memory for the sake of those who do not have monitors or operating systems. The program will first perform phase I correction to the entire operand A – all fifteen – before operand B is ever examined. This finishes up lines 1 and 2, figure 3, and puts us on line 3 with all fifteen digits as shown in the figure. Now we work with LSD first, taking the FF on line 3, adding it to the 09 on line 4, and getting the 08 with a carry out on line 5. We now examine the carry out, find that there is in fact a carry out, and put the 08 in our answer without phase II correction. We now take this carry and add it to the next digit on line 3 (the hex FC) plus the corresponding digit on line 4 (the 04) and we get an 01 with a carry out. Line 3 thru 7 are performed on each digit before proceeding to the next digit.

Each digit will occupy an entire byte of memory with the digit itself contained in the lower four bits (least significant), and a zero in the upper four bits (most significant).

The subtract algorithm, believe it or not, is actually simpler than the add because phase I is not required. Figure 4 shows the general flow of a subtract operation. Here again, the absence of a carry out invokes phase II correction and causes a borrow from the next position by inhibiting carry out.

When we reach the F9 on line 3, we add that to the 03 on line 4 (along with a carry from the previous position) and get an FD with no carry out. The absence of a carry out invokes phase II correction and hex F6 is subtracted from the FD, and we store the result, 07, in the answer. We also suppress carry into the next position.

After processing an entire decimal quantity, we need to look at DF one last time. If it is set after an add operation it indicates that an overflow has occurred and appropriate action should be taken. If it is RESET after a subtract, it indicates that the answer is in complimentary form (the answer is negative) and must be decomplimented. One way to decompliment or decomp, as it is often called, is to force a 01 into that extra byte on the most significant end, clear out (00) the other 15 bytes, and subtract the bad answer from this quantity. In other words, place 01 in memory address 0010 and 00 in address 0011 thru 001F. Move the bad answer to operand B memory area and perform another subtract. There is an easier way which I will leave to the reader to discover.

Looking at the program listing in Table 1, addresses 0000 thru 000C are used to point R8 to operand A, R9 to operand B and RA to the answer. Address 0040 and address 004F place a hex 0F in RB, used to define the number of significant decimal digits we are working with. By allocating more memory per operand, and changing the number loaded into RB (and re-locating some code), we can work with practically any number of decimal digits. (Didn't I say it was easy?)

In Table II, the subtract program is shown starting at memory location 0044. The addresses 0000 thru 0043 are exactly the same as the add program (and MUST be loaded). Notice that in the subtract program, RB is loaded only once—at address 0040—so to change the number of digits per operand you need only change addresses 0041 from hex 0F to hex ever-how-many-places-you-want.

Each program will turn on the Q-LED when finished. This should tip you off to any catastrophic load errors you might encounter. The Q-LED should come on instantly with these programs and if it doesn't, check your program code.

It is beyond the scope of this presentation to go into multiplication and division of decimal numbers. They are, of course, performed by repeated addition and subtraction as presented here. If you are still with us, you can no doubt add your own racing stripes to the programs. However, before you start figuring up the time required for that multiply operation, let me point out that phase I need be applied only once for the entire multiply. Once the operand is pre-corrected, it should remain that way throughout the calculation. (Don't let your stack pointer get ahold of it).

Hopefully, you now have at least some vague idea of how to work direct decimal with the 1802. If you are into high precision stuff, maybe you can utilize some of these concepts in your application. Have fun with it.

MUSICAL KEYBOARD

Kirk D. Bailey

This musical keyboard program demonstrates the use of masks, logic operation, and data tables. It turns an Elf into an organ, and with a minor modification, gives true organ function. The data lookup table contains the data necessary for the cycle duration loop, and simplifies the use of the machine. The Q-line is toggled by a four-byte sequence which, since it does not use addressed branches, can be used in other locations as it is. The logic sequence is:

STEP 1. LOGICAL AND to clear to 0 the .1 nibble.

STEP 2. ARITHMETIC ADD with 50 to form composite data byte.

