A TWO-DIMENSIONAL GRAPHING PROGRAM FOR THE TEKTRONIX 4050-SERIES GRAPHICS COMPUTERS

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A TWO-DIMENSIONAL GRAPHING PROGRAM FOR THE TEKTRONIX* 4050-SERIES GRAPHICS COMPUTERS

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ABSTRACT

This report describes a refined, two-dimensional graph-plotting program that was developed for use on Tektronix 4050-series graphics computers. Principal features of this program include: any combination of logarithmic and linear axes, optional automatic scaling and numbering of the axes, multiple-curve plots, character- or drawn symbol-point plotting, optional cartridge-tape data entry and plot-format storage, optional spline fitting for smooth curves, and built-in data-editing options. The program is run while the Tektronix is not connected to any large auxiliary computer, although data from files on an auxiliary computer easily can be transferred to data-cartridge tape for later plotting. The user is led through the plot-construction process by a series of questions and requests for data entry. Five example plots are presented to illustrate program capability and the sequence of program operation.

INTRODUCTION

A refined, two-dimensional graph plotting program has been developed for a Tektronix 4050-series graphics computer. It is based on the PLOT2D program currently available on a Multics computer in Denver, but a number of additional features have been incorporated. The program is run on the Tektronix graphics computer independent of any large computer. The main features of this plotting program are the following:

1. Any combination of logarithmic and linear coordinates for an x-y plot.
2. An option for a calendar axis divided into months and years.
3. Optional automatic-axis scaling and numbering.
4. Graph title and axis labels (title can have as many as 72 characters: x-axis label can have as many as 70 characters; y-axis label can have as many as 30 characters).
5. Character point plotting or drawn symbol-point plotting or curves only.
6. Multiple-curve plots.
7. Any combination of point plotting and curve plotting.
8. Option for spline fitting for smooth curves.
9. Data entry by keyboard or data-cartridge tape.

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*Any use of trade-names is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey.

10. Data-cartridge-tape storage of plot data points and plot format information.
11. A data-set identification title as the first record of each data-cartridge-tape file.
12. Editing of data including modification, insertion, deletion.
13. Selectable data-point plotting frequency.
14. Entry of multiple y values for each x value.
15. Automatic sorting of the data into order along the x-axis.

PROGRAM DESCRIPTION AND OPERATIONAL CONSIDERATIONS

This PLOT2D program is written in Tektronix Basic with Plot 50 graphic instructions. Its present (February 1983) length is 933 statements. A listing is in the Supplemental Data section of this report, but most users will want to obtain a copy on a data-cartridge tape. The minimum equipment required is a Tektronix 4050 series computer and a hardcopy unit, such as the Tektronix 4631 or 4611. The original version of this code was developed on a machine with 32,000 bytes of memory. However, an overlay version is available for 24,000-byte machines. Tektronix compatible plotting equipment is optional. The program operation is largely self-explanatory; the user is led through the plot-construction process by a series of questions and data-entry requests on the screen. The following section contains some amplification of several items of program operation.

It is assumed that the user knows the fundamentals of using a Tektronix graphic computer to run a program, including the reading and creation of data-cartridge-tape files. The following items provide further explanation for the new user:

1. The control file contains the plot format and labeling information necessary to recreate a given plot base before data are plotted or curves are drawn. This file is useful when many plots are to be made with the same axis length, labeling, and title. After the first plot is complete, the control file is read, and the data points are entered to create additional plots.
2. Keyboard entry is in the form x_i, $y1_i$, $y2_i$, ... with a maximum of three y-values for each x-value. The entry cycle can be repeated if four or more curves are desired on the same plot. Data in the form of x_i, y_i pairs are accommodated by the above entry format.
3. Each line of entered data x_i, $y1_i$, $y2_i$, ... is followed by a carriage return, denoted subsequently as (CR). Either a comma or a space can be used to separate the data items on a line. A second carriage return terminates the entry of the current data set.
4. The data for calendar-axis plots need to be in the form YYMM, where YY is the last two digits of the year (79 for 1979) and MM is the two-digit month number (04 for April).

5. The only limit on the number of data points for a given plot is set by the available memory space of the Tektronix graphics computer in use. The number of curves and the number of points per curve is user-selectable within this limit. Approximately 600 data points can be plotted with the 32,000-byte graphics computer but near this limit there may not be enough memory to perform a spline fit.
6. After data entry via keyboard or tape, each data set can be edited in turn. The editing sequence consists of: (1) Changes to x,y data pairs; (2) deletions of data pairs; (3) additions of data pairs to the end of the data set; and (4) insertions of data pairs. A (CR) is used to move on to the next editing option.
7. The first record of any data set on cartridge tape needs to be in identifiers of as many as 72 characters. This record is displayed on the screen when the data file is read in for a plot. The data-file title is concatenated to the plot title for the plot display.
8. If the data are to be saved on tape, or a control file is to be created, marking a file causes all subsequent files on that tape to be lost. See the Tektronix manual for the instructions regarding file marking, so that unintentional destruction of data files does not occur.
9. The spline-fit routine is used to create a smooth curve joining data points. About 20-50 spline-evaluation points, spread throughout the x-axis range, are satisfactory, depending on the smoothness of the data to be connected. The user can choose whether or not to apply a spline fit to each curve individually.
10. Any ASCII character can be used as a point symbol or curve label. Available drawn symbols are a diamond, a square, a triangle with apex up, and a triangle with apex down. Size of the drawn symbols can be changed by changing the SCALE instruction in the program code.
11. Drawn-point symbols will be clipped at the edges of the plot, character symbols will not be clipped.
12. Printout format for the data can be either exponential or fixed decimal, with six digits to the right of the decimal point. The exponential format can portray a larger range of values, but it is not as easily read from the screen. Each line of data is indexed with a data-line number.
13. Answers to questions can be YES or NO, or abbreviated to Y or N.
14. When data points are read from data-cartridge tape, the number of columns of data needs to be known. A maximum of four columns of data can be read from a given data set on tape. Any two columns can then be selected to be the x and y1 data values. In the same manner, any of the remaining two columns can be selected to be the y2 column.
15. With data entry from a tape cartridge, a data file can be created from a program on a large computer, then that file can be transferred onto the Tektronix data-cartridge tape for plotting off-line.
16. With data entry from a tape cartridge, the maximum number of data points per curve needs to be specified at least one greater than the maximum number of data-point x values on the tape files to be used.

EXAMPLE PLOTS

Example plot 1: A typical plot-construction sequence

The following example shows questions, answers to questions, data entry, and data-entry requests as they appear on the Tektronix screen (fig. 1). The final plot also is presented (fig. 2). The starting worksheet might look like the following:

Table 1.—*Data for example plot 1*

Time (days)	Concentration of hexavalent chromium (milligrams per liter)		
	Batch 1	Batch 2	Batch 3
0	0.200	0.200	0.200
9	.180	.193	.139
15	--	--	.103
20	.173	.186	--
22	--	--	.066
30	--	--	.037
34	.164	.183	--
39	--	--	0.
64	.136	.155	--
80	.130	.145	--

Note that not all options can be illustrated by one example. There is no provision for a legend on the plot to indicate which symbol and curve is associated with which batch number. Drawn- and character-point symbols probably would not be mixed; they are shown here for illustration. Carriage returns are indicated by (CR) when entered alone as a request for user response. User responses are indicated by shading. Note that the spline-fit curve may be unsuitable for curves with few data points as curve 2 in this example.

Example plot 2: The spline-fit curve for a smooth plot

This plot example shows the capability of the spline-fitting routine to generate a smooth curve through the data points. The sequence of plot construction appears in figure 3 and the plot in figure 4. A plot without the spline-fit curve also is presented for comparison (fig. 5). Note the concatenation of the title with the data-set title from the entry data tape.

Example plot 3: Test of saving the data on cartridge tape

This example (fig. 6) shows the procedure of saving plotted data points on cartridge tape. It also shows how the user may specify ranges of the axes for the plot (fig. 7).

```
     ***  PLOT2D GRAPHING PROGRAM  ***   REVISED 2-17-82
Enter maximum no. of data points per curve 15
Enter maximum no. of curves per plot 4
Do you wish to read a control file for this plot?  NO
Enter title of graph.
CHROMIUM BATCH EXPERIMENTS
Enter x-axis label. (Skip if calendar axis)
TIME (DAYS)
Enter y-axis label.
CONC. Cr+6 (MG/L)
Is this data to be in: 1=arithmetic scale,
                       2=logarithmic scale
                       3=calendar scale (x-axis only)
Enter as x-scale,y-scale.  1,1
Do you wish to read data in from the keyboard?  YES
How many columns of y-data are to be entered?
     Up to 3 allowed  2
Enter data values as x,y1,y2,.... Enter a carriage return
     after the last pair has been entered
0 .2 .2
9 .18 .193
20 .173 .186
34 .164 .183
64 .136 .155
80 .130 .145
(CR)
Do you want to list the data values or edit?  Y
Select listing format:-
      E - for exponential
      F - for fixed decimal (6 digits to right of point)  F
```

Figure 1.--Sequential printouts of the Tektronix screen during plot creation for example plot 1.

```
THE DATA VALUES
 J          X                Y 1              Y 2              Y 3
 1        0.000000         0.200000         0.200000

 2        9.000000         0.180000         0.193000

 3       20.000000         0.173000         0.186000

 4       34.000000         0.164000         0.183000

 5       64.000000         0.136000         0.155000

 6       80.000000         0.130000         0.145000

Is any editing required?  Y
Editing must be done on each x,y1,y2,... data set
        as a unit
Index of data to be changed  2
CURRENT VALUE OF X(2,1),Y(2,1),...IS
 9                  0.18 0.193

Change to  9 .185 .293
Index of data to be changed (CR)
Enter values of item to be appended -x1,y1,y2,...
90 .1 .1
(CR)
Index of item to be deleted  5
Value deleted   64                    0.136 0.155

Index of item to be deleted  (CR)
Index of item to be preceded  5
Enter values to be inserted  (x,y1,y2,...)
65 .14 .11
Index of item to be preceded (CR)
```

Figure 1.--Sequential printouts of the Tektronix screen during plot creation for example plot 1--Continued.

```
THE DATA VALUES
 J          X                Y 1              Y 2              Y 3
 1        0.000000         0.200000         0.200000

 2        9.000000         0.185000         0.293000

 3       20.000000         0.173000         0.186000

 4       34.000000         0.164000         0.183000

 5       65.000000         0.140000         0.110000

 6       80.000000         0.130000         0.145000

 7       90.000000         0.100000         0.100000

Is any editing required?  N
Curve no.  1
Enter type of plot wanted: 1=points,
                           2=lines,
                           3=points and lines.  3
Enter desired symbol. Any ASCII character or DRAW if
     drawn symbol is desired   DRAW
Enter desired drawn symbol:
       1 - diamond
       2 - square
       3 - triangle up
       4 - triangle down    1
Enter the frequency of symbol plotting. Every nth point
     after the first  1
Do you wish a cubic spline fit of the data for a smooth plot?  NO
```

