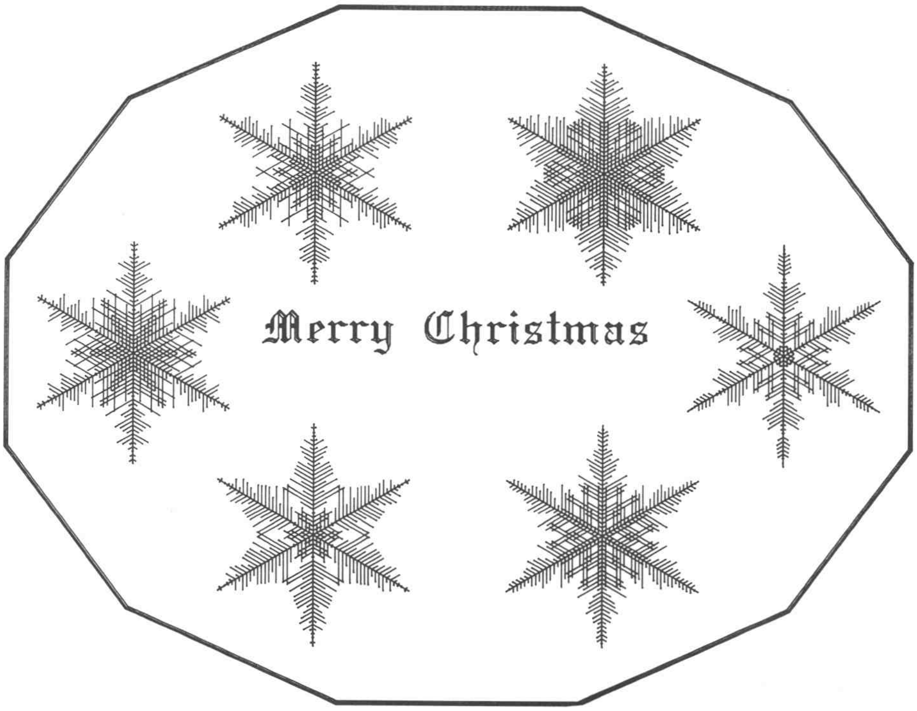
Tekniques

The 4051 Applications Library Newsletter Vol. 1 No. 10



Winning Christmas Card Program by S. Hansen generates snowflakes and old English lettering. See page 7 for contest results and page 10 for the program listing.

4051 Plots Roads in Australia

by E.S. Webber
Sydney, Australia

(At the request of TEKniques, Laurie, Montgomery and Pettit Pty. Ltd., consulting engineers and Tektronix Australia customers, obligingly subitted the following article through Tektronix Australia.)

Our most ambitious graphics effort so far is the perspective plotting of a road. Our client had questioned the sight lines and aesthetics of a section of a country road, straight in plan, where the vertical curves in our design were not continuous. They thought the effect might be a "kink" at the junction of the straights and the curves. The object of plotting the perspective of the road, therefore, was to investigate this possibility, and demonstrate if possible that the sight lines would have a smooth transition.

About two kilometres of road were critical, and cross sections were available every 25 metres. Fourteen points were used to fully define each cross section, including the standard template defining embankment and cutting slopes. Since not all the points appeared on every section, some were doubled up in order to keep the sequence the same. (See Fig. 1.)

In This Issue

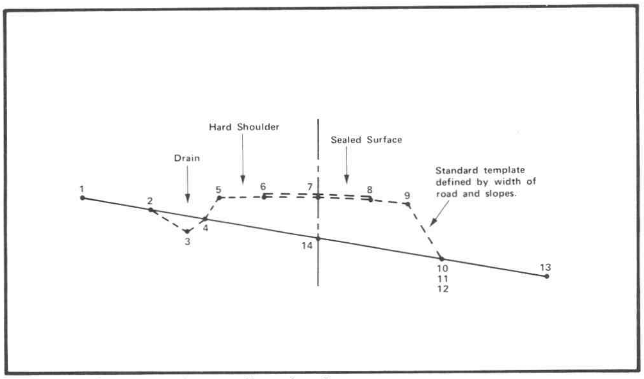


Fig. 1.a. Cross section—all embankment.

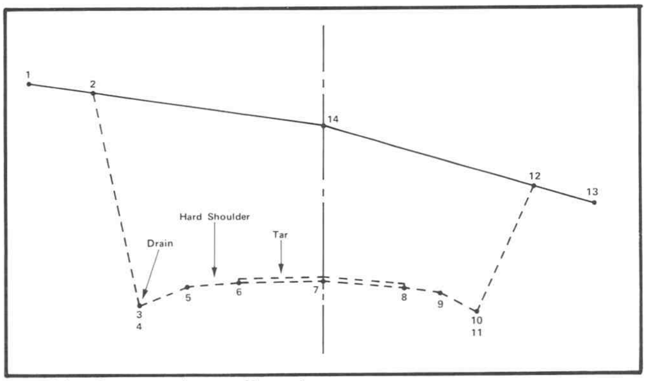


Fig. 1.b. Cross section—all cutting.

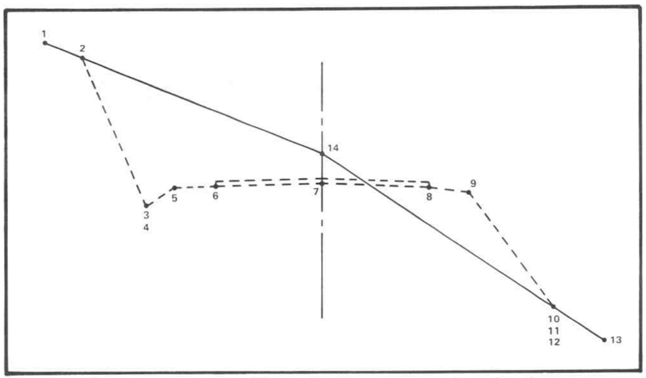


Fig. 1.c. Cross section—half-and-half cutting and embankment.

3D-Data for the perspective plot was generated by an initial program (ROADSECT) which stores the standard cutting and embankment templates. For each cross section, it is then necessary only to enter four elevations:

1. Ground level a standard distance, say 15 metres left of centreline (point 1)
2. Ground level at centreline (point 14)
3. Ground level 15 metres right of centreline (point 13)
4. Road formation level at centreline (point 7)

ROADSECT then checks at each cross section whether the road is all in cutting, all in embankment, or one side in and one side out; and then generates the 2-D data for all the other points, and stores it in a tape file. Sections were at regular intervals, so the Y dimension was not stored. There was no requirement for horizontal curves, road junctions, or other complications, but a little further effort in programming could accommodate these.

The second program is an adaptation of the perspective plotting routine given in the "PLOT 50 Introduction to Graphics Programming in BASIC" manual. The "draws" were set to connect points on consecutive cross sections having the same array number i.e., all point sevens were connected, all point eights, etc. Finally, the cross section was drawn for the end closest to the "camera."

Once the data was prepared by ROADSECT, the ROADPERSPECT program allowed input prompts to select at will:

The number of cross sections plotted

The number of repeat plots, and the distance increment between each repeat

The eye location (3 coordinates)

The perspective centre (3 coordinates)

Forward or backward view along the road.

When the most effective viewpoint etc., had been determined after several screen displays (some recorded on the hard-copy unit), the program was amended to create a plot on a Hewlett Packard 7202 plotter (bought previously, not in preference to the Tektronix plotter) using the Datacom interface. Removal of some hidden lines was achieved by watching the screen display and switching the plotter on and off at appropriate times. (The plotting speed was rather slow: about 10 minutes for each example shown.) Also, the program was modified so that the point-plot feature of the plotter was activated for the road centreline, and 50 m marker posts were drawn on the hard shoulder, each one metre high, thus giving a better feeling of scale (Fig. 3).

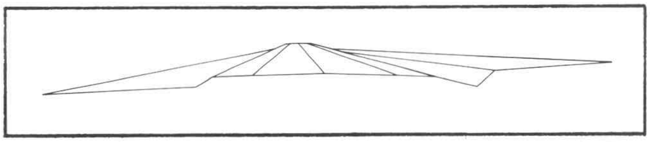


Fig. 2. Simulated view from driver's eye at 1.5 (x), 3395 (y), 892.97 (z) looking to -1.5, 3325 and 391.5.

TEKniques, the 4051 Applications Library Newsletter, is published by the Information Display Group of Tektronix, Inc., Group 451, P.O. Box 500, Beaverton, Oregon 97077. It is distributed to TEKTRONIX 4051 users and members of the 4051 Application Library.

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Volume 1 Number 10.

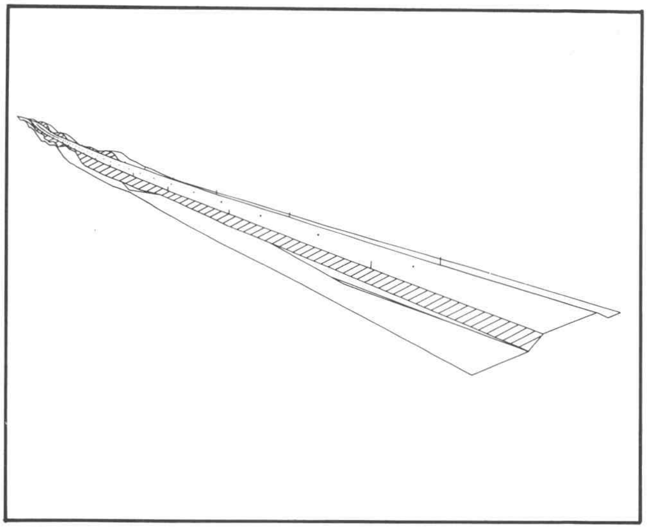


Fig. 3.a. Stereo left view—eye at -30 (x), 4090 (y), 900 (z) metres.

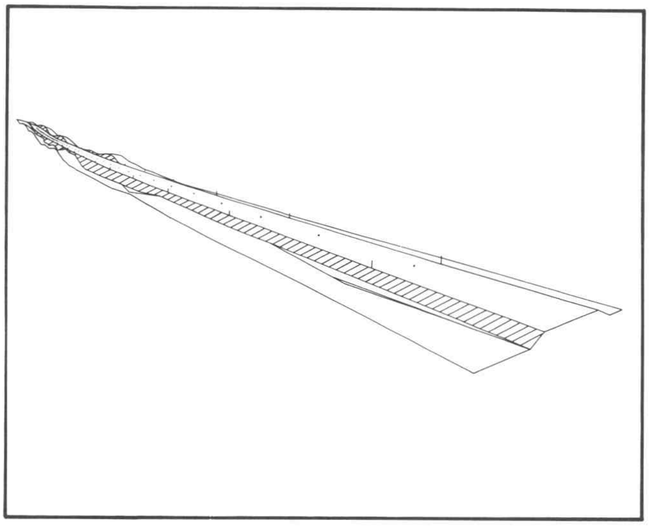


Fig. 3.b. Stereo right view—eye at -29 (x), 4090 (y), 900 (z) metres.

