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A MULTIPLE LINE PLOTTING ROUTINE

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) jmk The Multiple Line Plotting Routine is a set of programs designed to produce an annotated plot of several data files. These programs were written for use on the Hewlett-Packard 9845C Desktop Computer. Sample plots and program listings are included.		

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I. INTRODUCTION

In analyzing ballistic data, it is often useful to compare similar sets of data by plotting them on one graph. The Multiple Line Plotting Routine is designed to provide a means for producing such graphs.

A method is available on Hewlett-Packard's 9845C Desktop Computer to create and recall plotted lines. The computer uses the MAT PLOT command which translates these lines into numbers stored in a three-dimensional array. The array may be called back to be redrawn on the screen or any peripheral plotter. This produces a presentable plot in a short amount of time.

The routines described in this report are designed to run on a Hewlett-Packard 9845C Desktop Computer with the following options: Mass Storage ROM, I/O ROM, Graphics ROM, Structured Programming ROM and Advanced Programming ROM (AP ROM). These last two are not entirely necessary; without them, the user will need to rewrite any IF-THEN-ELSE statements and construct a subroutine to find the maximum and minimum values in a given array.

II. DATA FORMAT AND SPECIAL LANGUAGE FEATURES

All of the programs are written in Hewlett-Packard's Enhanced BASIC language. The programs are tailored to the data files used by ANPACK, a data analysis package described in Reference 1. The package includes data acquisition programs, routines used to communicate with other computers, and a data reduction and analysis section which uses graphical and numerical techniques to analyze data files. The plotting routines are called from this last section, which displays the menu shown in Figure 1.

There are many options available in this part of the ANALYSIS PACKAGE. After completion of any task below, this selection menu will be redisplayed. Selection of task 0 returns you to the option list for the SCALED GRAPHICS, ANALYSIS AND CALIBRATION ROUTINE.

- 0 - RETURN TO PROGRAM SELECTION LIST
- 1 - PROCESS A CALIBRATION FILE
- 2 - RETRIEVE/STORE DATA ON DISC
- 3 - ADJUST INCREMENT AND NO. OF DATA POINTS TO PROCESS
- 4 - ADJUST DATA ZERO LEVEL
- 5 - CONVERT DATA TO ENGINEERING UNITS
- 6 - SPECTRAL ANALYSIS OF DATA
- 7 - APPLY DIGITAL FILTER TO DATA
- 8 - ANNOTATED PLOT OF DATA, WITH DISC STORAGE AND/OR RETRIEVAL
- 9 - DATA INTEGRATION AND/OR DIFFERENTIATION
- 10 - MULTIPLE DATA FILE MANIPULATION
- 11 - MEAN AND STANDARD DEVIATION OF A SET OF DATA ARRAYS
- 12 - ANNOTATED MULTIPLE DATA FILE PLOTS

Figure 1. Analysis and Graphics Routine Menu

¹
J.N. Walbert, Data Acquisition and Analysis Software for Interactive Computing Systems in the Interior Ballistics Division," Ballistic Research Laboratory Memorandum Report, in process.

The data file itself contains a maximum of 4133 points arranged as shown in Table 1. The files are accessed using Hewlett-Packard's fast binary read and write commands, FREAD and FPRINT. This differs from the standard READ# and PRINT# file commands, which may be used with an internal tape drive if a Mass Storage ROM is not installed.

TABLE 1. DATA FILE STRUCTURE

<u>Location</u>	<u>Contents (Corresponding program variable)</u>
1-32	ASCII file label up to 64 characters long (Label\$);
33	Starting point for data - initially 1 (Start);
34	Number of data points in the file (Nwords);
35	Current data increment - initially 1 (Inc);
36	Total number of points in the file (Last_word);
37	Interval between points in milliseconds (Delta_t);
38-4133	Data points (array Data).

As mentioned earlier, the 9845C has the capability to translate a given graphics command into a triplet (vector) of numbers. Several such vectors are stored in an array which may be retrieved at any time to either plot the information or add additional vectors. The plot array can store up to 10922 vectors, most of which contain plotted points. Other vectors include pen color, line type and an end-of-information indicator.

The computer assumes it is plotting to a 100-by-100 point display, scaled from zero to 100 left to right and bottom to top. Normally, the user will plot to a different scale. A plotted point will correspond to a vector (x,y,z) in the array, where x and y are computed as a function of the ratio of computer scaling to user scaling, and z is dependent on the operation performed (MOVE, PLOT or DRAW).

III. THE PROGRAMS

The plot routine consists of four separate programs: a multiple-line plot on one set of axes, a plot of one set of data against another (rather than the data versus time), a double y-axis plot where there are two y-axes with different ranges of values sharing a single time axis, and a driver program to shuttle between the plot routines and the menu displayed in Figure 1.

A. Driver Program. This is the communications link between the different plot programs and the main ANPACK graphics programs. Any of the three routines or the ANPACK graphics menu may be accessed from here.

The Driver prints a menu on the screen, as shown in Figure 2, and the user selects the program he wants to use. The appropriate program is loaded and run automatically.

OPTIONS -

- 0 - RETURN TO MENU LIST
- 1 - CREATE MULTIPLE-LINE PLOT
- 2 - PLOT ONE DATA FILE AGAINST ANOTHER
- 3 - CREATE DOUBLE Y-AXIS PLOT

Figure 2. Plot Routine Menu

B. Multiple Line Plot. The program allows many data files to be plotted on one set of axes. It is important that the data be similar in magnitude. This is very handy in viewing several files, either to detect trends or to compare the data to a computed mean. There is a program in the Analysis and Graphics Routine which will compute the mean of several data files and the standard deviation from that mean. Plotting the mean plus and minus the standard deviation is helpful, especially if there are many files containing measurements taken from the same instrument.

When the Multiple-Line program is called (selection 1 of the Driver program), it will print

ENTER THE NUMBER OF FILES TO BE PLOTTED.

The user types in a number greater than one. The program then asks

ENTER THE NAME OF FILE 1.

If for some reason the file cannot be read from disc (either it's the wrong type or it isn't on the disc), the program will print an error message:

ERROR ON FILE READ --

ERROR nn IN LINE xxxx

DO YOU WANT A DISC CATALOG?

where nn is the error number and xxxx is the line in the program in which the error occurred. A listing of the names of the files on disc may be printed to the screen, and the user is again requested to enter the file name. If the file can be retrieved, the contents are loaded into array Data, its label printed on the screen and the user is asked

IS THIS THE CORRECT FILE?

If this is the right file, information about the file is relayed to the internal printer. This includes the file name, number of data points, length of the file in milliseconds, maximum and minimum values and the time between points. This process is repeated for each remaining file.