Figure 1.--Sequential printouts of the Tektronix screen during plot creation for example plot 1--Continued.

```
Curve no.  2
Enter type of plot wanted: 1=points,
                           2=lines,
                           3=points and lines.  3
Enter desired symbol. Any ASCII character or DRAW if
     drawn symbol is desired   DRAW
Enter desired drawn symbol:
       1 - diamond
       2 - square
       3 - triangle up
       4 - triangle down    2
Enter the frequency of symbol plotting. Every nth point
     after the first  1
Do you wish a cubic spline fit of the data for a smooth plot?  YES
Enter number of points to be spread over x-range
     for spline curves  30
Do you wish to have the data saved (resaved) in a file?
     (automatic marking of file)  NO
Do you wish to plot another data set?  Y
Do you wish to read data in from the keyboard?  Y
How many columns of y-data are to be entered?
     Up to 3 allowed  1
Enter data values as x,y1,y2,.... Enter a carriage return
     after the last pair has been entered
0 ,2
9 .139
15 .103
22.0 .066
30 .037
39 0.
(CR)
```

Figure 1.--Sequential printouts of the Tektronix screen during plot creation for example plot 1--Continued.

```
Do you want to list the data values or edit? Y
Select listing format:-
      E - for exponential
      F - for fixed decimal (6 digits to right of point) E
```

Figure 1.--Sequential printouts of the Tektronix screen during plot creation for example plot 1--Continued.

```
THE DATA VALUES
 J          X                Y 3                Y 4                Y 5
  1   0.00000E+000    2.00000E-001

  2   9.00000E+000    1.39000E-001

  3   1.50000E+001    1.03000E-001

  4   2.20000E+001    6.60000E-002

  5   3.00000E+001    3.70000E-002

  6   3.90000E+001    0.00000E+000

Is any editing required?  NO
Curve no.  3
Enter type of plot wanted: 1=points,
                           2=lines,
                           3=points and lines.  3
Enter desired symbol. Any ASCII character or DRAW if
     drawn symbol is desired   A
Enter the frequency of symbol plotting. Every nth point
     after the first  1
Do you wish a cubic spline fit of the data for a smooth plot?  N
Do you wish to have the data saved (resaved) in a file?
     (automatic marking of file)  N
Do you wish to plot another data set?  N
Minimum and maximum values of x are:
0.                    90.
Minimum and maximum values of y are:
0.                    0.293
Do you wish automatic tic and axis labels?  YES
Do you wish to make a control file containing the
previous information?  NO
```

Figure 1.--Sequential printouts of the Tektronix screen during plot creation for example plot 1--Continued.

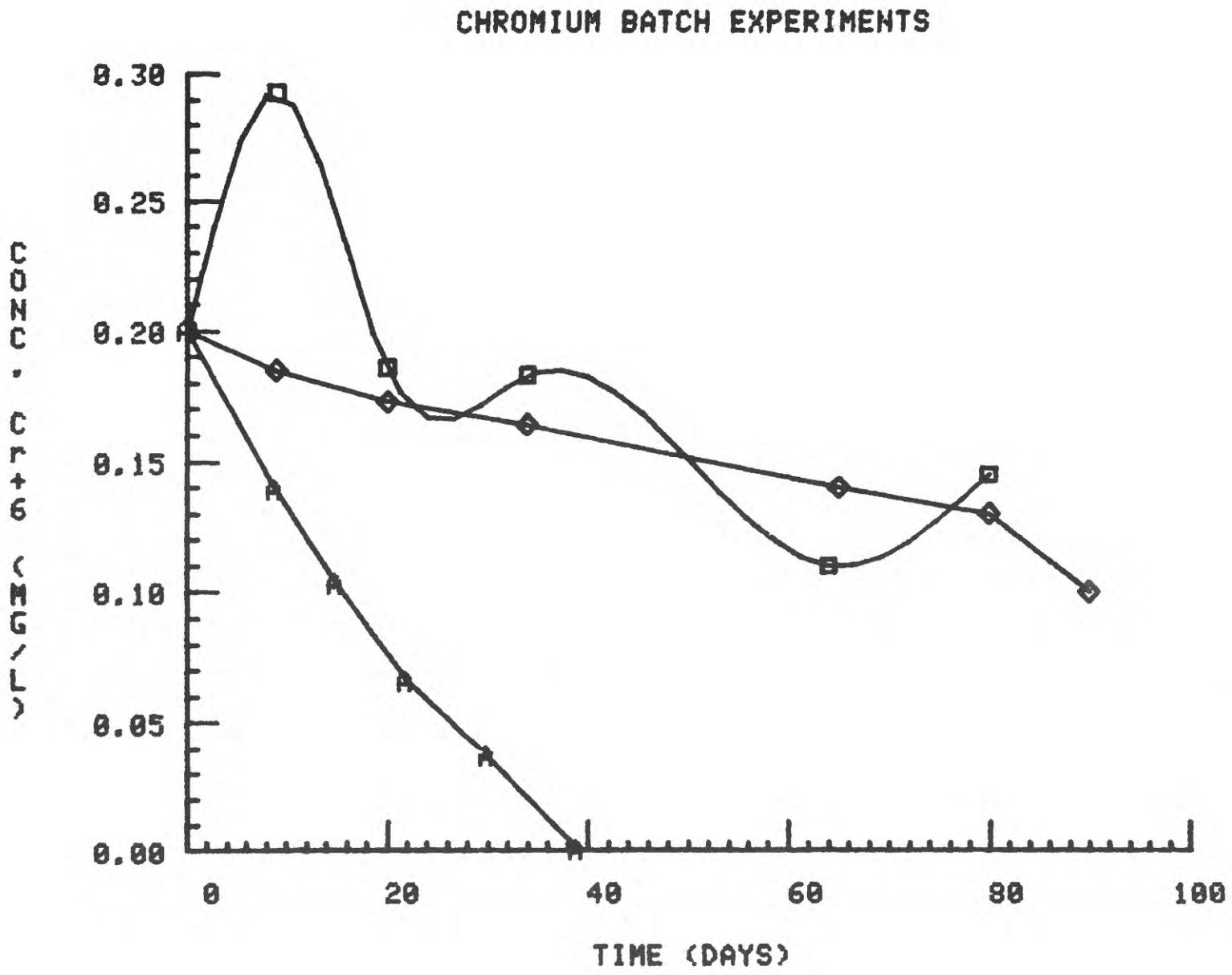

Figure 2.--Example plot 1.

```
     ***  PLOT2D GRAPHING PROGRAM  ***   REVISED 2-17-82
Enter maximum no. of data points per curve 20
Enter maximum no. of curves per plot 1
Do you wish to read a control file for this plot?  NO
Enter title of graph.
TEST OF SPLINE FIT CURVE
Enter x-axis label. (Skip if calendar axis)
TIME
Enter y-axis label.
CONC.
Is this data to be in: 1=arithmetic scale,
                       2=logarithmic scale
                       3=calendar scale (x-axis only)
Enter as x-scale,y-scale.  1,1
Do you wish to read data in from the keyboard?  NO
Insert tape and enter file number of input.  1
 CONCENTRATION - TIME  RUN #1
How many columns are there in this data set? Up to 4 allowed
2
Do you want to list the data values or edit?  NO
Curve no.  1
Enter type of plot wanted: 1=points,
                           2=lines,
                           3=points and lines.  2
Do you wish a cubic spline fit of the data for a smooth plot?  YES
Enter number of points to be spread over x-range
     for spline curves  40
Do you wish to have the data saved (resaved) in a file?
     (automatic marking of file)  NO
Minimum and maximum values of x are:
0.1                    1.5
Minimum and maximum values of y are:
0.000000000011329      0.61244
Do you wish automatic tic and axis labels?  YES
Do you wish to make a control file containing the
```

Figure 3.--Sequential printouts of the Tektronix screen dring plot creation for example plot 2.

previous information? NO

Figure 3.--Sequential printouts of the Tektronix screen during plot creation for example plot 2.