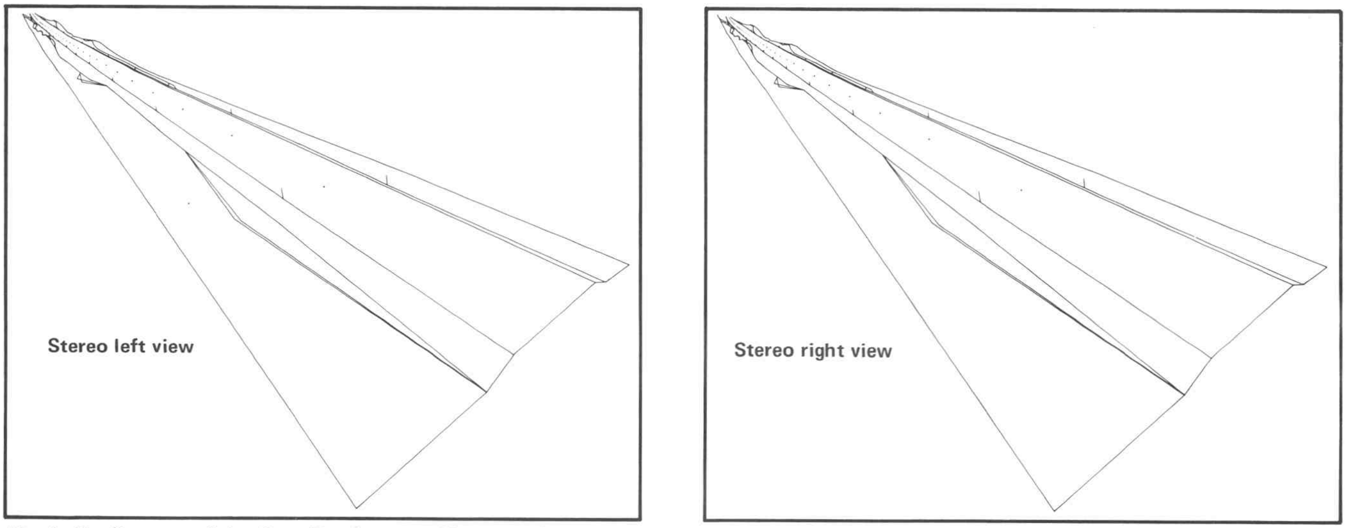


Fig. 4. Goulbourn to Pejar Dam Road—eye at 10 metres above and to left of centreline.

Views were produced from many different viewpoints. Initially, the eyeline of a driver of a car was simulated as he drove down the road in each direction. The results of this were a little disappointing (Fig. 2) because points more than a hundred metres away merged to a single blob on the screen. A much more explicit effect was obtained by moving the eye point (in response to an input prompt) about 10 metres up and 30 m to one side of the road, even though it is unlikely anyone would see the view from such a position.

Finally, stereo pairs were made by means of a 1 metre eyeshift. When viewed through a stereoscope, the landscape popped into view very effectively, with the road superimposed.

Another program developed for the 4051 is RESLAG, a Reservoir Flood Routing Program. This program is capable of routing a flood through a storage area, with the outflow initially controlled by pipe capacity and later by spillway capacity if the water level rises above the spillway crest. Any form of outflow is accepted; variable water surface area is assumed.

The program optionally supports a printer and/or a hardcopy unit. It will output time, infow, outflow, depth, area, and volume, along with maximum depth and outflow. The program will also plot input and output hydrographs.

In its present form, the Road Plotting Program is most useful for straight roads, but can be modified. Both will be upgraded for prospective customers. Both the Road Plotting Programs and the Reservoit Flood Routing Program may be purchased from Laurie, Montgomery, and Pettit Pty, Ltd. Their address is K.M.S. Building, 8-24 Kippax St., Sydney, N.S.W. 2010, Australia.

Computer-Aided Design Contest

Do you have a 4051 program for computer-aided design? Or, have you been thinking about writing one? Well here's contest news for you! Send in any 4051 program for computer-aided design to TEKniques. Your program can be for circuit board design, ship hull design, mechanical parts design, kite design—anything that you'd like to design.

Programs must be submitted on a tape cartridge, and must be accompanied by program documentation and a submittal form and order form for your exchange programs. All programs will be entered into the 4051 Applications Library. Each entry will receive the usual new tape with three programs of your choice, so you can't lose.

The First Prize winner will receive 15 new tapes and 15 programs from the library. The Second Prize winner will receive 10 free tapes and 10 programs from the library. Third prize is 5 tapes and 5 programs.

Deadline for entries is March 31, 1978. Send your entries to: 4051 Applications Library, Tektronix, Inc. Group 451, P.O. Box 500, Beaverton, OR 97077

Survey Provokes Suggestions, Criticism

A form was distributed with TEKniques Vol. 1, No. 6, questioning 4051 Applications Library members about the services of the Library. Over 27% replied; their time and remarks are greatly appreciated.

Of those who replied, 41% rated TEKniques as Very Useful and 59% as Useful. There were no bad marks (Not Useful). The Programming Tips were the favorites, with "How To Do It" articles rating a close second. Following in order of popularity were Applications and Product articles. Abstracts and Software Notices were less popular, but suggestions for improvement were made.

The program library received an even split between Useful and OK. However, 40% of those responding couldn't find programs applicable to their needs, and wrote their own programs. Programs desired by members had engineering leading the field, with the scientific group right behind. Graphics and utility programs (both mentioned often to be in the form of subroutines) followed closely, with business behind them. Also up for consideration were games, interfacing packages, military tactics and tutorial programs.

Some suggestions for improving TEKniques have already been acted upon. Several readers suggested printing articles without breaking their continuity, by continuing each article on an adjacent page. This is now being done. Abstracts received heavy criticism, most of it directed to their briefness. This has been improved with better (and lengthier) descriptions, along with inclusion of the number of statements in the program.

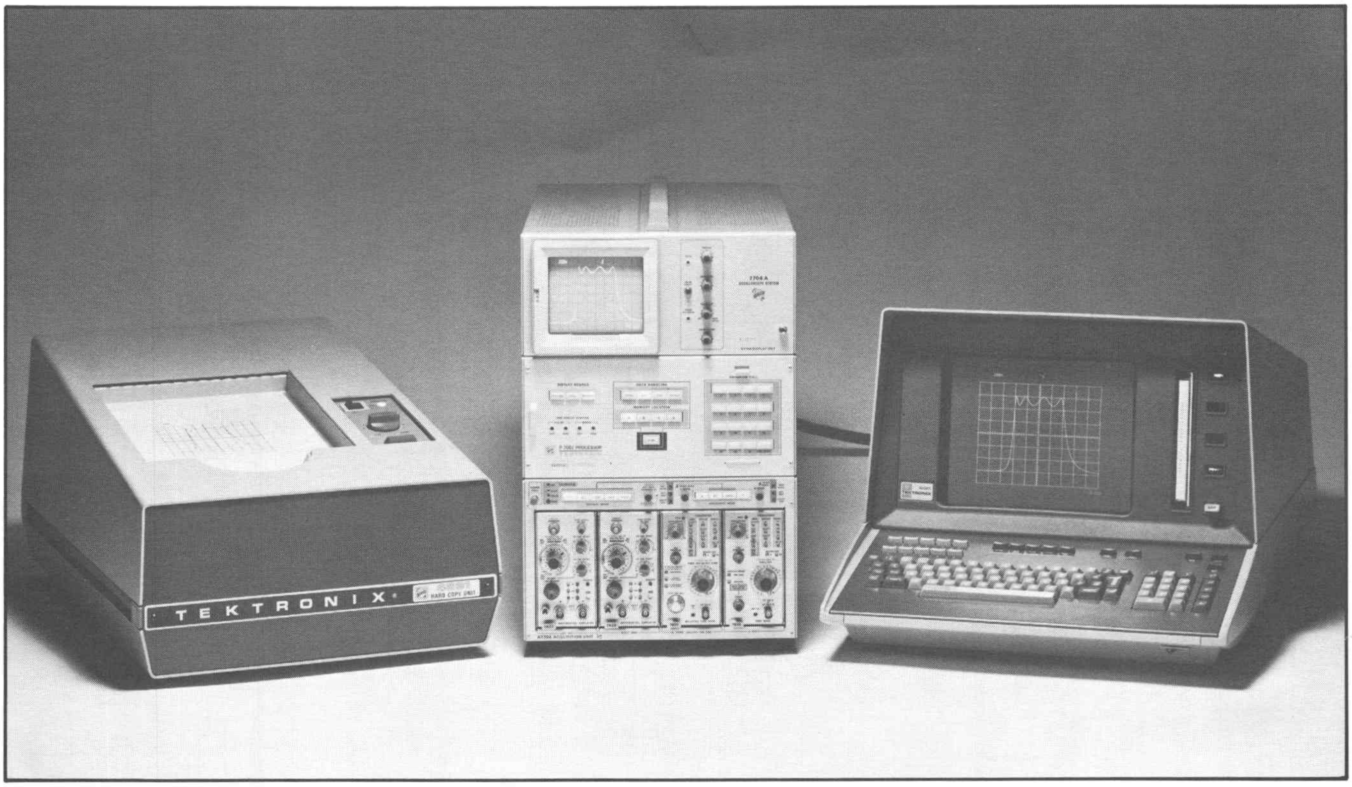
However, several suggestions can only be implemented with your help. These suggestions include more applications articles, programming tips, and interfacing articles. TEKniques would love to publish your application—we'll even write the article—but we must hear from you first. Any many of you may have a program tip that would benefit other readers. After all, ingenuity runs rampant among programmers. Several articles have been published recently on interfacing the 4051 with other equipment, and more are to come. But we'd like to publish more about how you are actually interfacing your 4051 with equipment; pictures or diagrams would be welcome.

Lack of program documentation seemed to be the stumbling block for 52 members who would like to contribute programs to the Library. Time, as always, is the main factor and any methods anyone has for speeding up the process or making it less painful will be published in TEKniques if you'll send them in.

Many of your replies included compliments, which are always nice to receive. One comment suggested raising the editor's salary. Somehow this particular questionnaire floated to the top when the boss wanted to look them over, but he managed to retain his usual taciturnity.

Drop us a postcard or write us a letter. Tell us if you have an application and give us a telephone number so we can call and get the details. We want to hear from you—suggestions or criticisms. Don't hesitate to pass them along.

The 4051 Applications Library address is: Tektronix, Inc., Group 451, P.O. Box 500, Beaverton, OR 97077.



Tektronix announces its first IEEE-488 interfacing Digital Processing Oscilloscope (DPO). 4051 computing power interfaced to programmable instrumentation enhances the ability to analyze the digitized waveforms provided by the DPO.

4051 And DPO Constitute Waveform Processing System Through New Interface

By Dale Aufrecht, Tektronix SPS Engineering

The Tektronix Digital Processing Oscilloscope (DPO) has already proven itself as a general waveform processing instrument. Now there is something new for the DPO — a special product that utilizes the 4051 Graphic System to boost its capabilities into the realm of ATE (Automatic Test Equipment) systems. This new product is the P7001/IEEE 488 Interface (part no. 021-0206-00).

The P7001/IEEE 488 Interface conforms to IEEE Standard 488-1975, "IEEE Standard Digital Interface for Programmable Instrumentation". This interface allows the DPO to be used with a controller compatible with IEEE 488. The Tektronix 4051 Graphic System serves ideally for this purpose.

As an IEEE 488 device, the DPO can be a talker only or a listener only. When it is a talker the DPO can send digitized waveforms, readout information, and its current device status to the system controller or other IEEE 488 device. As a listener it can receive data and commands from the system controller or another IEEE 488 device. The 4051 controls the talking and listening functions in the system.