Once all the files have been correctly entered, the user enters the maximum and minimum y-axis values and the times over which the data are to be plotted. As an example, the user enters the names of three data files and the program prints the following table.

TABLE 2. DATA FILE INFORMATION LISTING

<u>FILENAME</u>	<u>NWORDS</u>	<u>XMAX</u>	<u>YMIN</u>	<u>YMAX</u>	<u>DELTA TIME</u>
THTZ:C12	1748	174.7	-.016927	.00779413	.1
THTZ+:C12	1748	174.7	-.0157243	.0164498	.1
THTZ-:C12	1748	174.7	-.023741	.00757101	.1

This tells the user each file has 1748 data points with time between points of .1 millisecond for a total time of 174.7 milliseconds. The program also displays the maximum and minimum data values for each file, so the appropriate x- and y-axis values may be chosen.

After the plot boundaries have been set (start and stop, maximum and minimum y-axis values), the program asks for the labels to be printed along the x and y axes. These labels may use any character on the keyboard (except control characters) up to 32 characters in length. They are normally used to indicate the type of measurement (displacement, pressure, time) and its associated units (m, MPa, ms).

The program now retrieves the data files one at a time and asks the user, for each file,

ENTER THE LINE TYPE (ENTER 0 FOR CHART).

The user then chooses from the ten line types available. If he is not familiar with the line types, the user may, by entering 0, display the chart shown in Figure 3. The patterned line types may be spread out by setting the length to a number greater than one. The program will ask for the pattern

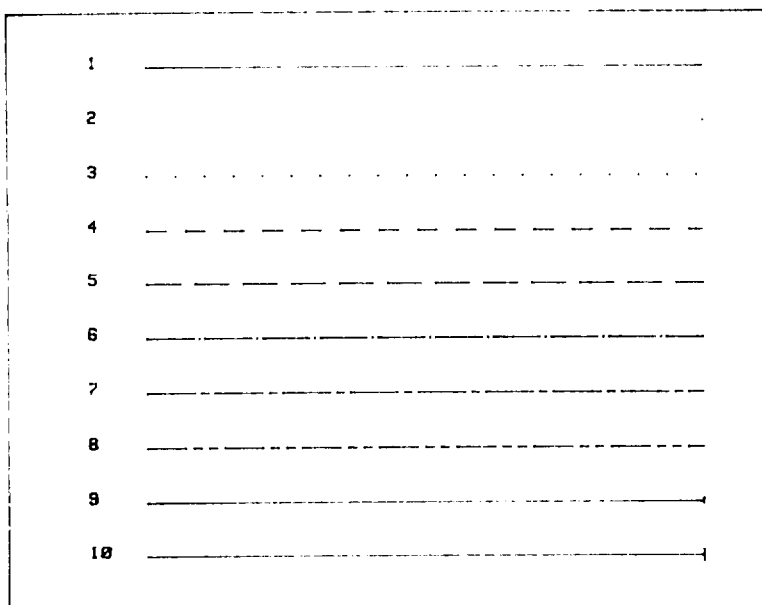


Figure 3. Line Type Chart

length if the user has chosen other than line type 1 (solid line). The flat bed plotter is much more sensitive to the size of the length factor than the screen; therefore, length two may not be noticeably different than length one on the screen, but it is readily apparent on the plotter.

Another thing to keep in mind: The internal printer on the H-P 9845C doesn't print in color; only in black or blue on white. When choosing pen color, use the numbers corresponding to the pen colors in the peripheral plotter. In most cases, these will not correspond to the screen colors.

Figure 4 is a plot of the sample files above, measuring the rotation of a gun tube. The mean file is plotted with line type 1. To achieve contrast, the files showing the deviation from the mean are drawn using the dotted line type 3 of length 2. The frame and labels are always drawn using pen 1; be sure the pen in stable 1 is the color desired for the labels.