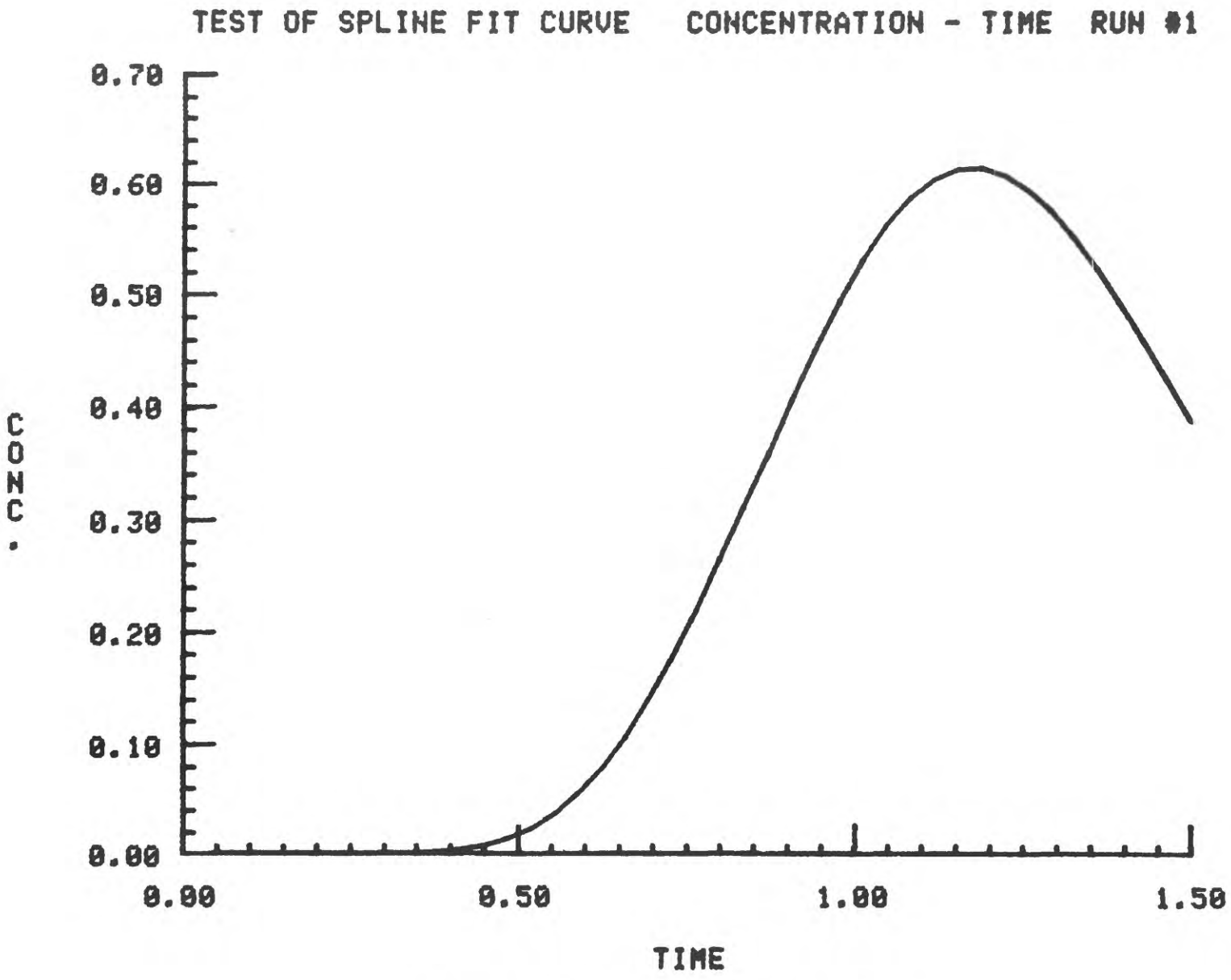

Figure 4.--Example plot 2 with spline.

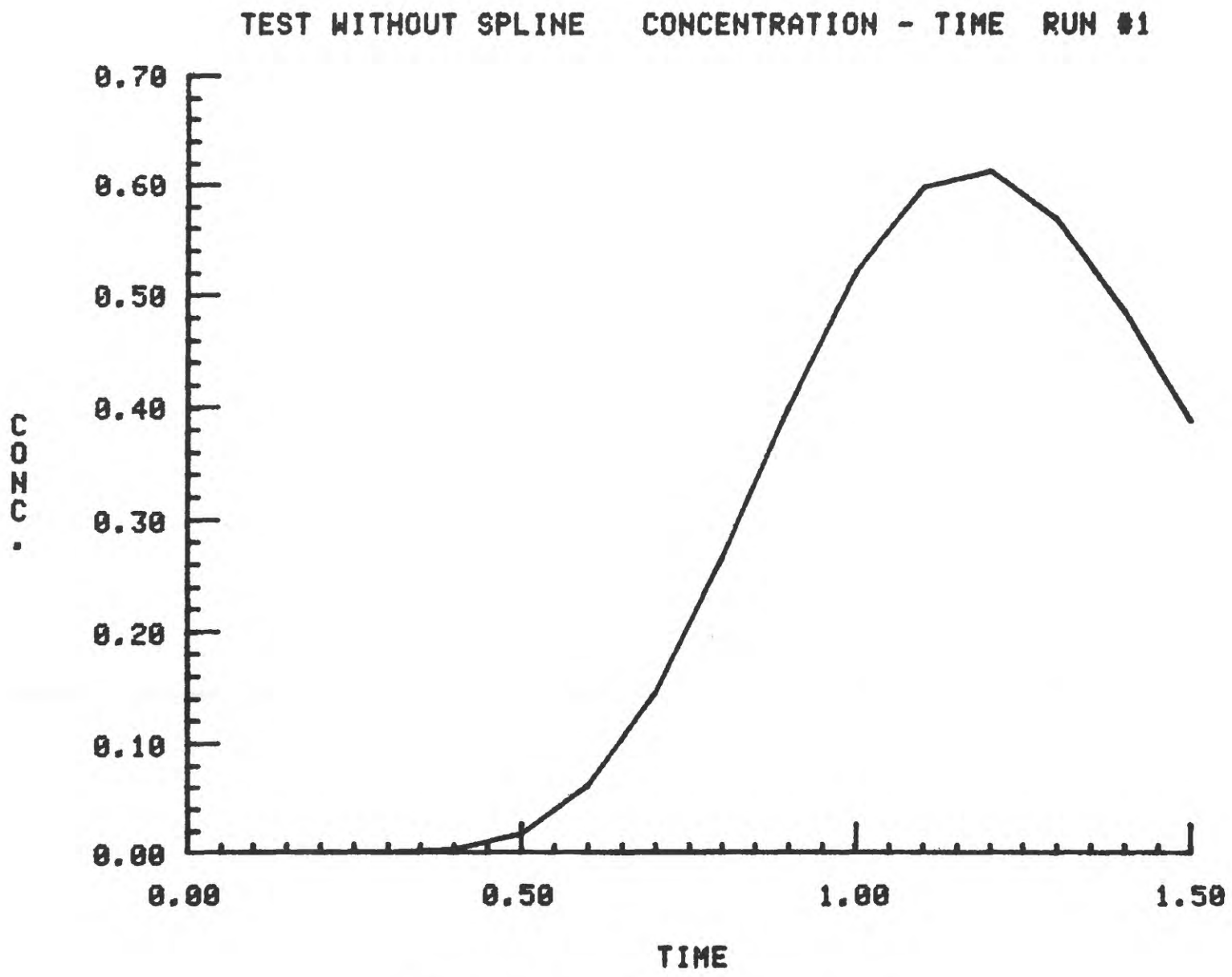

Figure 5.--Example plot 2 without spline.

```
     ***  PLOT2D GRAPHING PROGRAM  ***   REVISED 2-17-82
Enter maximum no. of data points per curve 8
Enter maximum no. of curves per plot 1
Do you wish to read a control file for this plot?  NO
Enter title of graph.
TEST OF DATA SAVE OPTION
Enter x-axis label. (Skip if calendar axis)
X
Enter y-axis label.
Y
Is this data to be in: 1=arithmetic scale,
                       2=logarithmic scale
                       3=calendar scale (x-axis only)
Enter as x-scale,y-scale.  1,1
Do you wish to read data in from the keyboard?  Y
How many columns of y-data are to be entered?
     Up to 3 allowed  1
Enter data values as x,y1,y2,.... Enter a carriage return
     after the last pair has been entered
1,2
2,3
3,4
4,2
5,1
 (CR)
Do you want to list the data values or edit?  Y
Select listing format:-
      E - for exponential
      F - for fixed decimal (6 digits to right of point)  F
```

Figure 6.--Sequential printouts of the Tektronix screen during plot creation for example plot 3.

```
THE DATA VALUES
 J          X                Y 1                Y 2                Y 3
  1       1.000000         2.000000

  2       2.000000         3.000000

  3       3.000000         4.000000

  4       4.000000         2.000000

  5       5.000000         1.000000

Is any editing required?  NO
Curve no.  1
Enter type of plot wanted: 1=points,
                           2=lines,
                           3=points and lines.  3
Enter desired symbol. Any ASCII character or DRAW if
     drawn symbol is desired   X
Enter the frequency of symbol plotting. Every nth point
     after the first  1
Do you wish a cubic spline fit of the data for a smooth plot?  N
Do you wish to have the data saved (resaved) in a file?
     (automatic marking of file)  YES
Enter title for data save file (up to 72 characters)
TEST OF DATA TAPE SAVE
Insert tape and enter file number for data save file.  1
Minimum and maximum values of x are:
1.                    5.
Minimum and maximum values of y are:
1.                    4.
Do you wish automatic tic and axis labels?  NO
```

Figure 6.--Sequential printouts of the Tektronix screen during plot creation for example plot 3--Continued.

```
Do you wish to change these limits?
Y
Enter minimum and maximum values of x as xmin,xmax.
0,5
Enter minimum and maximum values of y as ymin,ymax.
0,8
Enter number of data units between labeled tick marks---
Enter as: x-units,y-units (0-if log scale,1-if calendar)
1,2
Enter number of subdivisions between labeled tick marks---
Enter as: x,y (0-if log scale,12-if calendar scale)
2,2
Do you wish to make a control file containing the
previous information?  NO
```

Figure 6.--Sequential printouts of the Tektronix screen during plot creation for example plot 3--Continued.

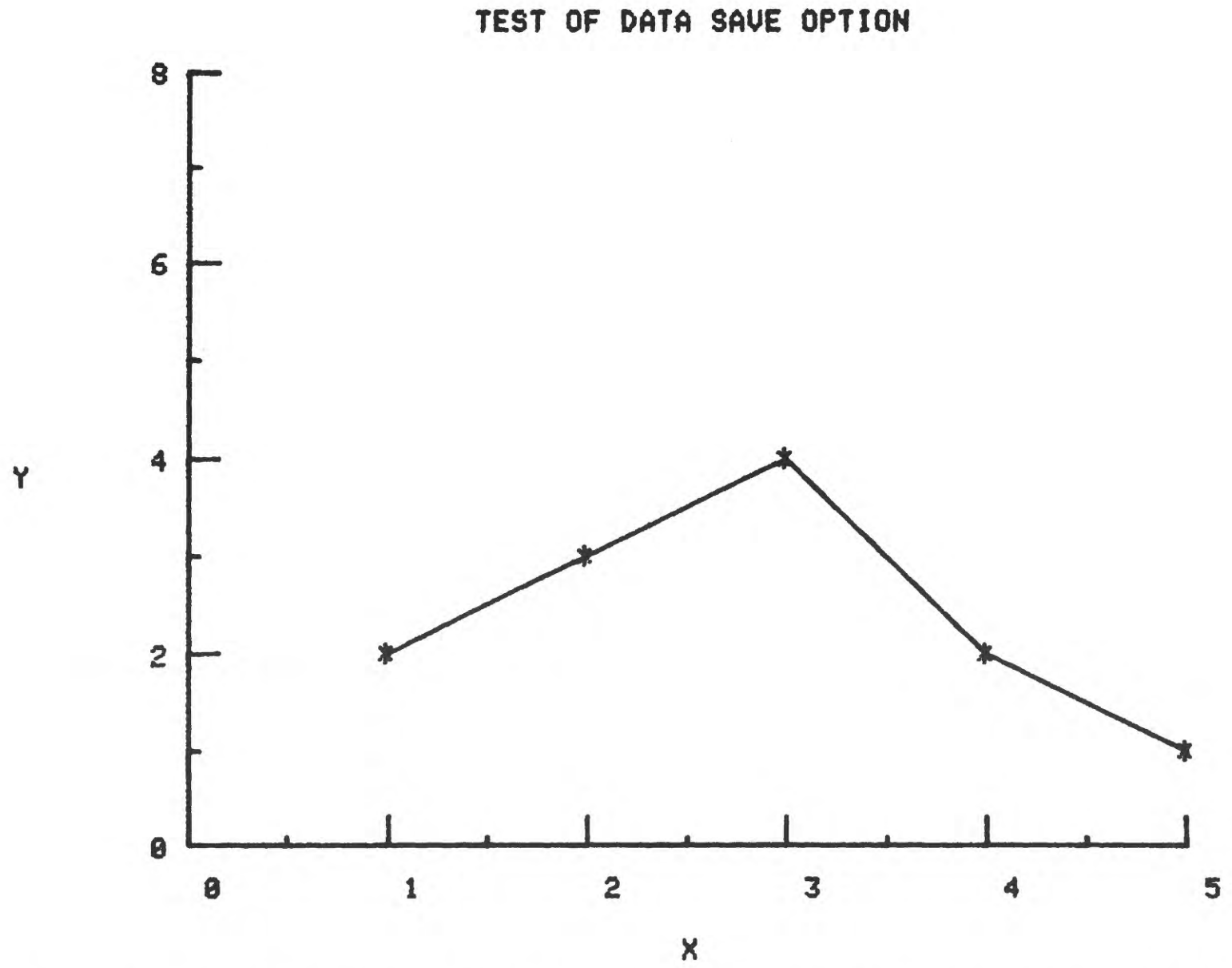

Figure 7.--Sequential printouts of the Tektronix screen during plot creation for example plot 3.