Interfacing occurs within the P7001 Processor section of the DPO. The P7001/IEEE 488 Interface is a dual-card assembly that is installed in the interface slots of the P7001. All necessary power for the interface is taken from the P7001 Power Supply via the Main Interface Board. Thus, converting the DPO to IEEE 488 hardware compatibility consists of little more than putting a card into a slot and throwing a few switches to set a device address. With appropriate system-controller software, the DPO becomes fully compatible with other IEEE 488 instruments. The driver software was written specifically with the 4051 Graphic System in mind.

Programming information is given in the P7001/IEEE 488 interface instruction manual (part no. 061-1439-00). Complete examples are provided for using a 4051 Graphic System as the DPO system controller. With the 4051 interfaced to the DPO (via the P7001/IEEE 488 interface) you have a powerful yet economical waveform processing system. Tekniques

4907 FILE MANAGER IS A POWERFUL GRAPHICS AID

By Les Brabetz and Gary P. Laroff

The last issue of TEKniques (Vol. 1 No. 9) introduced the 4907 intelligent flexible disc mass storage unit for the 4051. A SORTing program was also included in that issue. This month begins a series of articles on powerful graphics handling routines made possible by the large direct access storage capability and multiple-level file-by-name library structure supported by the 4907. Just as numerical records can be accessed in any order on the disc, so can graphic entities be stored and retrieved.

Consider a large data base, perhaps the high resolution map of the United States in Fig. 1. It might be desirable to plot the entire map. In this case all of the coordinates in the data base are required and can be read sequentially. This is as easy and convenient to do with data stored on magnetic tape as it is with disc storage methods. But what if only a subset of the map is desired? How is it possible to quickly locate those coordinates that will be plotted in the desired map area, and discard those that fall outside the boundaries? The file library system available on the 4907 is designed to offer solutions to such graphic applications.

The data base consists of about 3000 X,Y pairs and takes about four minutes to display. The objective is to store the data so that any map area can be chosen and quickly displayed. The data base designs are described in this article. Succeeding articles will present a program to construct a segmented data base from an existing sequential data base and another program that selects the segments to display.

The map as originally digitized can be displayed with a number of DRAW commands and MOVE commands. The data is stored as a series of coordinates that can be displayed with a MOVE to the first coordinate pair and an array DRAW to the remaining coordinates. Because each of these data sections consists of a different number of coordinates, the number of coordinate pairs is also stored. The data format is:

$$N, X_1, Y_1, X_2, Y_2, \ldots, X_n, Y_n$$

where N is the number of coordinate pairs. The data base could be read and displayed from either tape or disc with similar programming:

```
FROM TAPE                  FROM 4907

100 READ @33:N             100 READ #1:N
110 DELETE X,Y             110 DELETE X,Y
120 DIM X(N),Y(N)          120 DIM X(N),Y(N)
130 READ @33:X,Y           130 READ #1:X,Y
```

These arrays can then be displayed by a MOVE to the first point and a DRAW for the entire array:

```
140 MOVE X(1),Y(1)
150 DRAW X,Y
```

All of the arrays are READ and displayed in this manner. The data base consists of 30 arrays containing about 3000 coordinate pairs.

This data base is not optimized for displaying subsections of the map. With this filing method, four minutes are required to display any map section because the 4051 must READ every data pair and "clip" all graphics that would appear outside the designated window.

A far superior technique would be to divide the map into many smaller sections. The program could then look at the desired plot boundaries and choose those map sections required for the display. The random file access feature of the 4907 makes this quite practical. For the

Fig. 1. Master file of digitized map with arbitrary grid values.

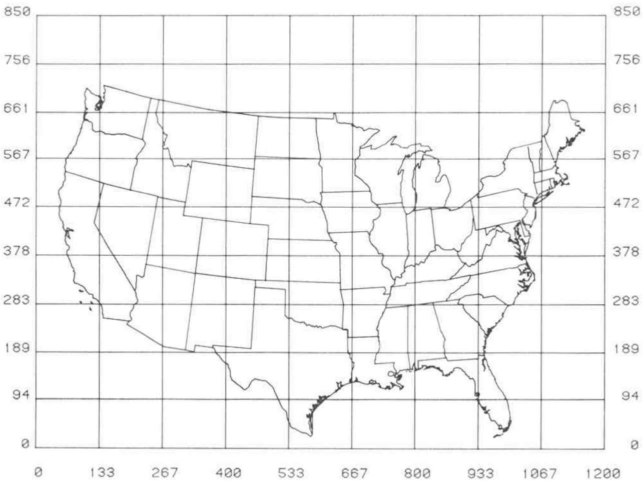
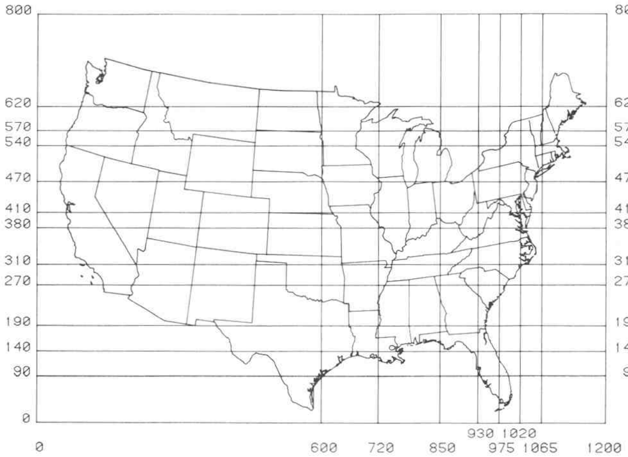


Fig. 2. Map data base illustrating segment division lines to produce 96 map segments.



purposes of this description, 96 segments created a data base that could quickly display any section of the original map. Fig. 2 shows the map as segmented into eight divisions horizontally and twelve vertically. An attempt was made to select a segment definition which would create an equal distribution of coordinates between the file segments. The fine detail required by the eastern coastline and minimum detail required for western state boundaries caused the density of graphic coordinates to be far greater toward the eastern part of the map. Smaller segment definition was required in some areas in order to attain reasonably equal vector densities in each segment.

Each segment is a rectangle and must contain the coordinates of intersection of any map lines with its borders. This is a substantial task; the program that builds this segmented data base will be discussed in the next issue.

Once the segmented data base is completed (as 4907 files USMAP/SEG1 through USMAP/SEG96), a simple program can be used to access the files, then quickly display any segment of the map. In this manner, one can rapidly access and display any section of a large data base (such as a map) and then use custom routines to add such information as county boundaries, major highways or weather information. Tekniques

Christmas Card Contest Results

The winner of the Christmas Card Design Contest is shown on the front page of this issue of TEKniques. The program, which draws six random snowflakes and the greeting "Merry Christmas" in old English type, was submitted by S. Hansen of Los Angeles, CA. The program also allows the option of printing names on the cards as well.

Two other programs that were submitted are also included in this issue. "Random Snowflakes" was submitted by Mark Mahall, a Tektronix S.A. "Christmas Card" was submitted by Dr. P. C. Holman of the University of Wisconsin, Stevens Point. TEKniques wishes to thank all entrants for their efforts. Happy Holidays! Tekniques

*EDITOR'S NOTE

There's an Asterisk on Your Mailing Label

As prior issues of TEKniques have mentioned, it is the desire of the TEKniques staff to provide TEKniques to everyone who wants it. However, we don't want to mail it to those who don't want or use it. Therefore, nonmembers who have been on the mailing list for longer than four months will be candidates for deletion from the distribution list. An asterisk has been placed on those mailing labels to denote this. If your mailing label carries an asterisk and you wish to continue to receive TEKniques, please complete and mail in the membership card accompanying this issue. If you don't receive Vol. 2, No. 1 by the middle of February, chances are your name has been dropped.

More Than One Copy

If you desire more than one copy of TEKniques for your office, you'll have to subscribe someone else to TEKniques. Our system has been designed to delete duplications. (For those of you who **are** getting two or more—the system is not perfect!)

Publication Deadlines

Great effort is being made to place and keep TEKniques on a six-week publication schedule. For this reason, the deadline for submitting articles is approximately six weeks prior to the publishing date. The following schedule will aid those of you planning to send in those useful tips and articles.

TEKniques	Copy Deadline	Publish Date
Vol 2 No 1	Dec 5, 1977	Jan 15, 1978
Vol 2 No 2	Jan 15, 1978	Mar 1, 1978
Vol 2 No 3	Mar 1, 1978	Apr 15, 1978
Vol 2 No 4	Apr 15, 1978	Jun 1, 1978
Vol 2 No 5	Jun 1, 1978	Jul 15, 1978
Vol 2 No 6	Jul 15, 1978	Sep 1, 1978
Vol 2 No 7	Sep 1, 1978	Oct 15, 1978
Vol 2 No 8	Oct 15, 1978	Dec 1, 1978

Catalog Reminder

If you have not received a 4051 Applications Library catalog of abstracts, write Tektronix, Inc. Information Display Group, P.O. Box 500, Group 451, Beaverton, OR 97077. Tekniques

Binary Counters in BASIC (Save Memory Too)

by Leland C. Sheppard
Sunnyvale, CA

During the rewrite of the Flowchart Program (51/00-8005/1) it became evident once again that necessity really is "the mother of invention."

One of the desired enhancements to the original Flowchart Program (51/00-8005/0) was the addition of page numbers to the Program's branch table. This would serve as an aid to quick indexing into the flowchart. The original program used alpha page numbers; this limited the chart to 52 pages before a program error would occur. (Some programs exceed that amount.) The technique that is described here is a little slower than equivalent numeric methods, but really saves memory and overcomes the 52 page limit.

A one-character field was already being used for from/to page references (corresponding to the from/to entries in the branch table). The aim was to get the Flowchart Program to run in a 16K 4051, so limiting the field to one character was important. The problem at hand was this: how can you count beyond nine in one byte?

The solution is to treat the character as an ASCII/Binary field. This allows a count to 127, which would be plenty for a page number value. The technique that is used to make that one-byte field a binary value is described in the following. (Note that the same technique can be used as a binary counter.)

1. To convert a decimal number to binary: A$=CHR(A)—the "ASCII representation" of A is actually the decimal value stored in binary; the 4051 software will now allow you to store that value (A$) in another string (of counters, page numbers, etc.). For example, if the value of A is 67 decimal (as in say Page # 67) then the CHR function would represent it as the character "C" but the decimal equivalent is still 67.

2. To convert binary to decimal: A=ASC(A$); you now have the 67 back in numeric form.

3. To fetch, increment by 1 and save back (perhaps in a string of counters, where it is assumed that P=9 because you want the 9th counter in the string; B$ is a string of 1 byte counters and A$ is a 1 byte string): A$=SEG(B$,P,1) to extract the counter byte at location P; A=ASC(A$) to convert the counter to decimal; A$=CHR(A+1) to increment the counter and convert back to ASCII/Binary; B$=REP(A$,P,1) to save the updated counter back in the counter string.

Of course you can count to 127 in 1 byte since the 4051 thinks it's dealing with an ASCII character, but the technique is appropriate for many applications.

If 127 isn't great enough, the technique can be expanded to count larger values or store larger values. This will still save considerable memory over string or numeric techniques. The technique is as follows:

1. Use two bytes per counter where the right hand byte will represent a value from 0-127 and the left hand byte will represent multiples of 128; the sum of the two (after multiplying the left hand byte by 128) will yield your number. (Assume C$ is a 1 byte string, P points to the counter number of field number desired, say 9, and B$ contains the counters as before.)