The resulting data byte is loaded into the data table pointer (RD) which, as a result of this logic sequence, is pointing at the byte in memory containing the necessary data to generate the tone selected by the keyboard.

The program will wait for FLAG 4 to go to 0V, then generates tones as long as $\overline{EF4}$ is at 0V. This can be replaced by C4's at locations 04 and 05 to get constant tones. On the Super Elf, the keyboard decoder chip (74C923) has a data available chip strobe pin, DA, which is pin number 13 If you run a jumper to P3on the 44 pin or 50 pin busses on the Super Elf, you will have taken care of the tone makers hardware requirements. Changing addresses 04 from 3F to 36, in the program, you will get tones when the keyboard is depressed, and only then. You may want to change the size of R13 (47K in the Super Elf) to a larger size, if necessary. Good luck and 73's.

LOC.	CODE	MNEM.	COMMENTS
0000	E2	SEX	Set X=2
01	F8 FF	LDI	Pointer to loc. FF
03	A2	PLO2	Pointer in R2.0
04	3F (36)	See text use 36 or Br. EF3 with	
05	04	hardware modification only	
06	6C	IMP 4	Imput from Bus
07	FA 0F	ANI	Logical And to clear
09	FC 50	ADI	ADD to form composite
0B	AD	PLOD	Resulting byte to RD.0
0C	0D	LDND	Get data from table
0D	FF 01	SMI	Tone delay
0F	3A 0D	BNZ	Br. back if delay not up
11	CD	LSQ	Long skip if Q=1
12	7B	SEQ	Set Q=1
13	38	SKP	Short skip
14	7A	REQ	Turn off Q
15	30 04	BR	GOTO 04 (get new tone)

TABLE OF TONE DATA

0050	84 77 6A 64 59 4E 45 40 39
0059	33 2F 29 25 20 1E 1A (last data in loc. 5F)

(Please turn to page 11 for a birds eye view of the p outs of the MM74C922 IC chip.)

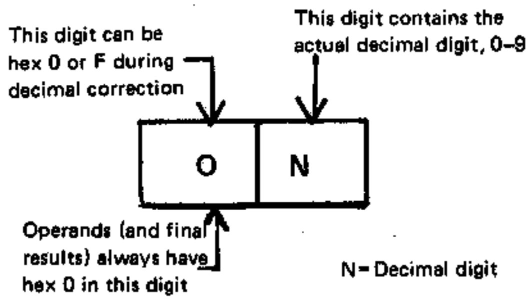


FIGURE 1. Representation of decimal numbers in memory. A single digit occupies an entire byte of memory.

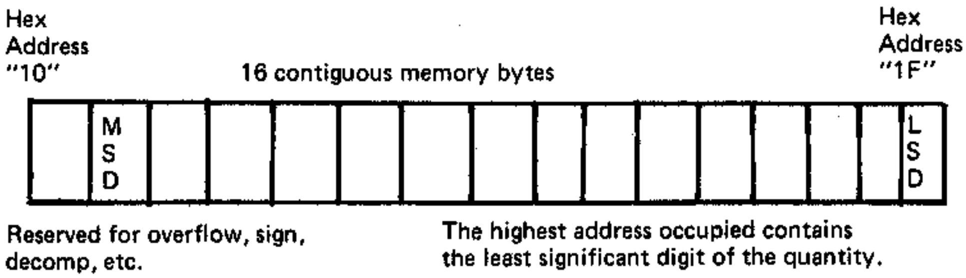


FIGURE 2. A single operand occupies 16 bytes of contiguous memory space, and can have 15 significant digits. This size is easily changed (see text).