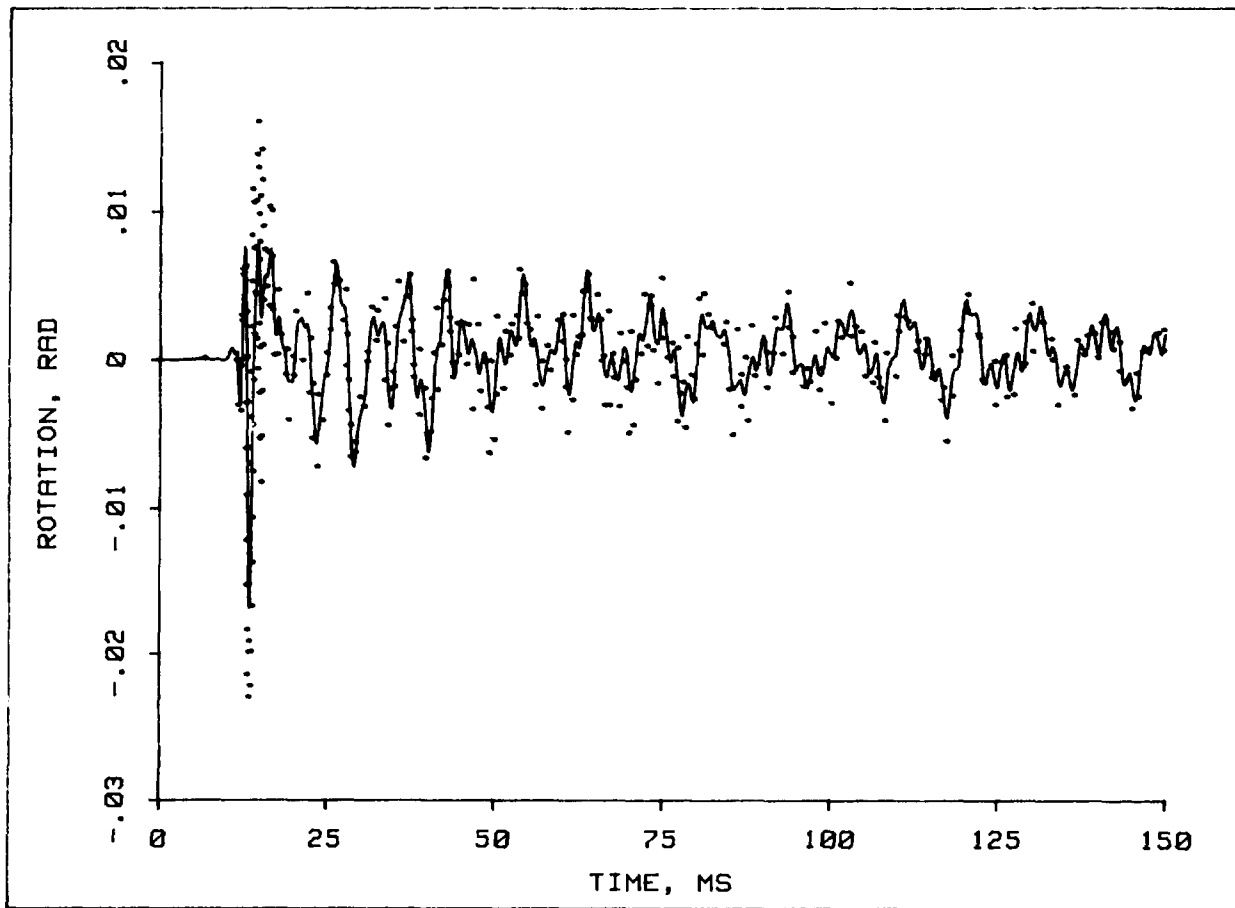


Figure 4. Mean Rotational Displacement Plus and Minus Three Standard Deviations

Figure 5 shows a plot of strain data measured over ten rounds and the mean of those ten rounds. Even though the individual rounds are obscured, the main shape of the envelope is well defined, and a contrasting pen color highlights the mean curve.

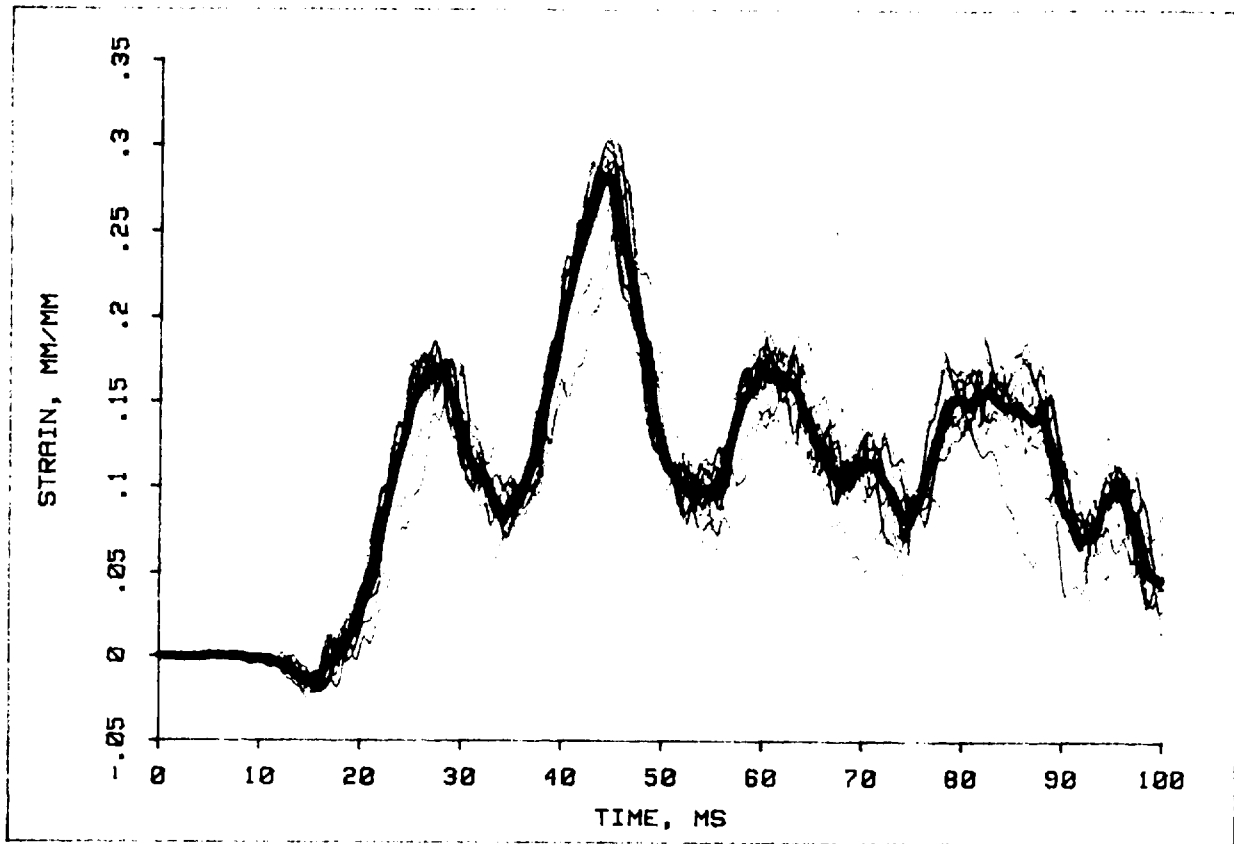


Figure 5. Strain Measured Over Ten Rounds and the Computed Mean

C. Plotting One File Against Another. Normally, all data is plotted versus time. Occasionally, the need to directly compare the data arises. This program will retrieve two data files and plot one against the other over a specified time interval. The files may have different time increments initially, but the program will correct this if the user so desires. It is important that the files be measured over the same time frame; otherwise, the plot is at best useless and at worst, misleading.

The program is called by selecting Option 2 of the Driver program.
The words

ENTER THE NAME OF THE X-AXIS FILE

appear at the top of the screen. The user enters the name of the file the dimensions of which will be measured along the x-axis. Once the file is found, the program will print the file label and ask

IS THIS THE CORRECT FILE?

If this is the correct file, the program asks for the y-axis file. If this is not the file the user had in mind, he may answer "N" and the program will prompt him to enter another file name. If an error occurs while retrieving the file, the program will print

ERROR ON FILE READ --

ERROR nn IN LINE xxxx

DO YOU WANT A DISC CATALOG?

where nn is the error number and xxxx is the line in which the error occurred. A disc catalog is helpful if you are unsure about the file name or its existence on a particular disc.

In order to simplify the plotting, the files are adjusted to the same length and equal time between points by incrementing and truncating the data. If the time between points is not the same for the two files, the program jumps to a separate section to correct this. The screen is cleared and the following information is printed:

```
TIME BETWEEN POINTS IS NOT THE SAME FOR EACH FILE.  
DELTA TIME FOR FILE  NIC1E:C12  IS  .002  
DELTA TIME FOR FILE  NIC2E:C12  IS  .001
```

Of course, the actual file names and times will vary with each set of files entered. The user has the option of entering a common time between points or starting over with two different files. If he decides to plot the current files, the program asks for a new time between points. The user should use his best judgement, but a good rule of thumb is to pick the lowest common multiple of the two times. In the example above, a good compromise would be .002 ms between points. The file NIC2E is incremented by two, which will bring the time between points to .002 ms. This incrementing has shortened file NIC2E, and file NIC1E is truncated to this same length. Note that if one time is not a multiple of the other, both files will be incremented to the proper time between points.