   1 A$=SEG (B$,P*2–1,1) to get the left hand byte of the counter
   2 C$=SEG(B$,P*2,1) to get the right hand byte of the counter
   3 A=ASC(A$) to convert the "128's" to decimal
   4 C=ASC(C$) to convert the "units" to decimal
   5 IF C is less than 127 THEN 10 to see if I can add to C
   6 C$=CHR(0) I can't, it's at maximum so set to zero
   7 A$=CHR(A+1) and add one to the "128's" position and convert
   8 A$=REP(B$,P*2–1,1) to save the "128's" back in B$
   9 GO TO 11 to skip the next statement
   10 C$=CHR(C+1) to add 1 to the "units" position and convert
   11 C$=REP(B$,P*2,1) to save the units counter.

Effectively, we've created a base 128 numbering system so that you can count to 16K-1 (16383 or 16256+127) in 2 bytes instead of 5 using strings or 8 using numeric variables. (A 3 byte setup would yield a total count of over 2,000,000.)

It is a slower technique than straight numeric, but if you have critical memory situations this technique may be important to you.

Speeding Up Trigonometric Functions

by Herman D'Hondt
Tektronix Australia

Speed can be improved appreciably in situations where sines and cosines must be repeatedly computed in a FOR/NEXT loop. This can be accomplished using the following well-known sum formulas:

$$\sin(a + b) = \sin a \cos b + \sin b \cos a$$
$$\cos(a + b) = \cos a \cos b - \sin a \sin b$$

Accuracy is slightly diminished using this method.

Usual Method

```
100 SET DEGREES
110 FOR I=0 TO 360 STEP 2
120 X=SIN(I)
130 Y=COS(I)
140 NEXT I
150 PRINT X,Y

RUN

 0                  1
```

Speed Method

```
100 SET DEGREES
110 A=SIN(2)
120 B=COS(2)
130 X=0
140 Y=1
150 FOR I=1 TO 180
160 X1=X*B+A*Y
170 Y1=Y*B-X*A
180 X=X1
190 Y=Y1
200 NEXT I
210 PRINT X,Y

RUN

 -4.352074257E-13  0.999999999999
```

Deleting Parentheses to Save Memory

by Aaron Eisenbach

If you are running a program that was originally written for a Hewlett-Packard calculator (such as an H.P. 9821), you may be using more of your 4051 memory than you need to. The H.P. 9821, for instance, identifies simple variables as R(21), R(5), R(56), and so forth. The parentheses are not required for simple variables in the 4051. You can save lots of memory by deleting the parentheses and using variables such as A-Z, A1-A9, B1-B9, etc.

In one example, a 900-register program for an H.P. machine, one thousand bytes of memory were saved by deleting unnecessary parentheses.

Branching Techniques

by J. L. Aubel
University of South Florida

Branching on Yes-No

Here's another simple method for branching on a Yes-No response. (Other methods were published in TEKniques Vol. 1 No. 8.)

```
100 DIM C$(1)
. . .

400 PRI "Do you wish to continue ";
410 INP C$
420 GO TO (C$="Y")+1 OF 500,600
. . .

500 REM No Processing
. . .

600 REM Yes Processing
```

Branching for Output

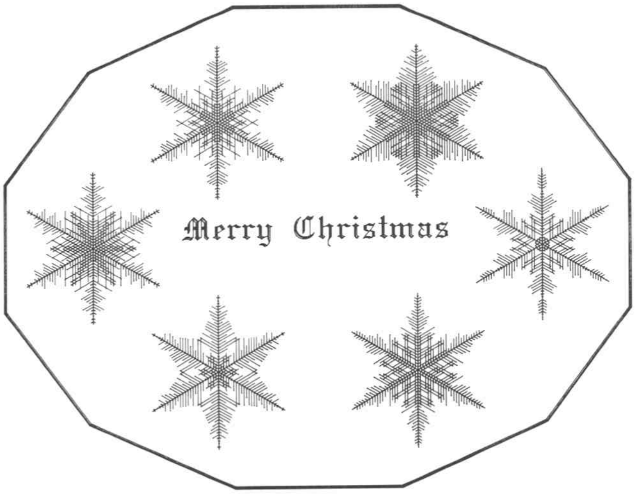
A variation of the above method works nicely for assigning output to the screen or the plotter. (Assume that the plotter is set to Device Address 1.) Use the following method:

```
400 PRINT "Output to screen or plotter? (Enter S or P) ";
410 INPUT C$
420 N=32-31*(C$="P")
. . .

450 PRI @N: . . .
```

Intro to Graphic Manual Valuable

by Ken Cramer

Look through the Introduction to Graphic Programming in BASIC manual (070-2059-00) supplied with your 4051. If you are a typical programmer, you probably skip over "introductory" manuals and go right to the reference manuals. In the case of the Graphic Programming manual, you could be missing a lot of helpful hints. Sections three through eight have many examples and explanations that can give you valuable insight and a starting point for algorithms you need. Just knowing where to look things up can save many hours of programming effort. Take an hour to look through these sections; it's worth it.