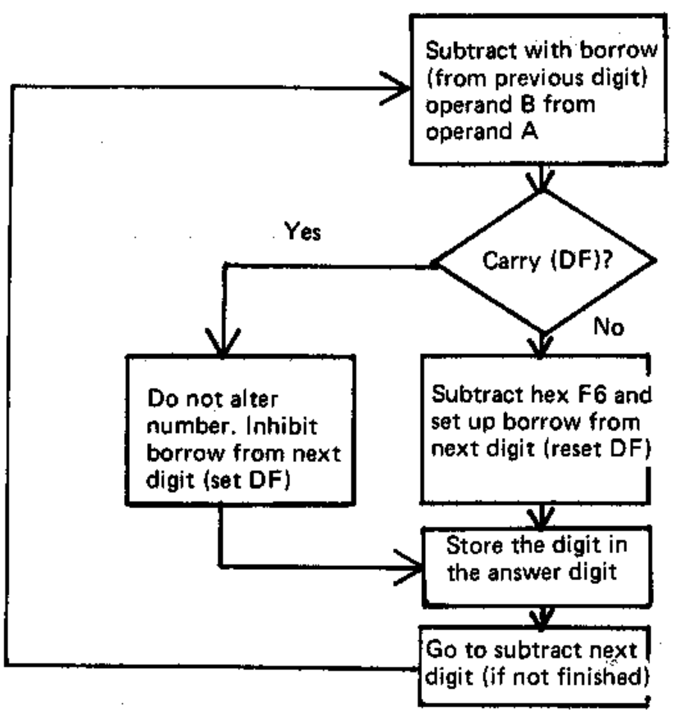


FIGURE 4. General subtract flow.

DIRECT DECIMAL ADD TABLE I

Address	Code	Action
0000	90B8B9BA	Clear R8.1, R9.1, RA.1
0004	F81FA8	Hex 1F to R8.0
0007	F82FA9	Hex 2F to R9.0
000A	F83FAA	Hex 3F to RA.0
000D	3040C4	Branch around operands
0010 thru 003F	RESERVED FOR OPERANDS (ANSWER APPEARS HERE)	
0040	F80FAB	Hex 0F to RB.0
0043	E8	Set X=8
0044	F8F6	Hex F6 to D
0046	F473	D plus M(R8) to M(R8), R8 minus 1
0048	2B8B	Decrement RB, RB.0 to D
004A	3A44	End of Phase I?
004C	F81FA8	Hex 1F to R8.0
004F	F80FAB	Hex 0F to RB.0
0052	0974	M(R9) plus M(R8) to D
0054	335A	Carry (DF)?
0056	FFF6	D minus hex F6
0058	FC00	Reset DF
005A	5A	Store result in M(RA)
005B	2B8B	Decrement RB, RB.0 to D
005D	28292A	Decrement R8, R9, RA
0060	3A52	Finished?
0062	7B00	Set Q, Stop

DIRECT DECIMAL SUBTRACT TABLE II

0044	FF01	Set DF
0046	0975	M(R8) minus M(R9) to D
0048	334E	DF?
004A	FFF6	D minus hex F6
004C	FC00	Reset DF
004E	5A	Result to M(RA)
004F	28292A	Decrement R8, R9, RA
0052	2B8B	Decrement RB, RB.0 to D
0054	3A46	Finished?
0056	7B00	Set Q, Stop

	MSD															LSD	
OPERAND A	00	00	00	00	00	00	00	00	00	00	00	00	01	03	06	09	Operand A = 1369 Operand B = 2349
PHASE I	Add hex F6 to each digit of operand A																Sum = 3718
MODIFIED OPERAND A	00	F6	F6	F6	F6	F6	F6	F6	F6	F6	F6	F6	F7	F9	FC	FF	
OPERAND B	00	00	00	00	00	00	00	00	00	00	00	00	02	03	04	09	

Represents propagated carry

INTERMEDIATE RESULT MODIFIED OPERAND A + B																
	00	F6	F6	F6	F6	F6	F6	F6	F6	F6	F6	F6	F9	FD	01	08

PHASE II

DECIMAL ANSWER	00	00	00	00	00	00	00	00	00	00	00	00	03	07	01	08

FIGURE 3. Direct decimal add.

PATTERNS

Michael Tyborski

Here is a graphics program that I wrote for the COSMAC Elf. I hope that the readers of QUESTDATA find it as intriguing as I have.