The user now must decide how much of the files he wants to plot. He may choose to view some portion of the data (say, the first 25 ms of data) or the entire file. The time is used to determine the first and last points plotted, although these time values are not shown on the final plot.

To illustrate, for the sample files above, the program prints

```
FOR FILE NIC1E:C12:      START = 0           STOP = 1.022  
FOR FILE NIC2E:C12:      START = 0           STOP = 1.022  
DO YOU WANT TO PLOT THE FILES:  
  0 - OVER THE ENTIRE INTERVAL  
  1 - OVER PART OF THE INTERVAL
```

If the user answers "0", the program asks for a pen color then begins to plot the curve. Otherwise, it will print

ENTER THE START AND STOP TIMES OF THE PLOT INTERVAL

The program checks the stop time, making sure it occurs after the start time and that there are enough data points in each file to cover the given interval. If the numbers are not right, the program asks for the times until they are acceptable.

After the plot is finished, the user may get a copy either from the internal printer or the plotter. A sample plot is shown in Figure 6.

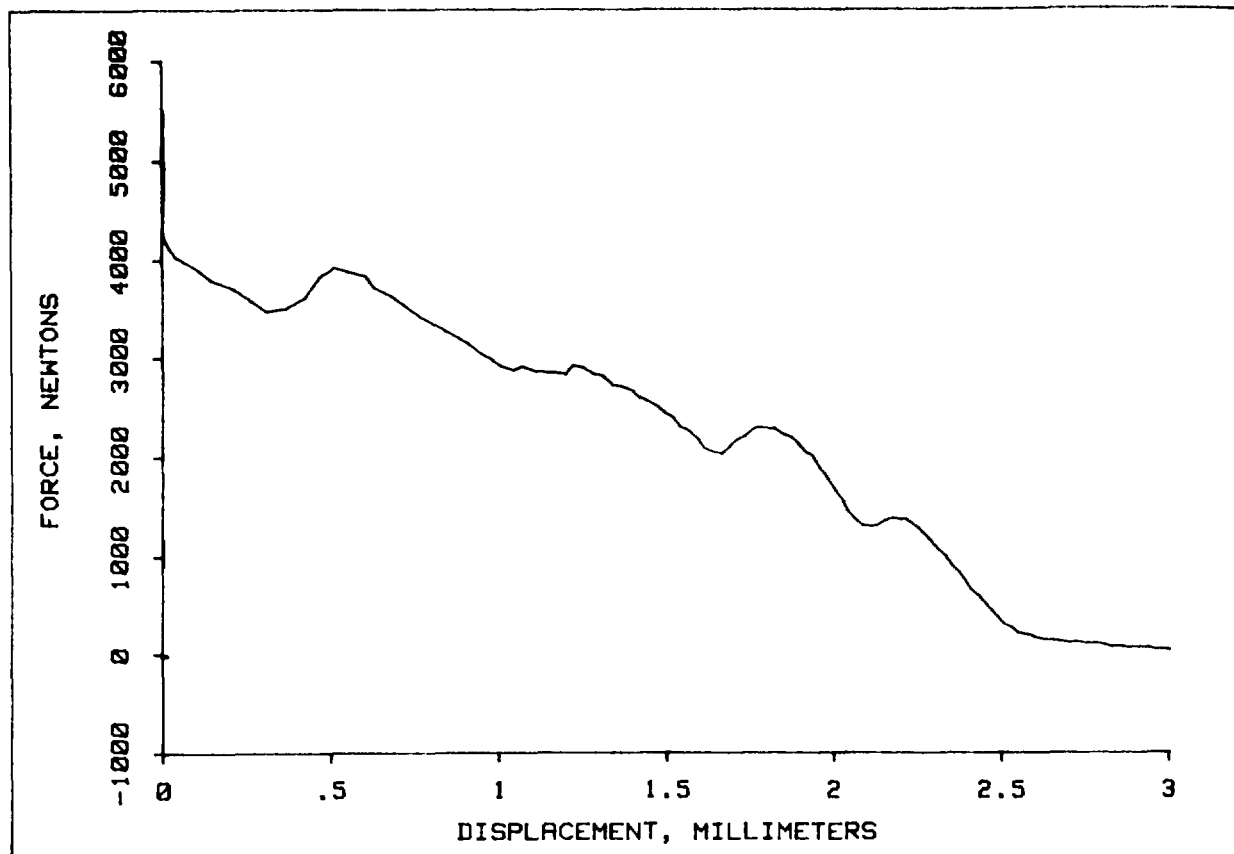


Figure 6. Displacement File vs. Force File

D. Double Y-Axis Plot. This allows for the plotting of dissimilar data over a common time span. It is useful in comparing, say, displacement and acceleration which are related but may not be of the same magnitude. Unfortunately, only two data sets may be plotted this way because the labels become illegible when the plotting area is divided more than twice.

Since the files to be plotted have different magnitudes, each file must be given separate maximum and minimum plot values. These values are variables assigned to the file; i.e., Ymin1 and Ymax1 are used for the first file and Ymin2 and Ymax2 are used for the second file. As a result, it is more efficient to plot each file to a separate array, scaled to its own parameters.

The program begins by asking for the file that will be drawn on the bottom half of the plot. As in the previous programs, if the file cannot be read, an error message appears and the user may obtain a catalog of the disc. The program then searches the file for maximum and minimum values and determines the length of time of the file. The user may change these values by following the program instructions. For the sample files shown in Figure 7, the program would print

CURRENT DATA PARAMETERS ARE AS FOLLOWS:

YMAX = 1293.4

YMIN = -11388

DO YOU WANT TO CHANGE THE Y-VALUES?