Example plot 4: Test of the entry of the plotted points from cartridge tape

This example (fig. 8) recovers the data of example plot 4 from tape for the plot. Automatic and semi-log axis ranges are used in this case (fig. 9) for contrast with the results of example plot 3 (fig. 7).

Example plot 5: Illustration of calendar axis

This example (fig. 10) illustrates the use of the calendar-axis option. The resulting plot appears in figure 11. Note the form of the entry of the month and year data.

ACKNOWLEDGMENTS

The original multics PLOT2D version was obtained from R. K. Waddell of the U.S. Geological Survey. Most of the graphics algorithms came from the Tektronix manuals. The sorting-routine algorithm by B. Gunn came from the Tektronix user-applications library newsletter.

```
     ***  PLOT2D GRAPHING PROGRAM  ***   REVISED 2-17-82
Enter maximum no. of data points per curve 8
Enter maximum no. of curves per plot 1
Do you wish to read a control file for this plot?  N
Enter title of graph.
TEST OF DATA INPUT FROM TAPE
Enter x-axis label. (Skip if calendar axis)
X
Enter y-axis label.
Y
Is this data to be in: 1=arithmetic scale,
                       2=logarithmic scale
                       3=calendar scale (x-axis only)
Enter as x-scale,y-scale.  1,2
Do you wish to read data in from the keyboard?  NO
Insert tape and enter file number of input.  1
TEST OF DATA TAPE SAVE
How many columns are there in this data set? Up to 4 allowed
2
Do you want to list the data values or edit?  Y
Select listing format:-
      E - for exponential
      F - for fixed decimal (6 digits to right of point)  F
```

Figure 8.--Sequential printouts of the Tektronix screen during plot creation for example plot 4--Continued.

```
THE DATA VALUES
 J          X                Y 1                Y 2                Y 3
  1       1.000000         2.000000

  2       2.000000         3.000000

  3       3.000000         4.000000

  4       4.000000         2.000000

  5       5.000000         1.000000

Is any editing required?  NO
Curve no.  1
Enter type of plot wanted: 1=points,
                           2=lines,
                           3=points and lines.  3
Enter desired symbol. Any ASCII character or DRAW if
     drawn symbol is desired   +
Enter the frequency of symbol plotting. Every nth point
     after the first  1
Do you wish a cubic spline fit of the data for a smooth plot?  N
Do you wish to have the data saved (resaved) in a file?
     (automatic marking of file)  NO
Minimum and maximum values of x are:
1.                        5.
Minimum and maximum values of y are:
1.                        4.
Do you wish automatic tic and axis labels?  YES
Do you wish to make a control file containing the
previous information?  NO
```

Figure 8.--Sequential printouts of the Tektronix screen during plot creation for example plot 4.

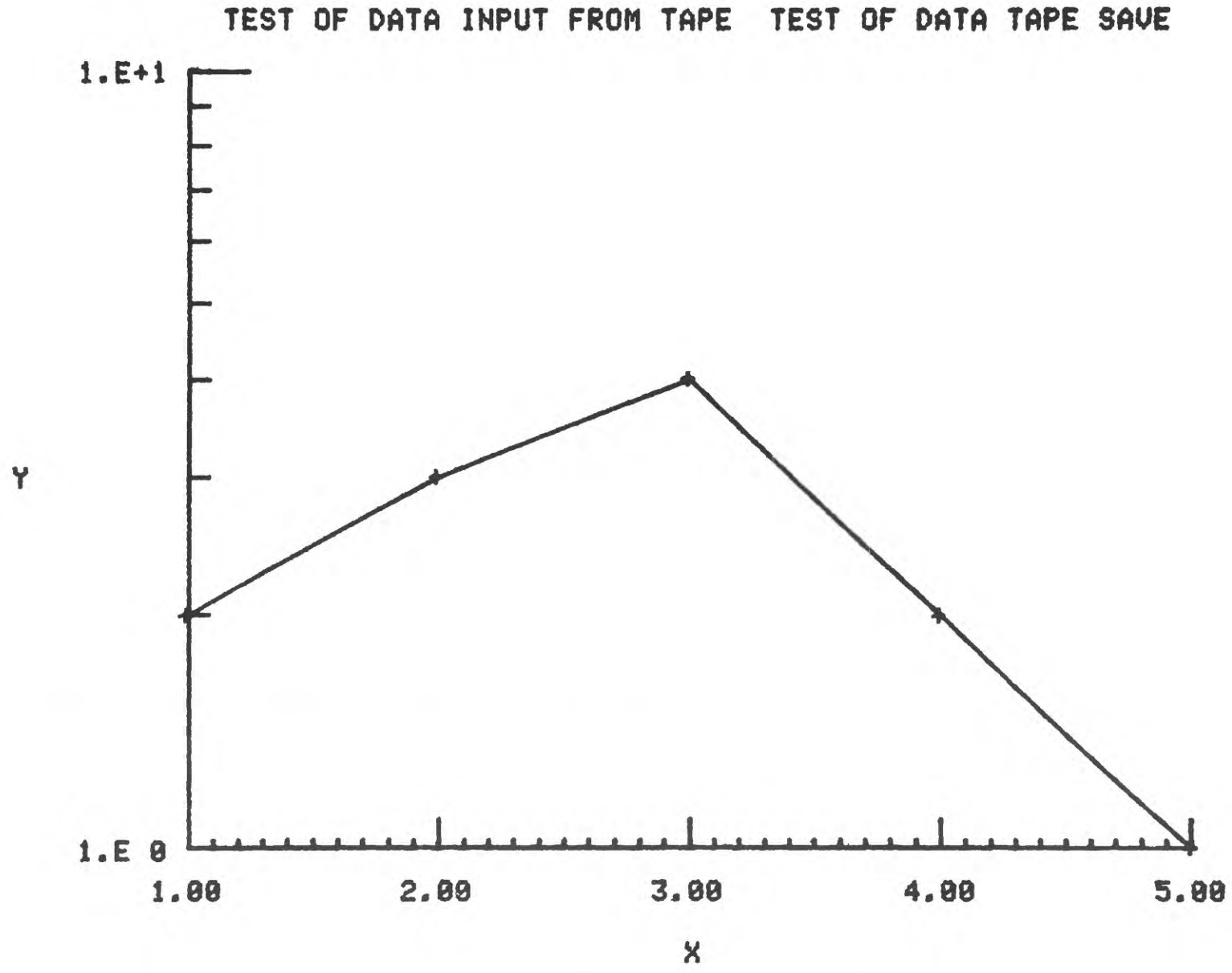

Figure 9.--Sequential printouts of the Tektronix screen during plot creation for example plot 4.

```
     ***  PLOT2D GRAPHING PROGRAM  ***   REVISED 2-17-82
Enter maximum no. of data points per curve 8
Enter maximum no. of curves per plot 1
Do you wish to read a control file for this plot?  N
Enter title of graph.
TEST OF CALENDAR AXIS
Enter x-axis label. (Skip if calendar axis)
(CR)
Enter y-axis label.
Y
Is this data to be in: 1=arithmetic scale,
                       2=logarithmic scale
                       3=calendar scale (x-axis only)
Enter as x-scale,y-scale.  3,1
Do you wish to read data in from the keyboard?  Y
How many columns of y-data are to be entered?
     Up to 3 allowed  1
Enter data values as x,y1,y2,.... Enter a carriage return
     after the last pair has been entered
Enter calendar date values as yymm digits
8201  3
8204  5
8206  2
8303  7
8312  7
(CR)
Do you want to list the data values or edit?  N
```

Figure 10.--Sequential printouts of the Tektronix screen during plot creation for example plot 5.

```
Curve no.  1
Enter type of plot wanted: 1=points,
                           2=lines,
                           3=points and lines.  3
Enter desired symbol. Any ASCII character or DRAW if
     drawn symbol is desired   DRAW
Enter desired drawn symbol:
       1 - diamond
       2 - square
       3 - triangle up
       4 - triangle down    3
Enter the frequency of symbol plotting. Every nth point
     after the first  1
Do you wish a cubic spline fit of the data for a smooth plot?  N
Do you wish to have the data saved (resaved) in a file?
     (automatic marking of file)  N
Minimum and maximum values of x are:
8201.                    8312.
Minimum and maximum values of y are:
2.                       7.
Do you wish automatic tic and axis labels?
Calendar axis will be automatically scaled  Y
Do you wish to make a control file containing the
previous information?  N
```

Figure 10.--Sequential printouts of the Tektronix screen during plot creation for example plot 5--Continued.