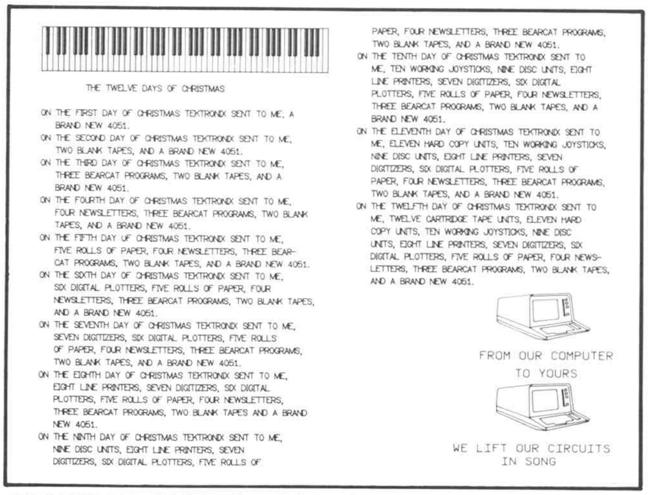


```
        *****   SNOWFLAKES BY S. HANSEN   *****

OUTPUT DEFAULT IS TO THE 4051 GRAPHIC SCREEN.  TO OUTPUT
TO PLOTTER, PRESS USER DEFINABLE KEY #1.

STATEMENTS 1890 TO 1990 CONTAIN THE CODE FOR PRINTING
THE INDIVIDUAL NAMES 'SIG AND GWEN'.

SUGGESTED CODE TO SUBSTITUTE YOUR OWN LINE OF GREETING
FOLLOWING 'MERRY CHRISTMAS':

        DEL 1890,1990
        131 PRINT 'ENTER LINE OF GREETING'
        132 INPUT A$
        !
        !
        2311 X=65-LEN(A$)
        2312 Y=47
        2313 FOR I=0 TO 0.3 STEP 0.1
        2314 PRINT @T,21:X+I,Y+I
        2315 PRINT @T:A$
        NEXT I
```

```
1 REM SNOWFLAKE DESIGN
2 REM AUTHOR - S. HANSEN, LOS ANGELES, CA.
3 GO TO 100
4 INIT
5 T=1
6 GO TO 110
100 INIT
105 T=32
110 SET DEGREES
120 WINDOW -34,34,-34,34
130 PAGE
140 FOR K=1 TO 6
150 READ H,M
160 DATA 0,30,25,55,65,55,90,30,65,5,25,5
170 VIEWPORT H,H+40,M,M+40
180 A=26
190 B=RND(-1)*0.4+0.3
200 FOR I=0 TO 25
210 C=0.866025*A
220 D=0.5*A
230 FOR J=1 TO 6
240 ROTATE 60*J
250 MOVE @T:0,0
260 RMOVE @T:0,I
270 RMOVE @T:C,D
280 RDRAW @T:-C,-D
290 RDRAW @T:-C,D
300 NEXT J
310 A=RND(-1)*(26-I)*B
320 NEXT I
330 NEXT K
340 WINDOW 0.130,0,100
350 DATA 0,0.-64.-64
360 DATA -14.14,-6,-8,-7,-7,-8,-5,-8,-3,-10,-3,-11,-2,-11,0
370 DATA -10,-1,-8,-1,-8,3,-64,0,-7,-6,-7,1,-64,0
380 DATA -10,-2,-7,-2,-64,0,-6,-8,-6,0,-7,2,-8,3,-64,0
390 DATA -13,9,-11,7,-9,6,-7,6,-5,7,-4,7,-3,6
400 DATA -64,0,-10,7,-7,7,-5,8,-64,0,-13,9,-11,8,-8,8
410 DATA -6,9,-5,9,-4,8,-3,6,-64,0,-6,-8,-2,-12
420 DATA 2,-8,2,5,3,7,4,7,-64,0,-2,-11,1,-8,1,6
430 DATA 0,7,1,8,2,7,1,6,-64,0,-2,-2,1,-2
440 DATA -64,0,-4,-10,-3,-10,0,-7,0,-3,-3,-3,-64,0,-3,-1
450 DATA 0,-1,0,6,-1,7,1,9,4,7,5,6,-64,0
460 DATA 2,-8.6,-12,10,-8,10,5,11,7,12,7,-64,0,6,-11
470 DATA 9,-8,9,6,11,8,-64,0,6,-2,9,-2,-64,0
480 DATA 4,-10,5,-10,8,-7,8,-3,5,-3,-64,0,5,-1,8,-1
490 DATA 8,7,10,9,12,7,-64,0,-3,-10,-3,6,-64,0
500 DATA 5,-10,5,6,-64,-64
510 DATA -8,6,-4,-3,-4,6,-6,7,-5,7,-3,8,-2,9,-64,0
520 DATA -3,-3,-3,7,-1,8,-64,0,-2,-3,-2,6,0,7
530 DATA 1,7,-1,8,-2,9,-64,0,-4,-3,0,-4,2,-5,5,-1
540 DATA 3.0,-2,3,-64,0,1,-4,4,-1,-64,0,-2,-3
550 DATA 0,-4,3,0,-64,-64
560 DATA -8,6,-6,-3,-5,-3,-4,-2,-4,6,-6,7,-5,7,-3,8
570 DATA -2,9,-64,0,-5,-4,-3,-3,-3,7,-1,8,-64,0
580 DATA -6,-3,-4,-5,-2,-3,-2,6,0,7,1,7,-1,8,-2,9
590 DATA -64,0,-2,-3,2,-5,3,-4,5,-3,6,-3,-64,0
600 DATA 1,-4,2,-3,4,-3,-64,0,0,-4,2,-2,4,-2,6,-3
610 DATA -64,-64
620 DATA -9,9,-7,-3,-6,-3,-5,-2,-5,6,-7,7,-64,0,-6,-4
630 DATA -4,-3,-4,7,-2,8,-64,0,-7,-3,-5,-5,-3,-3
640 DATA -3,6,-1,7,0,7,-64,0,-7,7,-6,7,-4,8,-3,9
650 DATA -2,8,0,7,3,6,-64,0,3,-5,4,-4,6,-3
660 DATA 7,-3,5,-2,5,10,4,13,2,15,0,16,-1,15,-3,14
670 DATA -5,14,-64,0,2,-4,4,-3,4,10,-64,0,1,15
680 DATA -1,14,-2,14,-64,0,3,-5,1,-3,3,-2,3,8,4,11
690 DATA 4,13,-64,0,2,15,1,14,-1,13,-3,13,-5,14
700 DATA -64,-64
710 DATA -8,8,-64,-64
720 DATA -13,11,-4,-11,-6,-10,-8,-8,-9,-6,-10,-3,-10,1,-9,4
730 DATA -8,6,-5,8,-2,9,1,9,4,8,6,7,8,5
740 DATA 9,3,-64,0,-8,-7,-9,-4,-9,1,-7,5,-4,7,-1,8
750 DATA 2,8,5,7,-64,0,-4,-11,-6,-9,-7,-7,-8,-4
760 DATA -8,0,-7,3,-4,6,-1,7,2,7,5,6,7,5,9,3
770 DATA -64,0,-2,-8,-2,4,-64,0,-1,-8,-1,2,-64,0
780 DATA 0,-9,0,1,-1,3,-2,4,-64,0,-2,-8,0,-9,3,-12
```

```
790 DATA 5,-11,7,-11,8,-12,-64,0,2,-11,4,-10,6,-10
800 DATA -64,0,1,-10,3,-9,5,-9,7,-10,8,-12,-64,0,5,-9
810 DATA 5,6,-64,-64
820 DATA -9,9,-6,-10,-5,-8,-5,6,-7,7,-6,7,-4,8,-3,9
830 DATA -64,0,-4,-8,-5,-10,-4,-11,-4,7,-2,8,-64,0
840 DATA -6,-10,-3,-12,-3,6,-1,7,-3,9,-64,0,-3,-2,0,-3
850 DATA 2,-4,3,-5,4,-4,6,-3,7,-3,5,-2,5,7
860 DATA 3,9,2,11,-64,0,2,-4,4,-3,4,7,3,9,-64,0
870 DATA 0,-3,1,-3,3,-2,3,7,2,11,2,14,3,16
880 DATA 4,16,2,14,-64,-64
890 DATA -5,5,0,-12,-2,-10,0,-9,2,-10,0,-12,-64,0,0,-11
900 DATA -1,-10,1,-10,0,-11,-64,0,0,-5,-1,-4,-3,-3
910 DATA -1,-2,-1,7,1,9,3,7,-64,0,0,-2,1,-3,0,-4
920 DATA -1,-3,0,-2,0,7,1,8,-64,0,0,-5,1,-4
930 DATA 3,-3,1,-2,1,6,2,7,3,7,-64,-64
940 DATA -8,8,-5,-3,-5,1,-3,2,3,2,5,3,5,7,-64,0
950 DATA -4,-3,-4,1,-64,0,4,3,4,7,-64,0,-2,-4
960 DATA -3,-3,-3,1,-1,2,-64,0,1,2,3,3,3,7,2,8
970 DATA -64,0,-5,-3,-2,-4,0,-5,2,-4,4,-4,5,-5
980 DATA -64,0,-1,-4,1,-4,-64,0,-2,-4,0,-3,2,-3,4,-4
990 DATA -64,0,5,7,2.8,0,9,-2,8,-4,8,-6,9
1000 DATA -64,0,1,8,-1,8,-64,0,2,8,0,7,-3,7,-6,9
1010 DATA -64,0,5,-5,4,-3,2,0,-3,5,-6,9,-64,-64
1020 DATA -5,5,-2,-10,-1,-8,-1,6,-3,7,-2,7,0,8,1,9
1030 DATA -64,0,0,-8,-1,-10,0,-11,0,7,2,8,-64,0
1040 DATA -2,-10,1,-12,1,6,3,7,4,7,2,8,1,9,-64,0
1050 DATA -4,-5,-1,-5,-64,0,1,-5,4,-5,-64,-64
1060 DATA -13,13,-11,-3,-10,-3,-9,-2,-9,6,-11,7,-10,7.-8.8
1070 DATA -7,9,-64,0,-9,-4,-8,-3,-8,7,-6,8,-64,0
1080 DATA -11,-3,-9,-5,-7,-3,-7,6,-5,7,-7,9,-64,0,-7,-2
1090 DATA -4,-3,-2,-4,-1,-5,1,-3,1,6,3,7,1,9
1100 DATA -64,0,-2,-4,0,-3,0,7,2,8,-64,0,-4,-3,-3,-3
1110 DATA -1,-2,-1,6,-2,7,0,8,1,9,-64,0,1,-2
1120 DATA 4,-3,6,-4,7,-5,8,-4,10,-3,11,-3,9,-2,9,6
1130 DATA 10,7,11,7,-64,0,6,-4,8,-3,8,7,9,8
1140 DATA -64,0,4,-3,5,-3,7,-2,7,7,9,9,11,7,-64,-64
1150 DATA -8,9,-2,0,-4,2,-5,4,-5,6,-4,8,-2,9,0,7
1160 DATA 3.6.-64,0,-5,4,-4,6,-3,7,-1,8,-64,0
1170 DATA -4,2.-4,4,-3,6,-1,7,0,7,-64,0,-4,-2,-2,-2
1180 DATA 1,-3,3,-4,4,-5,6,-3,5,-2,5,6,6,7
1190 DATA 7.7,-64,0,-3,-4,-4,-3,-1,-3,-64,0,2,-3,5,-3
1200 DATA 4,-4,4,7,5,8,-64,0,-5,-3,-3,-5,-2,-4
1210 DATA 0,-3,3,-2,3,7,5,9,7,7,-64,0,-5,-3,0,2
1220 DATA -64,-64
1230 DATA -7,8,5,-6,6,-6,7,-7,6,-4,5,-6,3,-7,0,-7
1240 DATA -2,-6,-3,-5,-3,-3,-2,-2,3,1,4,2,-64,0
1250 DATA -3,-4.-2,-3.3,0,4,1,4,4,3,5,1,6,-2,6
1260 DATA -4,5,-5,3,-6,6,-5,5,-4,5,-64,-64
1270 DATA -5,5,1,-7,1,-6,2,-6,2,-7,1,-7,-64,0,-4,0
1280 DATA -3,-2,-2.-3,0,-3,1,-2,1,0,0,3,0,5
1290 DATA 1,6,-64,0.-1,-3,0,-2,0,0,-1,3,-1,5,0,6
1300 DATA 2,6,3,5,4,3,-64,-64
1310 DATA -7,7,4,-3,2,4,1,7,0,9,-64,0,5,-3,3,4
1320 DATA 2,7,0,9,-2,10,-5,10,-6,9,-5,9,-4,10
1330 DATA -64,0,3,1,3,-1,1,-3,-1,-3,-3,-2,-4,-1,-5,1
1340 DATA -5,3,-4,5,-2,6,0,6,2,4,-64,0,-1,-3
1350 DATA -3,-1,-4,1.-4,4,-2,6,-64,-64
1360 DATA -6,6,-64,-64
1370 DATA -7,8,4,-3,2,4,2,5,3,6,5,6,6,5,7,3
1380 DATA -64,0,5,-3,3,4,3,5,4,6,-64,0,3,1
1390 DATA 3,-1,1,-3,-1,-3,-3,-2,-4,-1,-5,1,-5,3,-4,5
1400 DATA -2,6,0,6,2,4,-64,0,-1,-3,-3,-1,-4,1
1410 DATA -4.4,-2,6,-64,-64
1420 DATA -8,9,-7,0,-6,-2,-5,-3,-3,-3,-2,-2,-2,-1,-4,6
1430 DATA -64,0,-4,-3,-3,-2,-3,-1,-5,6,-64,0,-2,-1
1440 DATA -1,-2,1,-3,3,-3,5,-2,5,0,4,3,4,5,5,6
1450 DATA -64.0,3,-3,4,-2,4,0,3,3,3,5,4,6
1460 DATA 6.6,7,5,8,3,-64,-64
1470 DATA -7,8,5,-7,2,4,2,5,3,6,5,6,6,5,7,3
1480 DATA -64,0,6,-7,3,4,3,5,4,6,-64,0,3,1
1490 DATA 3.-1,1,-3,-1,-3,-3,-2,-4,-1,-5,1,-5,3,-4,5
1500 DATA -2.6,0,6,2,4,-64,0,-1,-3,-3,-1,-4,1
1510 DATA -4,4,-2,6,-64,0,3,-7,6,-7,-64,-64
1520 DATA -7,7,4,-6,5,-6,6,-7,5,-4,4,-6,2,-7,0,-7
1530 DATA -2,-6,-3,-5,-4,-3,-5,0,-5,3,-4,5,-2,6
1540 DATA 0,6,2.5,3,4,4,1,-64,0,0,-7,-2,-5,-3,-3
1550 DATA -4,0.-4,4.-2,6,-64,0,0,6,2,4,3,1
1560 DATA -64,0,1,1,6,1,-64,-64
1570 DATA -10,10,-9,0,-8,-2,-7,-3,-5,-3,-4,-2,-4,0,-5,3
1580 DATA -5,5,-4,6,-64,0,-6,-3,-5,-2,-5,0,-6,3
1590 DATA -6,5,-4,6,-3,6,-1,5,0,4,-64,0,2,-3,0,4
1600 DATA 0,5,2.6,-64,0,3,-3,1,4,1,5,2,6
1610 DATA 3,6,5,5,7,3,8,0,8,-3,7,-3,8,-2,-64,-64
1620 DATA -7,5,-4,3,0,2,2,1,3,0,3,-2,1,-3,-1,-3
1630 DATA -3,-2,-4,-1,-5,1,-5,3,-4,5,-2,6,0,6
1640 DATA 2,5,3,4,-64,0,-1,-3,-3,-1,-4,1,-4,4,-2,6
1650 DATA -64,-64
1660 VIEWPORT 10,120.60,47
1670 A=-131
1680 B=389
1690 RESTORE 350
1700 FOR I=1 TO 4
1710 GOSUB 2020
1720 NEXT I
1730 RESTORE 560
1740 FOR I=1 TO 5
1750 GOSUB 2020
1760 NEXT I
1770 RESTORE 560
1780 GOSUB 2020
1790 RESTORE 890
1800 FOR I=1 TO 5
1810 GOSUB 2020
1820 NEXT I
1830 RESTORE 940
1840 GOSUB 2020
1850 VIEWPORT 30,100,50,40
1860 A=-175
1870 B=345
1880 RESTORE 1230
1890 FOR I=1 TO 7
1900 GOSUB 2020
1910 NEXT I
1920 RESTORE 1360
1930 GOSUB 2020
1940 RESTORE 1520
1950 FOR I=1 TO 3
1960 GOSUB 2020
1970 NEXT I
1980 RESTORE 1420
1990 GOSUB 2020
2000 HOME @T:
2010 GO TO 2200
2020 READ C,D
2030 A=A+C
2040 B=B+C
2050 WINDOW A,B,-30,30
2060 READ X,Y
2070 IF X=-64 AND Y=-64 THEN 2140
2080 MOVE @T:X,Y
2090 READ X,Y
2100 IF X=-64 AND Y=-64 THEN 2140
2110 IF X=-64 AND Y=0 THEN 2170
2120 DRAW @T:X,Y
2130 GO TO 2090
2140 A=A-D
2150 B=B-D
2160 RETURN
2170 READ X,Y
2180 MOVE @T:X,Y
2190 GO TO 2090
2200 WINDOW 0,130,0,100
2205 VIEWPORT 0.130,0,100
```

```
2210 SET DEGREES
2220 WINDOW -13,13,-10,10
2230 FOR J=12.9 TO 13 STEP 0.05
2240 K=J-3
2250 MOVE @T:J*COS(15),K*SIN(15)
2260 FOR I=45 TO 375 STEP 30
2270 X=J*COS(I)
2280 Y=K*SIN(I)
2290 DRAW @T:X,Y
2300 NEXT I
2310 NEXT J
2320 HOME @T:
2330 END
```



THE TWELVE DAYS OF CHRISTMAS

ON THE FIRST DAY OF CHRISTMAS TEKTRONIX SENT TO ME, A BRAND NEW 4051.