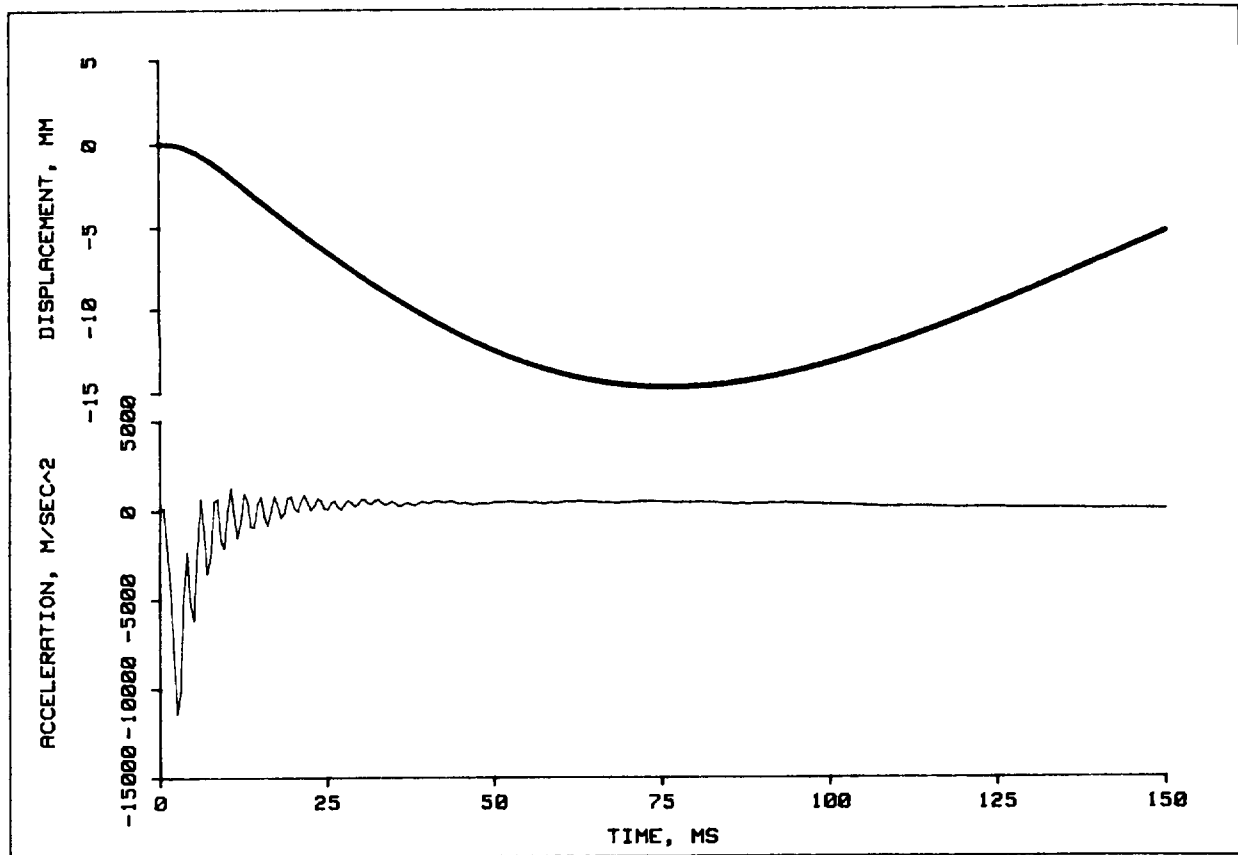


Figure 7. Acceleration and Displacement vs. Time

The user enters "Y" and is then asked to

ENTER THE NEW MAXIMUM AND MINIMUM

He types in the maximum and minimum, in that order. The program checks the values, assuring itself that the maximum is the larger of the two numbers. These values are then assigned to the variables Ymax1 and Ymin1, respectively, which will be used when the plot is drawn on the peripheral plotter. The same thing is done for the beginning and ending times of the file:

CURRENT START AND STOP VALUES:

START = 0

STOP = 174.5

DO YOU WANT TO CHANGE THESE VALUES?

If the user wants, he may change the times; these times are not assigned separate variables as are the y-axis values above, since the start and stop are the same for both files. The labels are entered for the x-axis and the bottom y-axis, and the first file is plotted to the graphics screen.

The second file is retrieved, and the upper y-axis values are entered as above. Since the start and stop times were entered previously, the program begins to plot the second file.

A copy of the completed plot may be obtained from the internal printer or a peripheral plotter. The user then has the option of replotting the same files to different scale, plotting another pair of files or returning to the Driver program.

IV. SUMMARY AND CONCLUSIONS

The Multiple Line Plotting Routine satisfies the need to produce a high-quality plot of several data files in a short amount of time. It may be used to create plots on paper for reports or on viewgraphs for lectures and presentations.

Because each of the routines is a program, not a subroutine, they may be used independently or together, as presented here. Despite the specialized data sets the programs use, they may be adjusted to accept another type of file structure. They may also be changed to communicate with different plotters by changing one or two lines in each program. These lines will be noted in the program listings in the Appendix.

APPENDIX A

PROGRAM LISTINGS FOR THE MULTIPLE LINE PLOT ROUTINE

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PROGRAM LISTINGS FOR THE MULTIPLE LINE PLOT ROUTINE

The programs are listed below in the order presented in the report. Figure A-1 shows how the programs interact with each other and the ANPACK Analysis and Graphics Programs.