This program uses the CDP 1861 video IC to plot various semi-animated patterns on a video monitor or TV with RF modulator. Interestingly, these images can become quite complex, depending upon the special mathematical equation used to define new points. As written, they will be circular in nature.

PATTERNS requires a minimum of 1¼K RAM for successful execution. This program should be partitioned with the program in page 00 and the display refresh buffer on a page boundary. These requirements are a result of various steps taken to minimize the programs length.

PATTERNS is extremely easy to use. Simply load and run the program, after connecting the computer to a video monitor. The direct video method is preferable as a better display will be obtained. The results will amaze almost anyone.

Many more patterns may be created by writing different point subroutines based upon new equations. As an incentive, ten additional equations are included. If you choose to use them, please note that upon entry, the data pointer (R6) is pointing to 'X' and that the stack or R2 should be used for storing intermediate results.

In addition, interested users may also desire to experiment with the display update speed or density. Simply change the value of the delay count at M(0086) to whatever is desired. This also holds true for the point counter at M(0045).

BIBLIOGRAPHY

Anderson, D. John, *Serendipitous Circles*, **Byte, II** (August 1977)

Kellerman, Eduardo, *Serendipitous Circles Explored*, **Byte, III** (April 1978)

PLOTTING EQUATION USED IN *PATTERNS*

ADDRESS = A0+X/8+Y • 8
BIT POSITION = X • 7
WHERE A0 IS THE START ADDRESS

ADDITIONAL PATTERN EQUATIONS

1. X:=X+1
   Y:=Y+X
2. X:=X-(Y/3)
   Y:=Y+(X/1.5)
3. X:=X-(2 • Y)
   Y:=Y+(X/1.1)
4. X:=X-(Y/2)
   Y:=Y+(X/4)
5. X:=X-Y
   Y:=Y+(X/2)
6. X:=X-(2XY)
   Y:=Y+(X/3)
7. X:=X-(2 • Y)
   Y:=Y+(2 • X)
8. X:=X-(Y/8)
   Y:=Y-(X/8)
9. X:= X+(Y/2)
   Y:=Y-(X/2)
10. X_{OLD}=X
    X:=X-(Y/2)
    Y:=Y+(X_{OLD}/2)