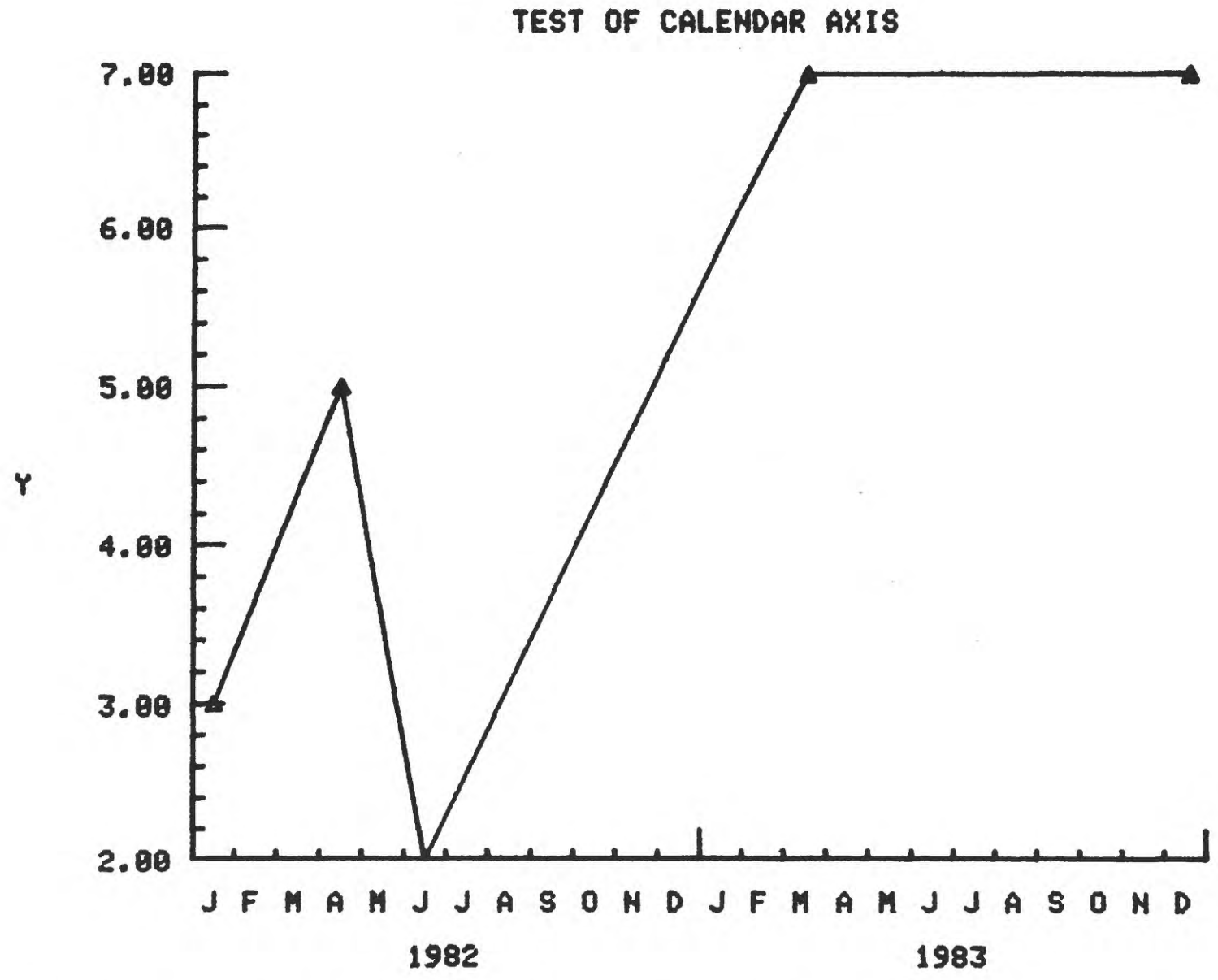

Figure 11.--Sequential printouts of the Tektronix screen during plot creation for example plot 5.