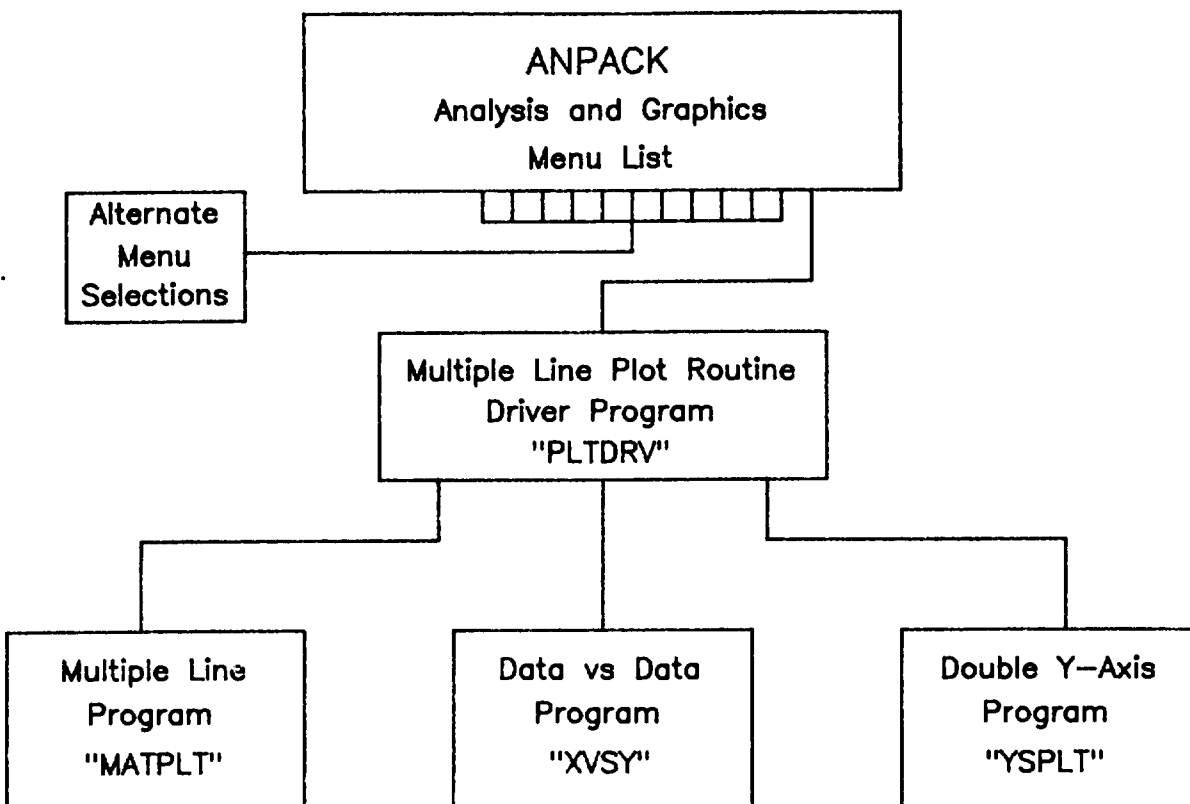


Figure A-1. Program Control Flow Chart

Driver Program

```

10  OPTION BASE 0                ! FILE "PLTDRV"
20                                ! COM variables are used by the
30                                ! ANPACK programs.
40                                !
50  COM SHORT Start,Stop,Inc,Nrec,Delta time
60  COM SHORT Data(1:12325),H(1:33),Win(1:33),Wout(1:33)
70  COM SHORT Xmax,Xmin,Ymax,Ymin,Xscale,Yscale
80  COM INTEGER Array_t(23835),Array_b(23940),Array1_t(23835),Array1_b(23940)
90  COM INTEGER First_word,Last_word,Nwords
100 COM Label$(64),Xaxis_label$(32),Yaxis_label$(32),Switch
110 IF GSTAT(1)=7 THEN PLOTTER 7,5 IS OFF
120 Options: PRINT PAGE
130 PRINT "OPTIONS:"
140 PRINT "0 - RETURN TO MENU LIST"
150 PRINT "1 - CREATE MULTIPLE-LINE PLOT"
160 PRINT "2 - PLOT ONE DATA FILE VS ANOTHER"
170 PRINT "3 - CREATE DOUBLE Y-AXIS PLOT"
180 BEEP                          ! Choose an option, then load the
190 INPUT Option                  ! appropriate program.
200 PRINT PAGE
210 IF Option=0 THEN LOAD "DRIVER:D12",10 ! All programs are stored on the
220 ON Option GOTO Mult,X_vs_y,Many_y ! Hewlett-Packard (H-P) Model 7906
230 Mult: LOAD "MATPLT:D12",10 ! Disc Drive. The notation :D12
240 X_vs_y: LOAD "XVSY:D12",10 ! refers to the fixed internal
250 Many_y: LOAD "YSPLT:D12",10 ! disc. Data files are stored on
260 END                          ! removable discs, denoted :C12.

```

Multiple Line Program

```

10     OPTION BASE 1                               ! FILE "MATPLT"
20     !
30     ! SHORT indicates a short-precision variable (up to six significant
40     ! digits).
50     !
60     ! The variables are:
70     !   Data - array containing the currently plotting data file;
80     !   Plot - array to which files are drawn;
90     !   Files$ - array containing the names of the files to be plotted;
100    !   Numplots - number of files to be plotted;
110    !   Xmin, Xmax - beginning and ending times for a data file;
120    !   Xbegin, Xend - start and stop times for the final plot;
130    !   Ymin, Ymax - upper and lower bounds for the final plot;
140    !   Xunit, Yunit           |>
150    !   Xplus, Yplus           |>
160    !   Type, Length, Pen     |>   Plotting parameters.
170    !   Xlabel$, Ylabel$     |>
180    !
190    SHORT Data(4133),Delta_t,Xmin,Xmax,Xbegin,Xend
200    SHORT Ymin,Ymax,Xunit,Yunit,Xplus,Yplus
210    SHORT Plot(10922,3)
220    INTEGER First_word,Last_word,Nwords
230    INTEGER Numplots,File,Type,Length,Pen
240    DIM Files$(15)[10],Xlabel${32},Ylabel${32},Label${64}
250  Get_files: PRINT PAGE
260    PRINT "ENTER THE NUMBER OF ARRAYS TO BE PLOTTED:"
270    BEEP
280    INPUT Numplots
290    IF Numplots<=1 THEN
300      PRINT LIN(1);"YOU MUST SPECIFY MORE THAN ONE FILE --"
310      BEEP                               ! The names of the files to be
320      GOTO Get_files                     ! plotted are entered in response
330    END IF                               ! to the program's questions.
340    REDIM Files$(Numplots)
350    FOR File=1 TO Numplots
360  Get_data: PRINT PAGE,"ENTER THE NAME OF FILE "&VAL$(File)&": "
370    BEEP
380    INPUT Filename$
390    Filename$=Filename$&" :C12"
400    ON ERROR GOTO File_error
410    FREAD Filename$,Data(*)
420    OFF ERROR
430    ENTER Data(1) USING "#,64A";Label$
440    PRINT LIN(2);TAB(8);Label$,LIN(1)    ! Once the correct files are
450    PRINT "IS THIS THE CORRECT FILE?"    ! found, the names are placed in
460    BEEP                                  ! array Files$. These names will
470    INPUT A$                              ! be used later to call the files,
480    IF A$="N" THEN Get_data              ! one at a time, to be plotted.
490    Files$(File)=Filename$              ! Information is printed for each
500    Delta_t=Data(37)                    ! file: Name, Length, Total time
510    First=38                             ! elapsed, Minimum and Maximum