ON THE SECOND DAY OF CHRISTMAS TEKTRONIX SENT TO ME, TWO BLANK TAPES, AND A BRAND NEW 4051.

ON THE THIRD DAY OF CHRISTMAS TEKTRONIX SENT TO ME, THREE BEARCAT PROGRAMS, TWO BLANK TAPES, AND A BRAND NEW 4051.

ON THE FOURTH DAY OF CHRISTMAS TEKTRONIX SENT TO ME, FOUR NEWSLETTERS, THREE BEARCAT PROGRAMS, TWO BLANK TAPES, AND A BRAND NEW 4051.

ON THE FIFTH DAY UF CHRISTMAS TEKTRONIX SENT TO ME, FIVE ROLLS OF PAPER, FOUR NEWSLETTERS, THREE BEARCAT PROGRAMS, TWO BLANK TAPES, AND A BRAND NEW 4051.

ON THE SIXTH DAY OF CHRISTMAS TEKTRONIX SENT TO ME, SIX DIGITAL PLOTTERS, FIVE ROLLS OF PAPER, FOUR NEWSLETTERS, THREE BEARCAT PROGRAMS, TWO BLANK TAPES, AND A BRAND NEW 4051.

ON THE SEVENTH DAY OF CHRISTMAS TEKTRONIX SENT TO ME, SEVEN DIGITIZERS, SIX DIGITAL PLOTTERS, FIVE ROLLS OF PAPER, FOUR NEWSLETTERS, THREE BEARCAT PROGRAMS, TWO BLANK TAPES, AND A BRAND NEW 4051.

ON THE EIGHTH DAY OF CHRISTMAS TEKTRONIX SENT TO ME, EIGHT LINE PRINTERS, SEVEN DIGITIZERS, SIX DIGITAL PLOTTERS, FIVE ROLLS OF PAPER, FOUR NEWSLETTERS, THREE BEARCAT PROGRAMS, TWO BLANK TAPES AND A BRAND NEW 4051.

ON THE NINTH DAY OF CHRISTMAS TEKTRONIX SENT TO ME, NINE DISC UNITS, EIGHT LINE PRINTERS, SEVEN DIGITIZERS, SIX DIGITAL PLOTTERS, FIVE ROLLS OF PAPER, FOUR NEWSLETTERS, THREE BEARCAT PROGRAMS, TWO BLANK TAPES, AND A BRAND NEW 4051.

ON THE TENTH DAY OF CHRISTMAS TEKTRONIX SENT TO ME, TEN WORKING JOYSTICKS, NINE DISC UNITS, EIGHT LINE PRINTERS, SEVEN DIGITIZERS, SIX DIGITAL PLOTTERS, FIVE ROLLS OF PAPER, FOUR NEWSLETTERS, THREE BEARCAT PROGRAMS, TWO BLANK TAPES, AND A BRAND NEW 4051.

ON THE ELEVENTH DAY OF CHRISTMAS TEKTRONIX SENT TO ME, ELEVEN HARD COPY UNITS, TEN WORKING JOYSTICKS, NINE DISC UNITS, EIGHT LINE PRINTERS, SEVEN DIGITIZERS, SIX DIGITAL PLOTTERS, FIVE ROLLS OF PAPER, FOUR NEWSLETTERS, THREE BEARCAT PROGRAMS, TWO BLANK TAPES, AND A BRAND NEW 4051.

ON THE TWELFTH DAY OF CHRISTMAS TEKTRONIX SENT TO ME, TWELVE CARTRIDGE TAPE UNITS, ELEVEN HARD COPY UNITS, TEN WORKING JOYSTICKS, NINE DISC UNITS, EIGHT LINE PRINTERS, SEVEN DIGITIZERS, SIX DIGITAL PLOTTERS, FIVE ROLLS OF PAPER, FOUR NEWSLETTERS, THREE BEARCAT PROGRAMS, TWO BLANK TAPES, AND A BRAND NEW 4051.

FROM OUR COMPUTER
TO YOURS

WE LIFT OUR CIRCUITS
IN SONG

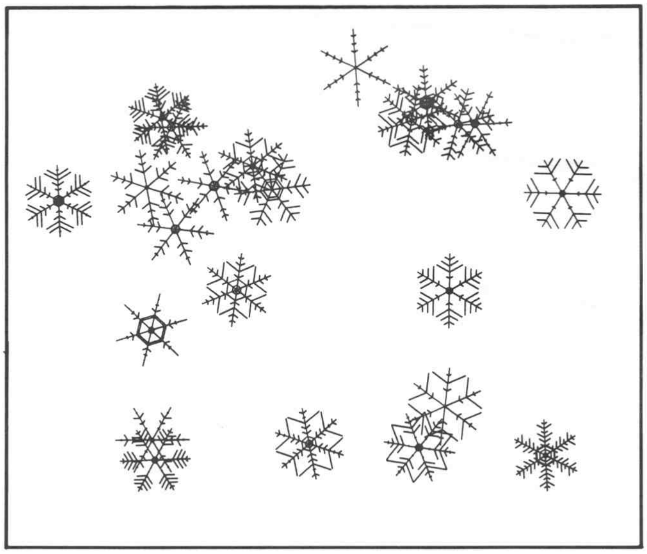
CHRISTMAS CARD plotted from the program of Dr. P.C. Holman and his staff of the University of Wisconsin-Stevens Point. 4051 Applications Library program #51/00-8012/0 (Leroy Character Generator) was incorporated as a subroutine to generate the text.

```
4 RUN 100
8 LIST
9 END
95 REM CHRISTMAS CARD
96 REM AUTHOR: DR. P.C. HOLMAN, U OF WISCONSIN, STEVENS POINT
100 INIT
110 T=1
130 LET U1=5
140 LET U=2
150 VIEWPORT 0,130,87,100
160 SCALE 4,4
170 LET I4=1
180 LET I1=0
190 REM
200 MOVE @T:0,10
210 DRAW @T:0,50
220 DRAW @T:260,50
230 DRAW @T:260,10
240 DRAW @T:0,10
250 FOR I=0 TO 260 STEP 260/52
260 LET I1=I1+1
270 IF I1=3 OR I1=6 OR I1=10 OR I1=13 OR I1=17 OR I1=20 OR I1=24 THE 410
280 IF I1=27 OR I1=31 OR I1=34 OR I1=38 OR I1=41 OR I1=45 THEN 410
290 IF I1=48 OR I1=52 THEN 410
300 MOVE @T:I,25
310 DRAW @T:I,10
320 MOVE @T:I,52
330 IF I1=1 OR I1=53 THEN 400
340 LET U=U+1
350 IF U<>10 THEN 380
360 LET U=0
370 LET U1=U1+1
380 REM
390 RMOVE @T:0,6
400 GO TO 440
410 REM
420 MOVE @T:I,50
430 DRAW @T:I,10
440 NEXT I
450 LET I8=260/52
460 FOR I=I8-2.5 TO 300 STEP ABS(I8)
470 IF I4=2 OR I4=5 OR I4=9 OR I4=12 OR I4=16 OR I4=19 OR I4=23 THEN 600
480 IF I4=26 OR I4=30 OR I4=33 OR I4=37 OR I4=40 OR I4=44 THEN 600
490 IF I4=47 OR I4=51 OR I4=52 THEN 600
500 IF I4>52 THEN 660
510 MOVE @T:I+1,50
520 DRAW @T:I+1,25
530 DRAW @T:I+4,25
540 DRAW @T:I+4,50
550 RMOVE @T:-2,0
560 FOR J=0 TO 1 STEP 0.3
570 RDRAW @T:0,-25
580 RMOVE @T:0.5,25
590 NEXT J
600 LET I4=I4+1
610 NEXT I
620 MOVE @T:1,13
630 FOR L=1 TO 5
640 FOR I=1 TO 10
650 LET I1=I
660 REM * SECOND FILE STARTS HERE *
670 INIT
690 T=1
710 REM
720 LET A=115
730 LET B1=25
750 B=2
760 WINDOW 0,76*B,0,56*B
770 MOVE @T:50,65
780 GOSUB 1030
790 PRINT @T,21:35,95
800 PRINT @T,21:20,50
810 PRINT @T,21:20,47
820 PRINT @T,21:35,38
```

```
830 PRINT @T,21:35,33
840 PRINT @T,21:35,28
850 IF T=32 THEN 880
860 PRINT @T,21:90,1
870 PRINT @T,21:150,100
880 PRINT @T,21:100,25
890 PRINT @T:"FROM OUR COMPUTER"
900 PRINT @T,21:108,21
910 PRINT @T:"TO YOURS"
920 LET A=115
930 LET B1=2
950 WINDOW 0,76*B,0,56*B
960 MOVE @T:50,65
970 GOSUB 1030
980 PRINT @T,21:94,4
990 PRINT @T:"WE LIFT OUR CIRCUITS"
1000 PRINT @T,21:105,1
1010 PRINT @T:"IN SONG"
1011 FOR I5=1 TO 1000
1012 NEXT I5
1013 HOME @T:
1020 GO TO 1960
1030 MOVE @T:A,B1
1040 SCALE 1.8,1.8
1050 RMOVE @T:18.5,5
1060 RMOVE @T:2,10.5
1070 RDRAW @T:-9.5,4
1080 RDRAW @T:-1,0.5
1090 RDRAW @T:-0.5,0.5
1100 RDRAW @T:0,2.25
1110 RDRAW @T:0.5,6.25
1120 RDRAW @T:0.25,0.75
1130 RDRAW @T:0.75,0.25
1140 RDRAW @T:13,1.5
1150 RDRAW @T:15,0.5
1160 RDRAW @T:0.75,-1
1170 RDRAW @T:1.25,-10
1180 RDRAW @T:6.5,-3.5
1190 RDRAW @T:-0.5,-1
1200 RDRAW @T:-17,-3.75
1210 RDRAW @T:-1,0
1220 RDRAW @T:-3.5,0.5
1230 RDRAW @T:-5,2.25
1240 RMOVE @T:5,-2.25
1250 RMOVE @T:-1.5,-7.75
1260 RMOVE @T:4.75,1.5
1270 RMOVE @T:1.25,5.75
1280 RDRAW @T:-20.25,8.25
1290 RMOVE @T:-0.25,1.75
1300 RDRAW @T:14,-5.25
1310 RDRAW @T:6,-3.5
1320 RDRAW @T:0.5,-1
1330 RMOVE @T:-0.25,1
1340 RDRAW @T:17,3
1350 RMOVE @T:-0.5,-0.5
1360 RDRAW @T:0.5,0.25
1370 RDRAW @T:0,0.25
1380 RDRAW @T:-6.75,3.5
1390 RDRAW @T:-1,10
1400 RDRAW @T:-0.75,0.75
1410 RDRAW @T:-15.25,-0.5
1420 RMOVE @T:1,0.75
1430 RDRAW @T:-1,-0.75
1440 RDRAW @T:-0.25,-0.75
1450 RDRAW @T:0.25,-12
1460 RDRAW @T:17,2.5
1470 RMOVE @T:0.25,-0.75
1480 RDRAW @T:3.75,-2.25
1490 RDRAW @T:-1.75,-0.25
1500 RDRAW @T:-3.5,2.25
1510 RDRAW @T:1.5,0.25
1520 RMOVE @T:-2.25,-0.5
1530 RDRAW @T:-11,-1.75
1540 RDRAW @T:3,-2.25
1550 RDRAW @T:3,0.5
1560 RDRAW @T:0.5,-0.5
1570 RDRAW @T:4.75,0.75
1580 RDRAW @T:-0.5,0.5
1590 RDRAW @T:3.5,0.5
1600 RDRAW @T:-3.25,2.25
1610 RMOVE @T:-0.75,3.5
1620 RDRAW @T:-0.5,-0.12
1630 RDRAW @T:-0.75,7
1640 RDRAW @T:0.5,0
1650 RDRAW @T:0.75,-6.87
1660 RMOVE @T:0.75,0.25
1670 RDRAW @T:1,0.12
1680 RDRAW @T:-0.12,0.75
1690 RDRAW @T:-1,-0.12
1700 RDRAW @T:0.12,-0.75
1710 RMOVE @T:-0.25,3
1720 RDRAW @T:1,0.12
1730 RDRAW @T:-0.12,0.75
1740 RDRAW @T:-1,-0.12
1750 RDRAW @T:0.12,-0.75
1760 RMOVE @T:-0.25,1.5
1770 RDRAW @T:1,0.12
1780 RDRAW @T:-0.12,0.75
1790 RDRAW @T:-1,-0.12
1800 RDRAW @T:0.12,-0.75
1810 RMOVE @T:-0.25,1.5
1820 RDRAW @T:1,0.12
1830 RDRAW @T:-0.12,0.75
1840 RDRAW @T:-1,-0.12
1850 RDRAW @T:0.12,-0.75
1860 RMOVE @T:-3.25,0.25
1870 RDRAW @T:-0.25,0.25
1880 RDRAW @T:-9.5,-0.5
1890 RDRAW @T:-0.25,-0.25
1900 RDRAW @T:0.5,-8.25
1910 RDRAW @T:0.25,-0.25
1920 RDRAW @T:9.75,1.25
1930 RDRAW @T:0.25,0.5
1940 RDRAW @T:-0.75,7.25
1950 RETURN
1960 REM
1970 GOSUB 2720
1980 A=0
1990 C1=31
2000 MOVE @T:0,155
2010 PRINT @T:
2025 Z9=0
2030 FOR I=1 TO C1
2040 READ C$
2050 IF C1<>21 THEN 2070
2060 PRINT @T:"
2065 REM***IF Z9=0 THEN 2070
2066 REM *** PRINT @T:
2070 LET S=1.35
2080 GOSUB 2840
2085 IF I=C1 THEN 2100
2090 PRINT @T:
2100 NEXT I
2101 Z9=1
2110 IF C1=21 THEN 2150
2120 HOME @T:
```