SUPPLEMENTAL DATA

PLOT2D Program Listing

```
80 REM "** PLOT2D GRAPHING PROGRAM   REVISED 2-15-82"
81 REM @100:PROGRAM-BEGINING
82 REM **      X-VALUE AND MULTIPLE Y-VALUES CAN BE ENTERED
83 REM ** VERSION WITH AUTOMATIC SCALING AND TIC INTERVALS
85 REM **VERSION WITH CUBIC SPLINE OPTION FOR SMOOTH CURVES
86 REM **VERSION WITH DRAWN PLOT SYMBOL OPTION
87 REM **VERSION WITH CALENDAR X-AXIS OPTION
88 REM **VERSION WITH TITLE ON INPUT DATA FILE
90 REM***USE 3 ("XREF.SYM")
95 REM **K.L.KIPP,USGS-WRD,DENVER
100 INIT
110 REM ** ASCII FILES ARE USED FOR TAPE WRITING AND INPUT
120 DIM Z(4),K$(20),L$(20),T$(20)
130 DIM H$(3),A$(3),W$(3),Z$(1),J$(3),B$(3),D$(1),E$(1),F$(1),I$(1)
140 DIM Q$(1),V$(12),U$(1),R$(1)
150 N1=0
160 V1=20
170 V2=120
180 V3=15
190 V4=95
200 T$=""
210 V$="JFMAMJJASOND"
220 PAGE
230 PRINT "     ***  PLOT2D GRAPHING PROGRAM  ***   REVISED 2-15-82"
240 PRINT "Enter maximum no. of data points per curve ";
250 INPUT M1
260 PRINT "Enter maximum no. of curves per plot ";
270 INPUT M2
280 M4=MEMORY
290 IF M1*M2*18<M4 THEN 320
300 PRINT "Too many points and curves desired"
310 GO TO 240
320 DIM S(M1,M2),T(M1,M2),M(M2),N2(M2),A(M2),S2(M2),I5(M2)
330 DIM W5(M2)
340 PRINT "Do you wish to read a control file for this plot?"
350 INPUT H$
360 F$=SEG(H$,1,1)
370 IF F$="y" THEN 550
380 PRINT "Enter title of graph."
390 INPUT C$
400 H=LEN(C$)
410 WINDOW 0,130,0,100
420 VIEWPORT 0,130,0,100
430 PRINT "Enter x-axis label. (Skip if calendar axis)"
440 INPUT X$
450 PRINT "Enter y-axis label."
460 INPUT Y$
470 Q1=LEN(X$)
480 R1=LEN(Y$)
```

```
490 PRINT 'Is this data to be in: 1=arithmetic scale,"
500 PRINT "                       2=logarithmic scale "
510 PRINT "                       3=calendar scale (x-axis only) ?"
520 PRINT 'Enter as x-scale,y-scale.'
530 INPUT L3,L4
540 GO TO 620
550 PRINT 'Insert tape and enter file number of control segment.'
560 INPUT F1
570 FIND F1
580 INPUT @33:C$


590 INPUT @33:H
600 INPUT @33:X$,Y$
610 INPUT @33:Q1,R1,L3,L4,C,D,E,F,T1,T2,U1,U2,K3,K4,E5,E6,E7,E8
620 I=0
630 PRINT 'Do you wish to read data in from the keyboard?"
640 INPUT A$
650 D$=SEG(A$,1,1)
660 IF D$="y" THEN 1170
670 REM ** TAPE INPUT
680 PRINT 'Insert tape and enter file number of input.'
690 INPUT F2
700 FIND F2
710 INPUT @33:N$
720 PRINT N$
730 C$=C$&"  "
740 C$=C$&N$
750 H=LEN(C$)
760 ON EOF (0) THEN 1110
770 N=N1
780 C5=1
790 PRINT 'How many columns are there in this data set? Up to 4 allowed"
800 INPUT C6
810 IF C6>2 THEN 860
820 N=N+1
830 I=I+1
840 INPUT @33:S(I,N),T(I,N)
850 GO TO 830
860 PRINT 'How many columns of y-data are to be read? Up to 3 allowed"
870 INPUT C5
880 PRINT 'Which columns contain the x- and y1-values?"
890 INPUT C1,C2
900 IF C5=1 THEN 960
910 PRINT 'Which column contains y2-values?"
920 INPUT C3
930 IF C5=2 THEN 960
940 PRINT 'Which column contains y3-values?"
950 INPUT C4
960 N=N+1
```

```
970 I=I+1
980 IF C6=4 THEN 1010
990 INPUT @33:Z(1),Z(2),Z(3)
1000 GO TO 1020
1010 INPUT @33:Z(1),Z(2),Z(3),Z(4)
1020 S(I,N)=Z(C1)
1030 T(I,N)=Z(C2)
1040 IF C5=1 THEN 970
1050 T(I,N+1)=Z(C3)
1060 S(I,N+1)=S(I,N)
1070 IF C5=2 THEN 970
1080 T(I,N+2)=Z(C4)
1090 S(I,N+2)=S(I,N)
1100 GO TO 970
1110 N1=N1+C5
1120 I=I-1
1130 FOR N=N1-C5+1 TO N1
1140 N2(N)=I
1150 NEXT N
1160 GO TO 1580
1170 REM ** KEYBOARD DATA ENTRY
1180 PRINT "How many columns of y-data are to be entered?"
1190 PRINT "     Up to 3 allowed"
1200 INPUT C5
1210 IF N1+C5-1<=M2 THEN 1240
1220 PRINT "Too many curves desired "


1230 GO TO 1180
1240 PRINT "Enter data values as x,y1,y2,.... Enter a carriage return"
1250 PRINT "     after the last pair has been entered"
1260 IF L3<3 THEN 1280
1270 PRINT "Enter calendar date values as yymm digits"
1280 N=N1
1290 INPUT K$
1300 IF K$=T$ THEN 1570
1310 L=LEN(K$)
1320 P1=POS(K$,",",1)
1330 IF P1<>0 THEN 1350
1340 P1=POS(K$," ",1)
1350 L$=SEG(K$,1,P1-1)
1360 I=I+1
1370 S(I,N1+1)=VAL(L$)
1380 N=N+1
1390 P2=P1
1400 P2=P2+1
1410 R$=SEG(K$,P2,1)
1420 IF R$=" " THEN 1400
1430 IF N=C5+N1 THEN 1480
1440 P1=POS(K$,",",P2)
```

```
1450 IF P1<>0 THEN 1490
1460 P1=POS(K$," ",P2)
1470 GO TO 1490
1480 P1=L+1
1490 L$=SEG(K$,P2,P1-P2)
1500 T(I,N)=VAL(L$)
1510 IF N=N1+1 THEN 1530
1520 S(I,N)=S(I,N-1)
1530 P2=P1
1540 N2(N)=I
1550 IF P2<=L AND N<C5+N1 THEN 1380
1560 IF I<M1 THEN 1280
1570 N1=N1+C5
1580 N=N1-C5+1
1590 REM **SHELLSORT THE DATA ON S(I,N(INIT))
1600 D1=2^INT(LOG(I)/LOG(2)+1)
1610 D1=INT((D1-1)/2)
1620 IF D1=0 THEN 1900
1630 I1=INT(I-D1)
1640 FOR I2=1 TO I1
1650 J=I2
1660 L1=J+D1
1670 IF S(L1,N)=>S(J,N) THEN 1880
1680 S1=S(J,N)
1690 T3=T(J,N)
1700 IF C5=1 THEN 1740
1710 T4=T(J,N+1)
1720 IF C5=2 THEN 1740
1730 T5=T(J,N+2)
1740 S(J,N)=S(L1,N)
1750 T(J,N)=T(L1,N)
1760 IF C5=1 THEN 1800
1770 T(J,N+1)=T(L1,N+1)
1780 IF C5=2 THEN 1800
1790 T(J,N+2)=T(L1,N+2)
1800 S(L1,N)=S1
1810 T(L1,N)=T3
1820 IF C5=1 THEN 1860
1830 T(L1,N+1)=T4
1840 IF C5=2 THEN 1860
1850 T(L1,N+2)=T5
1860 J=J-D1


1870 IF J>0 THEN 1660
1880 NEXT I2
1890 GO TO 1610
1900 PRINT "Do you want to list the data values or edit?  ";
1910 INPUT B$
1920 D$=SEG(B$,1,1)
```

```
1930 IF D$="n" THEN 3010
1940 PRINT "Select listing format:-"
1950 PRINT "       E - for exponential"
1960 PRINT "       F - for fixed decimal (6 digits to right of point)"
1970 INPUT Q$
1980 IF D$="n" THEN 3010
1990 PAGE
2000 PRINT "THE DATA VALUES"
2010 N=N1-C5+1
2020 IMAGE 2T,A,12T,A,27T,A,2D,45T,A,2D,60T,A,2D
2030 PRINT USING 2020:"J","X","Y",N,"Y",N+1,"Y",N+2
2040 FOR J=1 TO I
2050 N9=N
2060 IF Q$="E" THEN 2090
2070 PRINT USING "3D,2X,2(6D.6D,3X),S":J,S(J,N9),T(J,N9)
2080 GO TO 2100
2090 PRINT USING "3D,2X,2(5E,3X),S":J,S(J,N9),T(J,N9)
2100 N9=N9+1
2110 IF N9>N1 THEN 2170
2120 IF Q$="E" THEN 2150
2130 PRINT USING "6D.6D,S":T(J,N9)
2140 GO TO 2160
2150 PRINT USING "5E,3X,S":T(J,N9)
2160 GO TO 2100
2170 PRINT USING "/":
2180 NEXT J
2190 REM **EDITOR
2200 PRINT "Is any editing required?"
2210 INPUT B$
2220 D$=SEG(B$,1,1)
2230 IF D$="n" THEN 3010
2240 PRINT "Editing must be done on each x,y1,y2,... data set"
2250 PRINT "       as a unit"
2260 N=N1-C5+1
2270 PRINT "N(start)=",N
2280 REM **CHANGE DATA
2290 PRINT "Index of data to be changed =";
2300 INPUT J$
2310 IF J$="" THEN 2420
2320 J=VAL(J$)
2330 IF J=>1 AND J<=I THEN 2360
2340 PRINT "Index is out of range"
2350 GO TO 2290
2360 PRINT "CURRENT VALUE OF S(";J;",";N;"),T(";J;",";N;"),...IS "
2370 N9=N
2380 GOSUB 8990
2390 PRINT "Change to "
2400 GOSUB 8900
2410 GO TO 2290
2420 REM **APPEND DATA VALUE
```

```
2430 IF I<M1 THEN 2460
2440 PRINT "Arrays are filled"
2450 GO TO 2510
2460 PRINT "Enter values of item to be appended -x1,y1,y2,..."
2470 I=N2(N)
2480 N9=N
2490 GOSUB 9080
2500 N2(N)=I


2510 REM **DELETE DATA
2520 PRINT "Index of item to be deleted =";
2530 INPUT J$
2540 IF J$="" THEN 2720
2550 J=VAL(J$)
2560 IF J=>1 AND J<=I THEN 2590
2570 PRINT "Index is out of range"
2580 GO TO 2520
2590 PRINT "Value deleted =";
2600 N9=N
2610 GOSUB 8990
2620 IF J=I THEN 2690
2630 FOR K=J+1 TO I
2640 S(K-1,N)=S(K,N)
2650 FOR N9=N1-C5+1 TO N1
2660 T(K-1,N9)=T(K,N9)
2670 NEXT N9
2680 NEXT K
2690 I=I-1
2700 N2(N)=I
2710 GO TO 2520
2720 REM **INSERT DATA
2730 IF I<M1 THEN 2760
2740 PRINT "Arrays are filled"
2750 GO TO 1990
2760 PRINT "Index of item to be preceded =";
2770 INPUT J$
2780 IF J$="" THEN 1990
2790 J=VAL(J$)
2800 IF J=>1 AND J<=I THEN 2830
2810 PRINT "Index is out of range"
2820 GO TO 2720
2830 FOR K=I TO J STEP -1
2840 S(K+1,N)=S(K,N)
2850 FOR N9=N TO N1
2860 T(K+1,N9)=T(K,N9)
2870 NEXT N9
2880 NEXT K