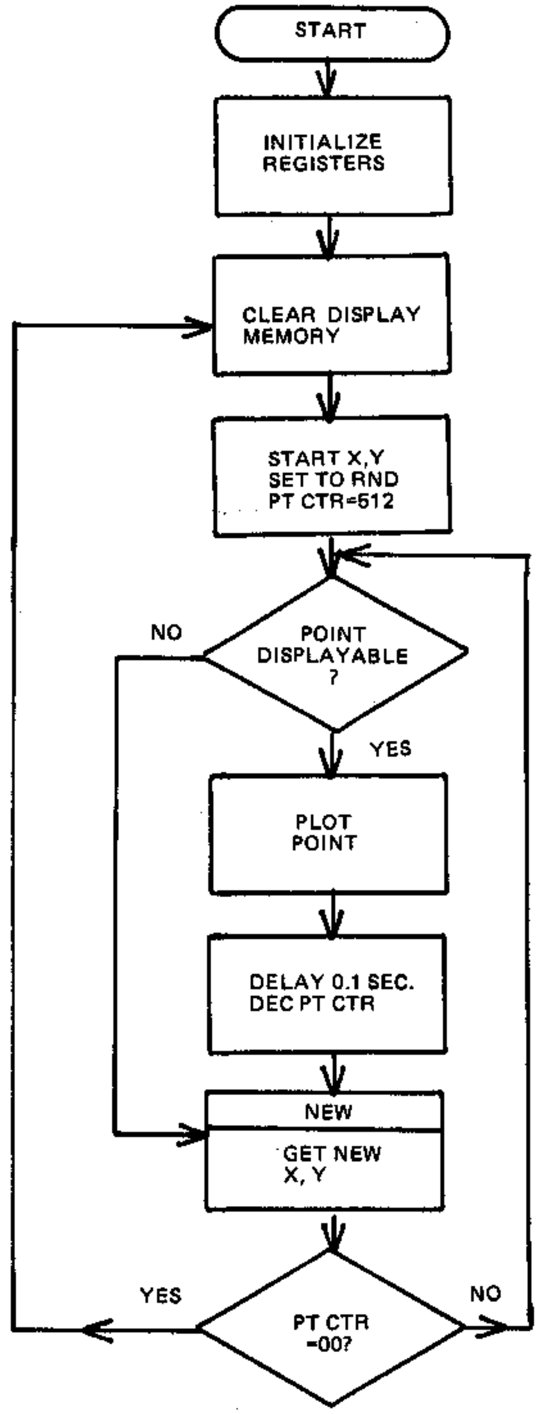


Figure 1. MAIN PROGRAM ALGORITHM

REGISTER	APPLICATION
0	Refresh Pointer
1	Interrupt Routine
2	Stack Pointer
3	Main Program Counter
4	Random Number Subroutine
5	New Point Calculation Routine
6	Data Pointer
7	Point Counter
8	Point Address
9	Utility