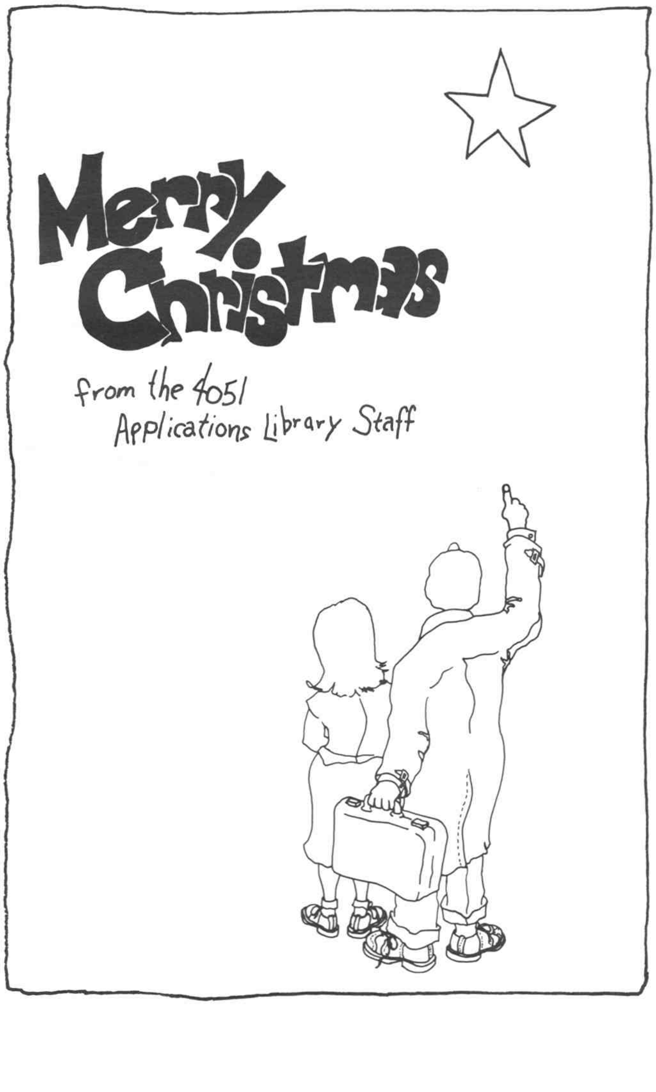
```
2130 LET C1=21
2140 GO TO 2030
2150 END
2160 REM
2170 REM
2180 REM
2190 DATA "         THE TWELVE DAYS OF CHRISTMAS"
2200 DATA " "
2210 DATA "ON THE FIRST DAY OF CHRISTMAS TEKTRONIX SENT TO ME, A"
2220 DATA "   BRAND NEW 4051."
2230 DATA "ON THE SECOND DAY OF CHRISTMAS TEKTRONIX SENT TO ME,"
2240 DATA "   TWO BLANK TAPES, AND A BRAND NEW 4051."
2250 DATA "ON THE THIRD DAY OF CHRISTMAS TEKTRONIX SENT TO ME,"
2260 DATA "   THREE BEARCAT PROGRAMS, TWO BLANK TAPES, AND A "
2265 DATA "   BRAND NEW 4051."
2270 DATA "ON THE FOURTH DAY OF CHRISTMAS TEKTRONIX SENT TO ME,"
2280 DATA "   FOUR NEWSLETTERS, THREE BEARCAT PROGRAMS, TWO BLANK"
2290 DATA "   TAPES, AND A BRAND NEW 4051."
2300 DATA "ON THE FIFTH DAY OF CHRISTMAS TEKTRONIX SENT TO ME,"
2310 DATA "   FIVE ROLLS OF PAPER, FOUR NEWSLETTERS, THREE BEAR-"
2320 DATA "   CAT PROGRAMS, TWO BLANK TAPES, AND A BRAND NEW 4051."
2330 DATA "ON THE SIXTH DAY OF CHRISTMAS TEKTRONIX SENT TO ME,"
2340 DATA "   SIX DIGITAL PLOTTERS, FIVE ROLLS OF PAPER, FOUR"
2350 DATA "   NEWSLETTERS, THREE BEARCAT PROGRAMS, TWO BLANK TAPES,"
2360 DATA "   AND A BRAND NEW 4051."
2370 DATA "ON THE SEVENTH DAY OF CHRISTMAS TEKTRONIX SENT TO ME,"
2380 DATA "   SEVEN DIGITIZERS, SIX DIGITAL PLOTTERS, FIVE ROLLS"
2390 DATA "   OF PAPER, FOUR NEWSLETTERS, THREE BEARCAT PROGRAMS,"
2400 DATA "   TWO BLANK TAPES, AND A BRAND NEW 4051."
2410 DATA "ON THE EIGHTH DAY OF CHRISTMAS TEKTRONIX SENT TO ME,"
2420 DATA "   EIGHT LINE PRINTERS, SEVEN DIGITIZERS, SIX DIGITAL"
2430 DATA "   PLOTTERS, FIVE ROLLS OF PAPER, FOUR NEWSLETTERS,"
2440 DATA "   THREE BEARCAT PROGRAMS, TWO BLANK TAPES AND A BRAND"
2445 DATA "   NEW 4051."
2450 DATA "ON THE NINTH DAY OF CHRISTMAS TEKTRONIX SENT TO ME,"
2460 DATA "   NINE DISC UNITS, EIGHT LINE PRINTERS, SEVEN "
2470 DATA "   DIGITIZERS, SIX DIGITAL PLOTTERS, FIVE ROLLS OF"
2480 DATA "   PAPER, FOUR NEWSLETTERS, THREE BEARCAT PROGRAMS,"
2490 DATA "   TWO BLANK TAPES, AND A BRAND NEW 4051."
2500 DATA "ON THE TENTH DAY OF CHRISTMAS TEKTRONIX SENT TO "
2510 DATA "   ME, TEN WORKING JOYSTICKS, NINE DISC UNITS, EIGHT"
2520 DATA "   LINE PRINTERS, SEVEN DIGITIZERS, SIX DIGITAL"
2530 DATA "   PLOTTERS, FIVE ROLLS OF PAPER, FOUR NEWSLETTERS,"
2540 DATA "   THREE BEARCAT PROGRAMS, TWO BLANK TAPES, AND A"
2545 DATA "   BRAND NEW 4051."
2550 DATA "ON THE ELEVENTH DAY OF CHRISTMAS TEKTRONIX SENT TO"
2560 DATA "   ME, ELEVEN HARD COPY UNITS, TEN WORKING JOYSTICKS,"
2570 DATA "   NINE DISC UNITS, EIGHT LINE PRINTERS, SEVEN"
2580 DATA "   DIGITIZERS, SIX DIGITAL PLOTTERS, FIVE ROLLS OF"
2590 DATA "   PAPER, FOUR NEWSLETTERS, THREE BEARCAT PROGRAMS,"
2596 DATA "   TWO BLANK TAPES, AND A BRAND NEW 4051."
2600 DATA "ON THE TWELFTH DAY OF CHRISTMAS TEKTRONIX SENT TO"
2610 DATA "   ME, TWELVE CARTRIDGE TAPE UNITS, ELEVEN HARD"
2620 DATA "   COPY UNITS, TEN WORKING JOYSTICKS, NINE DISC"
2630 DATA "   UNITS, EIGHT LINE PRINTERS, SEVEN DIGITIZERS, SIX"
2640 DATA "   DIGITAL PLOTTERS, FIVE ROLLS OF PAPER, FOUR NEWS-"
2650 DATA "   LETTERS, THREE BEARCAT PROGRAMS, TWO BLANK TAPES,"
2655 DATA "   AND A BRAND NEW 4051."
2720 REM THIS ROUTINE INITIALIZES THE TABLES USE BY THE
2730 REM CHARACTER GENERATOR. IT SHOULD BE EXECUTED (ONCE) BEFORE
2740 REM THE CHARACTER GENERATOR IS USED. (i.e. GOSUB 9000)
```

EDITOR'S NOTE: STATEMENTS 2750 THRU 4790 ENCOMPASS 4051 APPLICATIONS LIBRARY PROGRAM 51/00-8012/0, "LEROY CHARACTER GENERATOR."