```

```

520     Last=ROW(Data)                ! values and Time between points.
530     Nwords=Last-37                ! Lines 560 and 570 use the AP ROM
540     Xmax=Delta_t*(Nwords-1)       ! to find the maximum and minimum
550     Xmin=0                          ! values in each file. If the ROM
560     MAT SEARCH Data,MAX;Ymax,First ! is not installed, a subroutine
570     MAT SEARCH Data,MIN;Ymin,First ! to find these values in an array
580     PRINTER IS 0                    ! is required.
590     IF File=1 THEN PRINT USING Header
600     PRINT USING Im;Filename$,Nwords,Xmax,Ymin,Ymax,Delta_t
610     IF File=Numplots THEN PRINT LIN(3)
620     PRINTER IS 16
630     NEXT File
640     PRINT PAGE
650 Y_in: PRINT "ENTER THE MAXIMUM AND MINIMUM Y-AXIS VALUES:"
660     BEEP
670     INPUT Ymax,Ymin                ! Plotting parameters are entered.
680     IF Ymax<=Ymin THEN             ! Each file is plotted to the same
690         PRINT "YMAX <= YMIN -- TRY AGAIN" ! set of axes, but they may be
700         GOTO Y_in                  ! distinguished by using different
710     END IF                          ! line types and/or pen colors.
720 X_in: PRINT "ENTER THE START AND STOP TIMES:"
730     BEEP
740     INPUT Xbegin,Xend              ! Lines 810 and 880 use LINPUT
750     IF Xend<=Xbegin THEN           ! instead of INPUT to allow the
760         PRINT "STOP <= START -- TRY AGAIN" ! labels to contain punctuation
770         GOTO X_in                  ! marks.
780     END IF
790     PRINT PAGE,"ENTER THE X-AXIS LABEL (32 CHARACTER MAX):"
800     BEEP
810     LINPUT Xlabel$
820     PRINT "ENTER THE INTERVAL BETWEEN TICK MARKS:"
830     PRINT START="";Xbegin,"STOP="";Xend
840     BEEP
850     INPUT Xunit
860     PRINT "ENTER THE Y-AXIS LABEL (32 CHARACTER MAX):"
870     BEEP
880     LINPUT Ylabel$
890     PRINT "ENTER THE INTERVAL BETWEEN TICK MARKS:"
900     PRINT "YMIN=";Ymin,"YMAX=";Ymax
910     BEEP
920     INPUT Yunit
930     PRINT PAGE
940     PLOTTER IS "GRAPHICS"
950     Pen=1
960     FOR I=1 TO Numplots
970         Filename$=Files$(I)
980         FREAD Filename$,Data(*)
990         Delta_t=Data(37)
1000        Last=ROW(Data)
1010 Line: PRINT "ENTER THE LINE TYPE FOR FILE "&VAL$(I)&": "
1020        PRINT "(ENTER 0 FOR LINE TYPE CHART)"
1030        BEEP
1040        INPUT Type
1050        IF Type<=0 THEN Linechart

```

```

1060 IF Type>10 THEN
1070 PRINT "LINE TYPE NOT VALID --"
1080 GOTO Line
1090 END IF
1100 IF Type>1 THEN
1110 PRINT "ENTER THE PATTERN LENGTH:"
1120 PRINT "(THE LARGER THE LENGTH, THE LONGER THE REPEAT DISTANCE)"
1130 BEEP
1140 INPUT Length
1150 END IF
1160 PRINT PAGE
1170 PRINT "DO YOU WANT TO CHANGE PENS?"
1180 BEEP
1190 INPUT P$
1200 IF P$="Y" THEN
1210 PRINT "ENTER THE PEN NUMBER (1-8):"
1220 BEEP
1230 INPUT Pen
1240 ELSE
1250 IF I=1 THEN
1260 Pen=1
1270 END IF
1280 END IF
1290 PLOTTER 13 IS ON
1300 Xloc=Xbegin
1310 Yloc=Data(First)
1320 Xplus=.15*(Xend-Xbegin)
1330 Yplus=.15*(Ymax-Ymin)
1340 PRINT PAGE
1350 GRAPHICS
1360 EXIT ALPHA
1370 SCALE Xbegin-Xplus,Xend+.5*Xplus,Ymin-Yplus,Ymax+.5*Yplus
1380 CLIP Xbegin,Xend,Ymin,Ymax
1390 IF I=1 THEN PLOTTER IS Plot(*)
1400 PLOTTER Plot(*) IS ON
1410 LINE TYPE Type,Length
1420 PEN Pen
1430 MOVE Xloc,Yloc
1440 FOR J=First TO Last
1450 Xloc=Xloc+Delta t
1460 IF Xloc<Xbegin THEN Nextj
1470 IF Xloc>Xend THEN Cont
1480 Yloc=Data(J)
1490 PLOT Xloc,Yloc,-1
1500 Nextj: NEXT J
1510 Cont: PENUP
1520 PLOTTER Plot(*) IS OFF
1530 PRINT PAGE
1540 ALPHA
1550 EXIT GRAPHICS
1560 NEXT I
1570 EXIT ALPHA
1580 GRAPHICS
1590 UNCLIP

```

! Preparation for plotting: Xloc
! is initialized to the plot's
! start time. Yloc is assigned
! the first data point in array
! Data. Xplus and Yplus define
! the area in which the axes and
! labels are drawn.

! Here is where the plotting takes
! place. The pen is positioned at
! the initial values of Xloc and
! Yloc. The program steps through
! the array and determines if a
! point is in the area of interest.
! If so, it is plotted. If it
! comes before the event, the time
! is increased by Delta t and the
! next point is fetched. If the
! point occurs after time Xend or
! the end of the file is reached,
! the program exits the loop and
! gets the next file.

! Labels are drawn in after all
! files have been plotted. Note

```

1600 Labels: LINE TYPE 1          ! they are not part of the plot
1610 PEN 1                        ! array, and must be redrawn on
1620 FRAME                        ! the flat bed plotter.
1630 CLIP Xbegin,Xend,Ymin-.15*Yplus,Ymin
1640 LAXES Xunit,Yunit,Xbegin-10*Xunit,Ymin,-1,-1
1650 UNCLIP
1660 Xcenter=(Xend-Xbegin)/2+Xbegin
1670 Ycenter=Ymin-.75*Yplus
1680 MOVE Xcenter,Ycenter
1690 LORG 5
1700 LABEL Xlabel$
1710 CLIP Xbegin-.15*Xplus,Xbegin,Ymin,Ymax
1720 LAXES Xunit,Yunit,Xbegin,Ymin-10*Yunit,-1,-1
1730 UNCLIP
1740 Xcenter=Xbegin-.75*Xplus
1750 Ycenter=(Ymax-Ymin)/2+Ymin
1760 MOVE Xcenter,Ycenter
1770 LDIR PI/2
1780 LABEL Ylabel$
1790 LDIR 0
1800 PRINT PAGE
1810 ALPHA
1820 EXIT GRAPHICS
1830 PRINT "PRESS CONT WHEN READY TO TYPE LABELS ONTO THE PLOT."
1840 PRINT "WHEN YOU ARE FINISHED, PRESS CONT AGAIN."
1850 PAUSE
1860 EXIT ALPHA
1870 GRAPHICS                      ! Additional information may be
1880 IF Device=0 THEN LIMIT 5,175,5,145 ! printed on the plot. This must
1890 CSIZE 3.3                      ! be re-entered on the peripheral
1900 LETTER                          ! plotter.
1910 PRINT PAGE
1920 ALPHA
1930 EXIT GRAPHICS
1940 IF Device=1 THEN
1950     PLOTTER 7,5 IS OFF
1960     GOTO Plotter
1970 END IF
1980 PRINT PAGE,"ENTER THE NUMBER OF COPIES DESIRED:"
1990 BEEP
2000 INPUT N
2010 IF N>0 THEN                    ! A hard copy of the plot may be
2020     PRINT PAGE                  ! dumped to the internal printer or
2030     GRAPHICS                    ! a peripheral plotter (here, an
2040     EXIT ALPHA                  ! H-P 9872C eight pen plotter).
2050     PRINTER IS 0
2060     FOR I=1 TO N
2070         DUMP GRAPHICS
2080         PRINT LIN(5)
2090     NEXT I
2100     PRINTER IS 16
2110     PRINT PAGE
2120     ALPHA
2130     EXIT GRAPHICS