TABLE 1: REGISTER ALLOCATION DATA

```
LOC.  CODE            MNEM.      COMMENT
0000  90              GHI R0     Initialize registers
0001  81              PHI R1
0002  82              PHI R2
0003  B3              PHI R3
0004  B4              PHI R4
0005  B5              PHI R5
0006  B6              PHI R6
0007  F8 19           LDI        Interrupt routine
0009  A1              PLO R1
000A  F8 FF           LDI        Stack pointer
000C  A2              PLO R2
000D  F8 28           LDI        Main
000F  A3              PLO R3
0010  F8 95           LDI        Random number subroutine
0012  A4              PLO R4
0013  F8 A8           LDI        New Point Subroutine
0015  A5              PLO R5
0016  D3              SEP R3     Go to Main
0017  72     INTRET:  LDXA       Return to main
0018  70              RET
0019  [redacted] C4  INT: NOP    4 Block display format
001A  22              DEC R2
001B  78              SAVE
001C  22              DEC R2
001D  52              STR R2
001E  E2 E2           SEX R2; SEX R2
0020  F8 04           LDI 04H    Display block
0022  B0              PHI R0
0023  F8 00           LDI 00H
0025  A0              PLO R0
0026  30 17           BR INTRET
0028  F8 04 START:    LDI 04H    Clear display memory
002A  B9              PHI R9
002B  93              GHI R3
002C  A9              PLO R9
002D  93       LOOP:  GHI R3     Zero a byte
002E  59              STR R9
002F  19              INC R9     Done with blocks?
0030  99              GHI R9
0031  FB 08           XRI 08H
0033  3A 2D           BNZ LOOP; no
0035  E6              SEX R6     Activate video IC
0036  [redacted] F8 FE  INP 9
0037  [redacted] A6   LDI Y      Set X, Y to random
0039  [redacted] 69   PLO R6     Initial values
003A  D4              SEP R4     Call RND
003B  FC 0B           ADI 0BH
003D  FA 7F           ANI 7FH    Get Y in display range
003F  73              STXD
0040  D4              SEP R4     Get random X
0041  FA 3F           ANI 3FH
0043  56              STR R6
```

```
LOC.  CODE            MNEM.      COMMENT
0044  F8 02           LDI 02H    Set point counter 0200..
0046  B7              PHI R7
0047  F8 04  PLOT:    LDI 04H    Set R9 to starting
0049  A9              PLO R9     Block of display
004A  F8 ED           LDI X      Is X out of range?
004C  A6              PLO R6
004D  F0              LDX
004E  FF 41           SDI 41H
0050  33 8D           BPZ NPOINT; yes
0052  72              LDXA       Compute X/8
0053  F6 F6 F6        SHR; SHR; SHR
0056  52              STR R2; Save in stack
0057  F0              LDX        Is Y out of range?
0058  FF 81           SDI 81H
005A  33 8D           BPZ NPOINT; yes
005C  F0              LDX        Compute Y • X
005D  FE              SHL        Times 2
005C  3B 61           BNF TIME4; Overflow?
0060  19              INC R9     Yes
0061  FE     TIME4:   SHL        Times 4
0062  3B 65           BNF TIME 8; Overflow?
0064  19              INC R9     Yes
0065  FE     TIME8:   SHL        Times 8
0066  3B 69           BNF ADD; Overflow now?
0068  19              INC R9     Yes
0069  E2       ADD:   SEX R2     Add X/8+Y•8
006A  F4              ADD
006B  3B 6E           BNF NC     Any carry
006D  19              INC R9     Yes
006E  A8        NC:   PLO R8     Set R8 to point addr.
006F  89              GLO R9
0070  B8              PHI R8
0071  F8 80           LDI 80H    Set bit position
0073  52              STR R2
0074  26              DEC R6     Compute X • 7 and
0075  06              LDN R6     put in counter R9
0076  FA 07           ANI 07H
0078  A9              PLO R9
0079  32 82           BZ DISP
007B  F0       BIT:   LDX        Shift 80H required
007C  F6              SHR        Number of times
007D  52              STR R2
007E  29              DEC R9     Done?
007F  89              GLO R9
0080  3A 7B           BNZ BIT; no
0082  08       DISP   LDN R8     Activate desired bit
0083  F1 ~ F3         OR
0084  58              STR R8
0085  F8 02           LDI 02H    Delay
0087  B9              PHI R9
0088  29       DLY:   DEC R9
0089  99              GHI R9     Time up?
008A  3A 88           BNZ DLY; no
```

```
008C  27             DEC R7    Decrement point counter
008D  E6   NPOINT:   SEX R6    Restore X to R6
008E  D5             SEP R5    Calculate new X, Y
008F  97             GHI R7    Required points plotted
0090  3A 47          BNZ PLOT; no
0092  30 28— 35      BR START; Begin again
* * * * RANDOM NUMBER SUBROUTINE * * * *
0094  D3     EXITRSEP R3       Return
0095  86      RND:   GLO R6    Save data pointer
0096  52             STR R2
0097  F8 EF          LDI rndnum; compute 5 times
0099  A6             PLO R6    Old random number
009A  F0             LDX
009B  FE FE          SHL; SHL
009D  F4             ADD
009E  FC 02          ADI 02H
00A0  56             STR R6    Set as new rndnum
00A1  A9             PLO R9
00A2  02             LDN R2    Restore data pointer
00A3  A6             PLO R6
00A4  89             Glo R9    Return to Main
00A5  30 94          BR EXITR; with rndnum in D
* * * * NEW POINT CALCULATION SUBROUTINE * * * *
00A7  D3    EXITN:   SEP R3    Return
00A8  16      NEW:   INC R6    Compute Y/2
00A9  06             LDN R6
00AA  F6             SHR
00AB  FB FF          XRI FFH Negate result
00AD  26             DEC R6
00AE  F4             ADD       XNew=X+(-Y/2)
00AF  56             STR R6
00B0  16             INC R6    YNew=Y+XNew/2
00B1  F6             SHR
00B2  F4             ADD
00B3  56             STR R6
00B4  30 A7          BR EXITN
```

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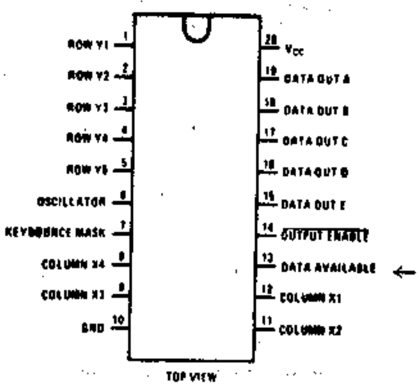
PIN OUTS FOR HARDWARE MODIFICATION (see page 6)

Dual-In-Line Package



TOP VIEW

Order Number MM54C923N or MM74C923N

NOTE: A typographical error on page 6 has been found.
PIN 13 IS THE DATA AVAILABLE.