2890 I=I+1
2900 N2(N)=I
```

```
2910 PRINT "Enter values to be inserted  (x,y1,y2,...)"
2920 GOSUB 8900
2930 GO TO 2720
2940 IF C5=1 THEN 3010
2950 FOR N9=N1-C5+2 TO N1
2960 FOR J=1 TO N2(N)
2970 S(J,N9)=S(J,N1-C5+1)
2980 N2(N9)=N2(N1-C5+1)
2990 NEXT J
3000 NEXT N9
3010 FOR N=N1-C5+1 TO N1
3020 PRINT "Curve no.  ";N
3030 PRINT "Enter type of plot wanted: 1=points,"
3040 PRINT "                           2=lines,"
3050 PRINT "                           3=points and lines."
3060 INPUT M(N)
3070 IF M(N)=2 THEN 3260
3080 S2(N)=0
3090 PRINT "Enter desired symbol. Any ASCII character or DRAW if"
3100 PRINT "     drawn symbol is desired   ";
3110 INPUT M$
3120 IF M$="DRAW" THEN 3160
3130 Z$=SEG(M$,1,1)
3140 A(N)=ASC(Z$)


3150 GO TO 3220
3160 PRINT "Enter desired drawn symbol:"
3170 PRINT "      1 - diamond"
3180 PRINT "      2 - square"
3190 PRINT "      3 - triangle up"
3200 PRINT "      4 - triangle down    ";
3210 INPUT S2(N)
3220 PRINT "Enter the frequency of symbol plotting. Every nth point"
3230 PRINT "     after the first  ";
3240 INPUT I5(N)
3250 IF M(N)=1 THEN 3400
3260 M4=MEMORY
3270 IF 13*N2(N)-25<=M4 THEN 3310
3280 PRINT "Insufficient memory for spline fit for curve ";N
3290 W5(N)=0
3300 GO TO 3400
3310 PRINT "Do you wish a cubic spline fit of the data for a smooth";
3320 PRINT " plot?"
3330 INPUT B$
3340 E$=SEG(B$,1,1)
3350 W5(N)=0
3360 IF E$="n" THEN 3400
3370 PRINT "Enter number of points to be spread over x-range "
3380 PRINT "     for spline curves "
```

```
3390 INPUT W5(N)
3400 NEXT N
3410 N=N1-C5+1
3420 REM **WRITE DATA TO TAPE
3430 PRINT "Do you wish to have the data saved (resaved) in a file?"
3440 PRINT "     (automatic markins of file)"
3450 INPUT W$
3460 D$=SEG(W$,1,1)
3470 IF D$="n" THEN 3660
3480 PRINT "Enter title for data save file (up to 72 characters)"
3490 INPUT N$
3500 PRINT "Insert tape and enter file number for data save file."
3510 INPUT F3
3520 FIND F3
3530 MARK 1,18*I*(N1+1)+LEN(N$)
3540 FIND F3
3550 PRINT @33:N$
3560 FOR K=1 TO N2(N)
3570 IF C5>1 THEN 3600
3580 PRINT @33:S(K,N),T(K,N)
3590 GO TO 3640
3600 IF C5>2 THEN 3630
3610 PRINT @33:S(K,N),T(K,N),T(K,N+1)
3620 GO TO 3640
3630 PRINT @33:S(K,N),T(K,N),T(K,N+1),T(K,N+2)
3640 NEXT K
3650 CLOSE
3660 IF N1=M2 THEN 3710
3670 PRINT "Do you wish to plot another data set?"
3680 INPUT A$
3690 D$=SEG(A$,1,1)
3700 IF D$="y" THEN 620
3710 IF F$="y" THEN 4050
3720 REM **FIND MINIMUM AND MAXIMUM VALUES
3730 C=1.0E+61
3740 D=-1.0E+61
3750 E=1.0E+61
3760 F=-1.0E+61
3770 FOR K=1 TO N1
3780 C=C MIN S(1,K)


3790 D=D MAX S(N2(K),K)
3800 FOR J=1 TO N2(K)
3810 E=E MIN T(J,K)
3820 F=F MAX T(J,K)
3830 NEXT J
3840 NEXT K
3850 PRINT "Minimum and maximum values of x are:"
3860 IMAGE fd.fd,25t,fd.fd
```

```
3870 PRINT USING 3860:C,D
3880 PRINT "Minimum and maximum values of y are:"
3890 PRINT USING 3860:E,F
3900 PRINT "Do you wish automatic tic and axis labels?"
3910 IF L3<3 THEN 3930
3920 PRINT "Calendar axis will be automatically scaled"
3930 INPUT H$
3940 I$=SEG(H$,1,1)
3950 IF I$="y" THEN 4050
3960 PRINT "Do you wish to change these limits?"
3970 INPUT A$
3980 D$=SEG(A$,1,1)
3990 IF D$="n" THEN 4050
4000 IF L3=3 THEN 4030
4010 PRINT "Enter minimum and maximum values of x as xmin,xmax."
4020 INPUT C,D
4030 PRINT "Enter minimum and maximum values of y as ymin,ymax."
4040 INPUT E,F
4050 IF L3<>2 THEN 4170
4060 REM **TAKE LOG10 OF THE DATA IF REQUIRED
4070 C=INT(LGT(C))
4080 D1=D
4090 D=INT(LGT(D)+1.0E-10)
4100 IF ABS(LGT(D1)-D)<2.0E-10 THEN 4120
4110 D=D+1
4120 FOR K=1 TO N
4130 FOR J=1 TO N2(N)
4140 S(J,K)=LGT(S(J,K))
4150 NEXT J
4160 NEXT K
4170 IF L3<3 THEN 4280
4180 REM **CALENDAR SCALE
4190 FOR K=1 TO N
4200 FOR J=1 TO N2(K)
4210 Y1=INT(S(J,K)/100)
4220 X9=(S(J,K)/100-Y1)*100/12-1/24
4230 S(J,K)=Y1+X9
4240 NEXT J
4250 NEXT K
4260 C=INT(C/100)
4270 D=INT(D/100+1)
4280 IF L4=1 THEN 4390
4290 E=INT(LGT(E))
4300 F1=F
4310 F=INT(LGT(F)+1.0E-10)
4320 IF ABS(LGT(F1)-F)<2.0E-10 THEN 4340
4330 F=F+1
4340 FOR K=1 TO N
4350 FOR J=1 TO N2(N)
4360 T(J,K)=LGT(T(J,K))
```

```
4370 NEXT J
4380 NEXT K
4390 IF F$="y" THEN 5300
4400 U1=0
4410 IF L3<3 THEN 4430
4420 U1=12


4430 T1=1
4440 U2=0
4450 T2=1
4460 E5=0
4470 E6=1
4480 E7=0
4490 E8=1
4500 K3=1
4510 K4=1
4520 IF L3=2 AND L4=2 THEN 5130
4530 IF I$="y" THEN 4600
4540 PRINT "Enter number of data units between labeled tick marks---"
4550 PRINT "Enter as: x-units,y-units. (0-if log scale,1-if calendar)"
4560 INPUT T1,T2
4570 PRINT "Enter number of subdivisions between labeled tick marks---"
4580 PRINT "Enter as: x,y (0-if log scale,12-if calendar scale)"
4590 INPUT U1,U2
4600 DELETE P
4610 DIM P(8)
4620 P(1)=C
4630 P(2)=D
4640 P(3)=T1
4650 P(5)=E
4660 P(6)=F
4670 P(7)=T2
4680 P(4)=INT((V2-V1)/1.8) MAX 1
4690 P(8)=INT((V4-V3)/1.8) MAX 1
4700 IF I$="n" THEN 4980
4710 REM **AUTOMATIC TIC INTERVALS AND LABELS
4720 P(3)=INT((V2-V1)/(8*1.8)) MAX 1
4730 P(7)=INT((V4-V3)/(3*2.8)) MAX 1
4740 REM **X-AXIS
4750 P5=3
4760 IF L3=2 THEN 4890
4770 IF L3=3 THEN 4860
4780 GOSUB 7900
4790 GOSUB 8190
4800 C=P(1)
4810 D=P(2)
4820 T1=P(3)
4830 X9=P(4)
4840 U1=T1/X9
```

```
4850 GO TO 4890
4860 T1=1
4870 U1=12
4880 REM **Y-AXIS
4890 P5=7
4900 IF L4=2 THEN 4980
4910 GOSUB 7900
4920 GOSUB 8190
4930 E=P(5)
4940 F=P(6)
4950 T2=P(7)
4960 Y9=P(8)
4970 U2=T2/Y9
4980 REM ** SELECT LABEL FORMAT
4990 REM **X-AXIS
5000 P5=3
5010 IF L3=2 OR L3=3 THEN 5070
5020 GOSUB 8330
5030 E5=P(1)
5040 E6=P(2)
5050 K3=P(4)
5060 REM **Y-AXIS

5070 P5=7
5080 IF L4=2 THEN 5130
5090 GOSUB 8330
5100 K4=P(8)
5110 E7=P(5)
5120 E8=P(6)
5130 PRINT "Do you wish to make a control file containing the"
5140 PRINT "previous information?"
5150 INPUT H$
5160 D$=SEG(H$,1,1)
5170 IF D$="n" THEN 5300
5180 PRINT "Insert tape and enter file number for the control file."
5190 PRINT "(Automatic marking of tape file)"
5200 INPUT F1
5210 FIND F1
5220 MARK 1,72+18+2*72+18*18
5230 FIND F1
5240 PRINT @33:C$
5250 PRINT @33:H
5260 PRINT @33:X$
5270 PRINT @33:Y$
5280 PRINT @33:Q1,R1,L3,L4,C,D,E,F,T1,T2,U1,U2,K3,K4
5290 PRINT @33:E5,E6,E7,E8
5300 REM **CONSTRUCT THE PLOT
5310 PAGE
5320 N=N1
```

```
5330 REM **PRINT THE TITLE
5340 MOVE 70-65/73*H,98
5350 PRINT C$
5360 IF L3=3 THEN 5400
5370 MOVE 70-65/73*Q1,3
5380 REM **PRINT THE X-AXIS LABEL
5390 PRINT X$
5400 IF E6=1 THEN 5440
5410 MOVE 70+73/65*Q1,3
5420 PRINT USING 5430:E5
5430 IMAGE "(*E",+fd,")"
5440 REM **PRINT THE Y-AXIS LABEL
5450 FOR J=1 TO R1
5460 MOVE 3,(R1+1-J)*20/7+(35-R1)*10/7
5470 S$=SEG(Y$,J,1)
5480 PRINT S$
5490 NEXT J
5500 IF E8=1 THEN 5530
5510 MOVE 0,(R1+2-J)*20/7+(35-R1-2)*10/7
5520 PRINT USING 5430:E7
5530 VIEWPORT V1,V2-1,V3,V4-1
5540 C2=ABS(D-C)
5550 E2=ABS(F-E)
5560 WINDOW C,D,E,F
5570 IF D>C THEN 5630
5580 FOR K=1 TO N
5590 FOR J=1 TO N2(N)
5600 S(J,K)=D-S(J,K)+C
5610 NEXT J
5620 NEXT K
5630 IF F>E THEN 5690
5640 FOR K=1 TO N
5650 FOR J=1 TO N2(N)
5660 T(J,K)=F-T(J,K)+E
5670 NEXT J
5680 NEXT K
5690 IF U1>0 THEN 5720
5700 X9=D-C


5710 GO TO 5730
5720 X9=T1/U1
5730 IF U2>0 THEN 5760
5740 Y9=F-E
5750 GO TO 5770
5760 Y9=T2/U2
5770 AXIS X9,Y9,C,E
5780 VIEWPORT V1,V2,V3,V4
5790 WINDOW C,D+0.01*C2,E,F+0.0125*E2
5800 REM ** X TICS MAJOR
```

```
5810 L5=C2/T1
5820 IF L3=2 THEN 5880
5830 FOR N9=1 TO L5
5840 MOVE T1*N9+C,E
5850 RDRAW 0,E2*3/80
5860 NEXT N9
5870 GO TO 5970
5880 H1=E2*1/40
5890 H=C
5900 FOR I=10^H TO 10^(H+1) STEP 10^H
5910 MOVE LGT(I),E
5920 RDRAW 0,H1
5930 NEXT I
5940 H=H+1
5950 RDRAW 0,2*H1
5960 IF H<D THEN 5900
5970 REM ** Y TICS MAJOR
5980 L6=E2/T2