RANDOM SNOWFLAKES generated from a program contributed by Mark Mehal, Tektronix Systems Analyst, Chicago.

```
1 REM default device is the screen.
2 GO TO 130
3 REM user definable key 1 will use the plotter. (unit=1)
4 INIT
5 U=1
6 V=130
7 GO TO 170
100 REM snowflake program 12/22/76 (almost christmas) mm
110 REM version 1.2 (random rotation and faster) 1/6/76
120 REM Mark Mehall Chicago Field Office
130 INIT
140 PAGE
150 REM U is the unit number (1=plotter, 32=screen).
160 U=32
170 REM V is the maximum viewport minus 20 (130=plotter, 110=screen).
180 V=110
190 SET DEGREES
200 WINDOW -20,20,-20,20
210 L=10
220 REM R1 is the number of flakes. (20 to 35)
230 R1=RND(-1)*20+15
240 FOR Q=1 TO R1
250 REM X1,Y1 is the random location.
260 X1=RND(-1)*V
270 Y1=RND(-1)*80
280 REM A is the rotation angle of the flake
290 A=RND(-1)*60
300 POTATE A
310 VIEWPORT X1,X1+20,Y1,Y1+20
320 REM J is the number of "spikes".
330 J=INT(RND(-1)*4+5)
340 DIM X(5*J-4),Y(5*J-4)
350 D1=L/(J-1)
360 REM H is the maximun length of a "spike".
370 REM H=TAN(30)*.5*1/SIN(60)*2 (if you care.)
380 H=0.6666667*L
390 FOR I=1 TO 5*J STEP 5
400 REM D2 is the cumulative distance from center.
410 D2=D1*((I-1)/5)
420 REM M is the actual "spike" length.
430 M=(H-H*ABS(D2-L/2)/(0.5*L))*RND(-1)
440 REM move out a distance d
450 X(I)=D1
460 Y(I)=0
470 IF I>4*J THEN 610
480 REM calculate x,y at 60 degree angle.
490 X(I+1)=0.5*M
500 Y(I+1)=0.866025*M
510 REM return to center line.
520 X(I+2)=-X(I+1)
530 Y(I+2)=-Y(I+1)
540 REM draw lower spike.
550 X(I+3)=X(I+1)
560 Y(I+3)=-Y(I+1)
570 REM return to center line.
580 X(I+4)=-X(I+1)
590 Y(I+4)=Y(I+1)
600 NEXT I
610 FOR R=0 TO 300 STEP 60
620 POTATE R+A
630 MOVE @U:0,0
640 PDRAW @U:X,Y
650 NEXT R
660 REM reset rotation angle to original.
670 ROTATE A
680 REM R2 is the number of concentric hexagons.
690 R2=RND(-1)*6
700 FOR J=1 TO R2
710 REM S is the size of the hexagon.
720 S=RND(-1)*J*1.5
730 MOVE @U:0,0
740 RMOVE @U:S,0
750 REM this loop draw a hexagon s units big.
760 FOR I=0 TO 360 STEP 60
770 ROTATE A+I
780 RDRAW @U:S*-0.5,S*0.866025
790 NEXT I
800 NEXT J
810 DELETE X,Y
820 NEXT Q
830 END
```



4051 Graphic System Publications

By Les Brabetz

The following table contains a summary of all current manuals related to the 4051 Graphic System. The correct nomenclature, latest published date, and Tektronix part number are included. This list contains all manuals published up to August 15, 1977.

Contact your local Tektronix office for prices, availability, and to order any of these publications.

4051 and RELATED PERIPHERAL MANUALS

Manual	Publication Date	Part #
STANDARD		
4051 Graphic System Operator's	JAN 76	070-1940-00
4051 Graphic System Reference	JAN 76	070-2056-00
Reference Guide to 4051 BASIC	3rd Printing	070-2142-00
PLOT 50: Introduction to Programming in BASIC	DEC 75	070-2058-00
PLOT 50: Introduction to Graphic Programming in BASIC	DEC 75	070-2059-00
SERVICE		
4051 Graphic System Service Vol. 1	MAY 77	070-2065-00
4051 Graphic System Service Vol. 2	MAY 77	070-2286-00
#067-0746-00 System Test Fixture	JUN 77	070-2304-00
ROM PACK		
4051R01 Matrix Functions	JUN 76	070-2127-00
4051R05 Binary Program Loader	AUG 76	070-2171-00
4051R06 Editor	FEB 77	070-2170-00
4051E01 ROM Expander Instruction	DEC 76	070-2215-00
INTERFACE		
4051 Option 1 Data Communications Interface	MAR 77	070-2066-01
4051 Option 10 RS-232 Printer Interface	JUN 76	070-2119-00
4051 GPIB Hardware Support	MAR 77	070-2270-00
4051 GPIB Application Support	APR 77	070-2307-00
SOFTWARE		
4050A01 PLOT 50: Statistics Vol. 1	DEC 75	062-1854-00
4050A02 PLOT 50: Statistics Vol. 2	JUN 76	062-1855-00
4050A03 PLOT 50: Statistics Vol. 3	DEC 75	062-1856-00
4050A04 PLOT 50: Mathematics Vol. 1	NOV 75	062-1857-00
4050A05 PLOT 50: Mathematics Vol. 2	DEC 75	062-1858-00
4050A06 PLOT 50: Electrical Engineering Vol. 1	DEC 75	062-2280-00
4050A07 PLOT 50: Graph Plot	MAR 77	070-2288-00
4050A08 PLOT 50: General Utilities Vol. 1	MAR 77	070-2287-00
4050A09 PLOT 50: Business Planning and Analysis	OCT 76	070-2226-00
4050A10 PLOT 50: Statistics Vol. 4	MAR 77	070-2214-00

Manual	Publication Date	Part No.
PERIPHERAL		
4631		
4631 Hard Copy Unit Users	SEP 74	070-1830-01
4631 Hard Copy Unit Service	DEC 76	070-1831-01
4641		
4641/4641-4 Character Printer Operator's	OCT 76	070-2110-00
4641/4641-4 Printer Service	NOV 76	070-2111-00
4662		
4662 Interactive Digital Plotter User	DEC 76	070-1932-01
4662 Interactive Digital Plotter Service	JAN 77	070-1933-00
#067-0829-00 4662 Test Tape Operators	JUN 77	070-2366-00
4924		
4924 Digital Cartridge Tape Drive Operator's	SEP 76	070-2128-00
4924 Digital Cartridge Tape Drive Service	NOV 76	070-2131-00
4924 Reference Guide	MAR 77	070-2302-00
4952		
4952 Joystick Option 2		070-2098-00
4956		
4956 Graphics Tablet Operator's	FEB 77	070-2210-00
4956 Graphics Tablet Service	FEB 77	070-2211-00

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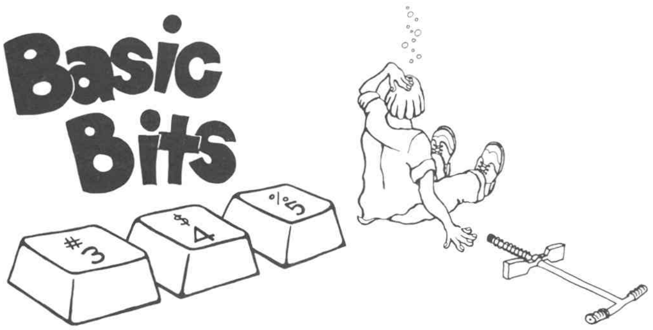

Speed and Memory Savings Suggestions

**by Han Klinkspoor, Tektronix Datatek
Badhoevedorp, The Netherlands**

Speeding Up Proceedings

*Take non-relevant statements out of loops. For example, consider the following listing:

```
100 For I=1 to 10
110 Print Using 120:1
120 Image ....
130 Rem
140 Next I
```

This loop can be speeded up by moving lines 120 and 130 outside the loop. (Overhead is .5 msec/line + processing time.)

*Minimize Jumps
*Use Subroutines
*Avoid recalculation of the same variable
*Avoid unnecessary numeric computations. For example:

110 Print 5*10, I should be 110 Print 50, I

Recover Your Memory

Delete data statements when they are no longer needed. For example:

```
150 DATA -----
160 DATA -----
170 DATA -----
180 DATA -----
190 READ A,B,C$,F
200 DELETE 150,200
```

Save Your Memory

When you need a Waiting Loop, instead of using a FOR/NEXT LOOP such as

```
FOR I=1 TO 1000
NEXT I
```

try using the following:

```
PRINT USING "128("""")S":
```

When you need a Horizontal Line, instead of using a FOR/NEXT loop such as

```
10000 FOR I=1 TO 72
10010 PRINT "_";
10020 NEXT I
```

try using the following:

```
10000 PRINT USING "72(""_"")":
```

This method not only saves memory, but is faster as well.

Correct Tape Inserted?

**by Leslie Diane Sivak
Florida Solar Energy Center**

Before MARKing a file (or files) on a tape cartridge, make sure that you have the **correct** tape cartridge in the 4051.

(The author of this bit speaks from experience. She says she didn't check, destroyed someone else's file, and was lucky to leave the computer room alive!—ed.)

4051 Applications Library Program Abstracts

Documentation and program listings of these programs may be ordered for $15.00 each. Programs will be put on tape for an additional $2.00 handling charge per program and a $26.00 charge for the tape cartridge. (The program material contained herein is supplied without warranty or representation of any kind. Tektronix, Inc. assumes no responsibility and shall have no liability, consequential or otherwise, of any kind arising from the use of this program material or any part thereof.)

Please use the Applications Library Order Form. Order forms are included in the Membership Packet and are available from your local Tektronix Sales Engineer. Orders outside of the U.S. must be ordered through the local Tektronix sales office.

ABSTRACT NUMBER: 51/00-5402/0

Title: **Globe Rotation**
Author: Donald N. Sweetnam
Jet Propulsion Lab
Pasadena, CA
Memory Requirements: 8K
Statements: 146

This program allows a user to view a global representation of a planet or spherical surface from any direction. This is accomplished by generating a reference globe and rotating about any or all of the three axes.

The reference globe is generated in a right hand Cartesian coordinate system with the Z-axis pointing toward the north pole, the X-axis pointing through the prime (0) meridian and the Y-axis completing the system. The reference globe is positioned on the 4051 screen with the Z-axis up, the X-axis to the left and the Y-axis toward the user. The step to create the reference globe need only be done once since the coordinates are saved on tape.

Desired rotations are then chosen, the rotations made, and the resulting globe projected onto the display. Longitude lines are provided every 30 degrees as are latitude lines. Longitude coordinates are plotted every 6 degrees and latitude coordinates every 3 degrees. Hidden coordinates are not displayed.

The program employs extensive use of the User Definable Keys.

ABSTRACT NUMBER: 51/00-8014/0

Title: **Program File Recovery**
Memory Requirements: 32K
Peripherals: 4631 Hard Copy Unit
Statements: 73

This program was designed to recover a file which was "lost" due to a user powering up the 4051, inserting a tape, typing FINd (n) and then inadvertently typing SAVe instead of OLD. The program is recovered line by line and written to another file as well as printing to the screen and copying. All but approximately eight lines will be recovered with the original statement numbers intact.

The program can also be used to recover program statements which were lost due to other circumstances, but the chances of success are smaller.

ABSTRACT NUMBER: 51/00-1403/0

Title: **Analysis of Logic Circuit Behavior**
Author: K. J. Orford
Physics Department
Durham University
Memory Requirements: 16K
Peripherals: None
Statements: 325

This program stores the interrelationships of logic elements (gates, latches, etc) in a complex circuit, and predicts the state of all the elements a short time later. The program then has three optional modes. It can stop and print out, or continue and predict the next state and print until stopped, or continually predict subsequent states and show a selected number (up to 12) as waveform on the display. The three modes are selected by User-Definable Keys. Up to eight input lines may be used and changed at will during execution by pressing the User-Definable Keys.

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