WARNING: The Super Elf Warranty is voided in the event that the product has been misused, damaged, or modified.

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Publisher . . . . **Quest Electronics**
Editor . . . .**Bill Haslacher**
Technical Coordinator . . . . **Bill Thompson**
Proofreading. . . . . **Ken Brown**

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BYTE BUMPER

By Alexander Petrou

I have a Super Elf and use its I/O device numbers in this program. The purpose of this program is to move all the bytes in a program one location forward to allow the insertion of a new byte. The Q light comes on when the operation is completed.

An example of the steps involved follows:

Your program starts at 00 and ends with 60. You find it necessary to insert a code at location 40. Start the program and enter:

- 00 (high byte) "where process STOPS" is displayed.
- 60 (low byte) "of STOP" is displayed.
- 00 (high byte) "of START of bumping process" is displayed.
- 40 (low byte) "of START" is displayed and Q light comes on.

If you examine memory, bytes 41 thru 61, you will see the contents of what was previously in locations 40 thru 60.

The program takes care of incrementing jump or branch instructions. It does this by detecting 3X. Care must be taken, therefore, to make sure that it does not increment a code following a data code, eg.: If you look at the instructions F8 30 A2 you will find A2 incremented to A3.

The program also looks to see whether the jump or branch location needs to be incremented. For example, if you had an instruction branch to start (30 00), the program will not increment the location code.

I have this program on ROM (1702A) and do a long Branch to the starting address of the program – C0 80 00.

The operation is a handy one to have in your programmer's toolbox.

LOC.	CODE	COMMENTS
00	F8 00 BC	Load high byte R.C
03	BD	and high byte R.D
04	F8 FE AC	Load Low byte R.C
07	F8 FC AD	Load low byte R.D
0A	3F 0A	Wait for INPUT
0C	ED 6C BF	X=D, load R1.F via keyboard
0F	64	Display keyed numbers
10	37 10	Wait for INPUT release
12	3F 12	Wait for INPUT
14	6C AF 64	Load R0.F via keyboard & display
17	37 17	Wait for INPUT release
19	3F 19	Wait for input
1B	EC	Set X to C
1C	6C BE 64	Load R1.E via keyboard & display
1F	37 1F	Wait for INPUT release
21	3F 21	Wait for INPUT
23	6C AE 64	Load R0.E via keyboard & display
26	2C 2C	Bring R.C to first loc.
28	30 40	Br. to subroutine at loc. 40
2A	2F EC	Decrement R.F and set X to C
2C	9F F7	Subtract high byte to and from addr.
2E	32 33	If result= 0 branch to loc. 33
30	2F 30 28	If result≠0 branch to 28
33	1C EC	Inc. R.C and set X to C
35	8F F7	Subtract low byte to and from address
37	32 3D	If result=0 branch to end loc. 3D
39	2F 2C	Dec. R.F and R.C
3B	30 28	and branch back to 28
3D	7B 30 3E	Turn Q on and halt
40	31 4D	Branch if Q is on to loc. 4D
42	4F 5F	Get from mem. pointed by R.F and increment and store in new address
44	FA F0	and mask high byte bits
46	FF 30	Subtract 30 from D
48	3A 2A	If D≠0 branch back to 2A
4A	7B	Turn Q on before
4B	30 2A	Branch back to main program
4D	7A	Q off
4E	1F 1F 1F	Decrement back to br. loc.
51	1C EC	Increment R.C & set X=C
53	0F F7	Subtract br. loc. from low byte 'to' addr.
55	3B 5E	If br. loc. is smaller than 'to' addr. go 5E
57	0F FC 01	If not add 1 to br. loc.
5A	5F 2C 2F	and store back in br. loc.- dec. R.C & R.F
5D	C8	Skip next two instructions
5E	2F 2C	Decrement R.C & R.F
60	30 2A	Br. back to main program

6
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