5990 IF L4=2 THEN 6050
6000 FOR N9=1 TO L6
6010 MOVE C,T2*N9+E
6020 RDRAW C2*3/100,0
6030 NEXT N9
6040 GO TO 6150
6050 H1=C2*2/100
6060 H=E
6070 FOR I=10^H TO 10^(H+1) STEP 10^H
6080 MOVE C,LGT(I)
6090 RDRAW H1,0
6100 NEXT I
6110 H=H+1
6120 RDRAW 2*H1,0
6130 IF H<F THEN 6070
6140 REM **LABEL THE MAJOR TIC MARKS
6150 Y5=E-E2/14
6160 REM **LABEL THE MAJOR TIC MARKS
6170 V1=C
6180 V2=E
6190 V3=C
6200 V4=E
6210 IF L3=3 THEN 6420
6220 FOR J=1 TO L5+1
6230 MOVE V3-39/730*C2,Y5
6240 IF L3=2 THEN 6330
6250 IF K3>1 THEN 6280
6260 PRINT USING "5d":V1*E6
6270 GO TO 6350
6280 IF K3>2 THEN 6310
6290 PRINT USING "2d.2d":V1*E6
6300 GO TO 6350
```

```
6310 PRINT USING "1d.3d":V1*E6
6320 GO TO 6350
6330 PRINT USING 6340:V1
6340 IMAGE "1.E",+fd


6350 IF D>C THEN 6380
6360 V1=V1-T1
6370 GO TO 6390
6380 V1=V1+T1
6390 V3=V3+T1
6400 NEXT J
6410 GO TO 6630
6420 REM **CALENDAR AXIS
6430 FOR K=1 TO C2
6440 M3=0
6450 FOR J=1 TO 12
6460 MOVE V3-0.5*C2*1.79/100+1/24,Y5
6470 M3=M3+1
6480 U$=SEG(V$,M3,1)
6490 PRINT USING "A":U$
6500 V3=V3+1/12
6510 NEXT J
6520 NEXT K
6530 V1=C
6540 V3=C
6550 FOR J=1 TO C2
6560 MOVE V3+0.5-2*C2*1.79/100,Y5-E2/14
6570 IMAGE "19",2D
6580 PRINT USING 6570:V1
6590 V3=V3+1
6600 V1=V1+1
6610 NEXT J
6620 REM **LABEL THE MAJOR TIC MARKS Y-AXIS
6630 X5=C-C2*(78/730)
6640 FOR J=1 TO L6+1
6650 MOVE X5,V4-E2/56
6660 IF L4=2 THEN 6750
6670 IF K4>1 THEN 6700
6680 PRINT USING "5d":V2*E8
6690 GO TO 6760
6700 IF K4>2 THEN 6730
6710 PRINT USING "2d.2d":V2*E8
6720 GO TO 6760
6730 PRINT USING "1d.3d":V2*E8
6740 GO TO 6760
6750 PRINT USING 6340:V2
6760 IF F>E THEN 6790
6770 V2=V2-T2
6780 GO TO 6800
```

```
6790 V2=V2+T2
6800 V4=V4+T2
6810 NEXT J
6820 FOR K=1 TO N
6830 IF M(K)=2 THEN 6950
6840 WINDOW C,D+0.01*C2,E,F+0.0125*E2
6850 REM **PLOT THE SYMBOLS
6860 FOR J=1 TO N2(K) STEP I5(K)
6870 IF S(J,K)<C OR S(J,K)>D THEN 6930
6880 IF T(J,K)<E OR T(J,K)>F THEN 6930
6890 MOVE S(J,K),T(J,K)
6900 SCALE 1.5,1.5
6910 GOSUB 8510
6920 WINDOW C,D+0.01*C2,E,F+0.0125*E2
6930 NEXT J
6940 IF M(K)=1 THEN 7080
6950 IF W5(K)>0 THEN 7020
6960 REM **PLOT THE LINES (STRAIGHT LINE SEGMENTS)
6970 MOVE S(1,K),T(1,K)
6980 FOR J=2 TO N2(K)


6990 DRAW S(J,K),T(J,K)
7000 NEXT J
7010 GO TO 7080
7020 GOSUB 7120
7030 REM **SPLINE FIT CURVE
7040 MOVE P(1),Q(1)
7050 FOR J=2 TO W6
7060 DRAW P(J),Q(J)
7070 NEXT J
7080 NEXT K
7090 G$=""
7100 PRINT G$
7110 END
7120 REM **SPLINE FIT SUBROUTINE
7130 IF N2(K)=>4 THEN 7170
7140 MOVE C,(E+F)/2
7150 PRINT "Insufficient number of points for spline fit"
7160 STOP
7170 L1=N2(K)-1
7180 DIM A0(L1),A1(L1),A2(L1),A3(L1)
7190 R=N2(K)-2
7200 DIM V5(R*3-2),V6(R),V7(R*3-2),V8(R),H2(L1)
7210 FOR J=1 TO L1
7220 H2(J)=S(J+1,K)-S(J,K)
7230 NEXT J
7240 V5(1)=2*(H2(2)+H2(1))/H2(2)
7250 IF V5(1)<>0 THEN 7270
7260 V5(1)=V5(1)+1.0E-6
```

```
7270 V5(3)=1
7280 V6(1)=6/H2(2)*((T(3,K)-T(2,K))/H2(2)-(T(2,K)-T(1,K))/H2(1))
7290 FOR J=2 TO R
7300 K1=3*J
7310 V5(K1-4)=H2(J)/H2(J+1)
7320 V5(K1-2)=2*(H2(J+1)+H2(J))/H2(J+1)
7330 IF J=R THEN 7350
7340 V5(K1)=1
7350 H3=H2(J)
7360 V6(J)=6/H2(J+1)*((T(J+2,K)-T(J+1,K))/H2(J+1)-(T(J+1,K)-T(J,K))/H3)
7370 NEXT J
7380 V7(1)=V5(1)
7390 K1=2
7400 J=2
7410 V7(K1)=V5(K1)
7420 V7(K1+1)=V5(K1+1)/V7(K1-1)
7430 V7(K1+2)=V5(K1+2)-V7(K1)*V7(K1+1)
7440 J=J+1
7450 K1=K1+3
7460 IF J<=R THEN 7410
7470 V8(1)=V6(1)/V7(1)
7480 FOR K1=2 TO R
7490 V8(K1)=(V6(K1)-V7(3*K1-4)*V8(K1-1))/V7(3*K1-2)
7500 NEXT K1
7510 FOR K1=2 TO R
7520 J=R-K1+1
7530 V8(J)=V8(J)-V7(3*J)*V8(J+1)
7540 NEXT K1
7550 A6=0
7560 FOR J=1 TO L1
7570 IF J=1 THEN 7590
7580 A6=B6
7590 B6=0
7600 IF J=L1 THEN 7620
7610 B6=V8(J)
7620 C6=T(J+1,K)/H2(J)-H2(J)*B6/6

7630 D6=T(J,K)/H2(J)-H2(J)*A6/6
7640 A0(J)=(A6*S(J+1,K)^3-B6*S(J,K)^3)/(6*H2(J))-C6*S(J,K)+D6*S(J+1,K)
7650 A1(J)=(B6*S(J,K)^2-A6*S(J+1,K)^2)/(2*H2(J))+C6-D6
7660 A2(J)=(A6*S(J+1,K)-B6*S(J,K))/(2*H2(J))
7670 A3(J)=(B6-A6)/(6*H2(J))
7680 NEXT J
7690 DELETE V5,V6,V7,V8,H2,P,Z
7700 W6=W5(K)+1
7710 DIM P(W6),Q(W6)
7720 N3=N2(K)
7730 G0=(S(N3,K)-S(1,K))/W5(K)
7740 FOR I=1 TO W6
```

```
7750 P(I)=S(1,K)+(I-1)*GO
7760 Z=I
7770 IF P(I)>S(2,K) AND P(I)<S(L1,K) THEN 7820
7780 I=1
7790 IF P(Z)<S(L1,K) THEN 7860
7800 I=L1
7810 GO TO 7860
7820 FOR J=2 TO N2(K)
7830 I=J-1
7840 IF P(Z)<=S(J,K) THEN 7860
7850 NEXT J
7860 Q(Z)=((A3(I)*P(Z)+A2(I))*P(Z)+A1(I))*P(Z)+A0(I)
7870 I=Z
7880 NEXT I
7890 RETURN
7900 REM **NEAT TIC SUBROUTINE
7910 P1=(P(P5-1)-P(P5-2))/P(P5)
7920 P2=10^INT(LGT(P1)+1.0E-10)
7930 P1=P1/P2
7940 IF P1>2 THEN 7980
7950 IF P1=1 THEN 8020
7960 P2=2*P2
7970 GO TO 8020
7980 IF P1>5 THEN 8010
7990 P2=5*P2
8000 GO TO 8020
8010 P2=10*P2
8020 REM ** ADJUST DATA MINIMUM
8030 P1=INT(P(P5-2)/P2)
8040 P3=P2*(P1+2)
8050 IF P3<=P(P5-2) THEN 8080
8060 P3=P3-P2
8070 GO TO 8050
8080 P(P5-2)=P3
8090 REM ** ADJUST DATA MAXIMUM
8100 P1=INT(P(P5-1)/P2)
8110 P3=P2*(P1-2)
8120 IF P3=>P(P5-1) THEN 8150
8130 P3=P3+P2
8140 GO TO 8120
8150 P(P5-1)=P3
8160 REM ** P(P5) - ADJUSTED TIC INTERVAL
8170 P(P5)=P2
8180 RETURN
8190 REM ** AUTOMATIC SUBDIVISION INTERVALS
8200 P1=(P(P5-1)-P(P5-2))/P(P5+1)
8210 P2=10^INT(LGT(P1)+1.0E-10)
8220 P1=P1/P2
8230 IF P1>2 THEN 8270
8240 IF P1=1 THEN 8310
```

```
8250 P2=2*P2
8260 GO TO 8310


8270 IF P1>5 THEN 8300
8280 P2=5*P2
8290 GO TO 8310
8300 P2=10*P2
8310 P(P5+1)=P2
8320 RETURN
8330 REM ** AUTO LABEL FORMAT SELECTION AND SCALING
8340 D1=ABS(P(P5-2)) MAX ABS(P(P5-1))
8350 P(P5-2)=0
8360 P(P5-1)=1
8370 P(P5+1)=1
8380 IF INT(P(P5))-P(P5)=0 THEN 8460
8390 P(P5+1)=2
8400 IF ABS(INT(P(P5))-P(P5))=>0.01 THEN 8480
8410 P(P5+1)=3
8420 IF ABS(INT(P(P5))+P(P5))=>1.0E-3 THEN 8500
8430 P(P5-2)=INT(LGT(D1)+1.0E-10)
8440 P(P5-1)=10^-P(P5-2)
8450 P(P5+1)=3
8460 IF D1<100000 THEN 8500
8470 GO TO 8430
8480 IF D1<100 THEN 8500
8490 GO TO 8430
8500 RETURN
8510 REM **SYMBOL CHARACTER SELECT & DRAW
8520 GO TO S2(K) OF 8600,8680,8760,8830
8530 REM **CHARACTER
8540 SCALE 1,1
8550 B$=CHR(A(K))
8560 RMOVE -0.5*1.55,-(5/8)*1.88
8570 PRINT B$
8580 RMOVE 0.5*1.55,5/8*1.88
8590 RETURN
8600 REM **DIAMOND
8610 RMOVE 1.41,0
8620 RDRAW -1.41,-1.41
8630 RDRAW -1.41,1.41
8640 RDRAW 1.41,1.41
8650 RDRAW 1.41,-1.41
8660 RMOVE -1.41,0
8670 RETURN
8680 REM **SQUARE
8690 RMOVE 1,1
8700 RDRAW 0,-2
8710 RDRAW -2,0
8720 RDRAW 0,2
```

```
8730 RDRAW 2,0
8740 RMOVE -1,-1
8750 RETURN
8760 REM ** TRIANGLE UP
8770 RMOVE 0,1
8780 RDRAW 1,-2
8790 RDRAW -2,0
8800 RDRAW 1,2
8810 RMOVE 0,-1
8820 RETURN
8830 REM ** TRIANGLE DOWN
8840 RMOVE 1,1
8850 RDRAW -1,-2
8860 RDRAW -1,2
8870 RDRAW 2,0
8880 RMOVE -1,-1
8890 RETURN
8900 REM **INPUT OF X,Y1,Y2,...


8910 IF C5>1 THEN 8940
8920 INPUT S(J,N),T(J,N)
8930 RETURN
8940 IF C5>2 THEN 8970
8950 INPUT S(J,N),T(J,N),T(J,N+1)
8960 RETURN
8970 INPUT S(J,N),T(J,N),T(J,N+1),T(J,N+2)
8980 RETURN
8990 REM **PRINTOUT OF AN X,Y1,Y2,... SET FOR ONE J VALUE
9000 PRINT S(J,N9),T(J,N9);
9010 N9=N9+1
9020 IF N9>N1 THEN 9050
9030 PRINT T(J,N9);
9040 GO TO 9010
9050 PRINT USING "/";
9060 RETURN
9070 REM **INPUT OF X,Y1,Y2,...WITH CR FOR TERMINATION
9080 INPUT K$
9090 IF K$=T$ THEN 9310
9100 L=LEN(K$)
9110 P1=POS(K$,",",1)
9120 IF P1<>0 THEN 9140
9130 P1=POS(K$," ",1)
9140 L$=SEG(K$,1,P1-1)
9150 I=I+1
9160 S(I,N9)=VAL(L$)
9170 P2=P1+1
9180 IF N9=N1 THEN 9230
9190 P1=POS(K$,",",P2)
9200 IF P1<>0 THEN 9240
```

```
9210 P1=POS(K$," ",P2)
9220 GO TO 9240
9230 P1=L+1
9240 L$=SEG(K$,P2,P1-P2)
9250 T(I,N9)=VAL(L$)
9260 P2=P1
9270 N9=N9+1
9280 IF P2<=L AND N9<=N1 THEN 9170
9290 N9=N
9300 IF I<M1 THEN 9080
9310 RETURN
9320 END

 END OF FILE
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