```

```

2140 END IF
2150 Plotter: PRINT PAGE,"DO YOU WANT A COPY ON THE FLAT BED PLOTTER?"
2160 BEEP
2170 INPUT A$
2180 IF A$="Y" THEN
2190     PRINT "RESET THE FLAT BED PLOTTER. PRESS CONT WHEN READY."
2200     PAUSE
2210     Device=1                                ! Line 2230 may be changed to
2220     PLOTTER 13 IS OFF                        ! specify another plotter.
2230     PLOTTER IS 7,5,"HPGL",1,8
2240     SCALE Xbegin-Xplus,Xend+Xplus/2,Ymin-Yplus,Ymax+Yplus/2
2250     CLIP Xbegin,Xend,Ymin,Ymax
2260     MAT PLOT Plot                            ! MAT PLOT redraws the data files,
2270     UNCLIP                                    ! then the program returns to draw
2280     GOTO Labels                              ! the labels and the axes.
2290 END IF
2300 PRINT PAGE,"DO YOU WANT TO CHANGE ANY PLOT PARAMETERS?"
2310 BEEP
2320 INPUT A$
2330 IF A$="Y" THEN Y in
2340 PRINT PAGE,"DO YOU WANT TO PLOT ANOTHER SET OF FILES?"
2350 BEEP
2360 INPUT A$
2370 IF A$="Y" THEN 190
2380 LOAD "PLTDRV:D12",10
2390 File_error:                                ! Error recovery - ERRM$ is a
2400 PRINT "ERROR ON FILE READ --",LIN(1)        ! built-in function which prints
2410 PRINT LIN(1),TAB(5),ERRM$,LIN(1)           ! the error number and where it
2420 PRINT "DO YOU WANT A DISC CATALOG?"        ! occurred in the program. A
2430 BEEP                                        ! catalog may help determine the
2440 INPUT A$                                    ! existence of a file on the disc.
2450 IF A$="Y" THEN CAT ":C12"
2460 DISP "PRESS CONT WHEN READY TO RE-ENTER FILENAME"
2470 PAUSE
2480 GOTO Get_data
2490 Linechart: IF I>1 THEN PLOTTER Plot(*) IS OFF
2500 PLOTTER IS "GRAPHICS"
2510 GRAPHICS                                    ! Line chart - An aid for finding
2520 EXIT ALPHA                                  ! a suitable line type for a file.
2530 SCALE 0,10,-11,0                          ! Each type is displayed with its
2540 LORG 2                                      ! identifying number.
2550 FOR L=1 TO 10
2560     MOVE 1,-L
2570     LINE TYPE 1
2580     LABEL L
2590     LINE TYPE L
2600     PENUP
2610     PLOT 2,-L,0
2620     DRAW 8,-L
2630 NEXT L
2640 LINE TYPE 1
2650 FRAME
2660 PAUSE                                       ! If the line chart is called
2670 GCLEAR                                       ! after files have been plotted,

```

```

2680 PRINT PAGE           ! the screen is cleared and the
2690 ALPHA               ! files redrawn using the MAT
2700 EXIT GRAPHICS      ! PLOT command.
2710 IF I>1 THEN
2720   SCALE Xbegin-Xplus,Xend+.5*Xplus,Ymin-Yplus,Ymax+.5*Yplus
2730   CLIP Xbegin,Xend,Ymin,Ymax
2740   MAT PLOT Plot
2750 END IF              ! Format statements used to print
2760 GOTO Line           ! file information.
2770 Header: IMAGE X"FILENAME"5X"WORDS"5X"XMAX"9X"YMIN"8X"YMAX"5X"DELTA TIME"/
2780 Im: IMAGE 10A,5X,DDDD,4(5XK)
2790 END

```


Data vs. Data Program

```

10     OPTION BASE 1                               ! FILE "XVSY"
20     !
30     ! SHORT indicates a short-precision variable (up to six significant
40     ! digits).
50     !
60     ! The variables are:
70     !   Data1 - array containing data for x-variable;
80     !   Data2 - array containing data for y-variable;
90     !   Xmin, Xmax - final plot minimum and maximum for Data1;
100    !   Ymin, Ymax - final plot minimum and maximum for Data2;
110    !   Array_t, Array_b - temporary graphics storage arrays;
120    !   Xunit, Yunit      <>
130    !   Xplus, Yplus      <>   Plotting parameters.
140    !   Xlabel$, Ylabel$  <>
150    !
160    SHORT Data1(4133), Data2(4133), Dt
170    SHORT Xmin, Xmax, Ymin, Ymax, Xbegin, Xend
180    SHORT Xunit, Yunit, Delta_t1, Delta_t2
190    INTEGER Array_t(23835), Array_b(23940)
200    INTEGER Nwords1, Nwords2, Last1, Last2
210    INTEGER Flag, First_word, Last_word
220    DIM Label${64}, Xlabel${32}, Ylabel${32}, File1${10}, File2${10}
230    File1: PRINT PAGE
240    PRINT "ENTER THE NAME OF THE X-AXIS FILE:"
250    BEEP
260    INPUT File1$                                ! The files are entered into two
270    Flag=1                                       ! arrays - Data1 and Data2.
280    File1$=File1$&" :C12"
290    ON ERROR GOTO File_error
300    FREAD File1$, Data1(*)
310    OFF ERROR
320    ENTER Data1(1) USING "#,64A"; Label$
330    PRINT LIN(2), TAB(8); Label$, LIN(1)
340    PRINT "IS THIS THE CORRECT FILE?"
350    BEEP
360    INPUT A$
370    IF A$="N" THEN File1
380    File2: PRINT PAGE, "ENTER THE NAME OF THE Y-AXIS FILE:"
390    BEEP
400    INPUT File2$
410    File2$=File2$&" :C12"
420    Flag=2
430    ON ERROR GOTO File_error
440    FREAD File2$, Data2(*)
450    OFF ERROR
460    ENTER Data2(1) USING "#,64A"; Label$
470    PRINT LIN(2); TAB(8); Label$, LIN(1)       ! Check to see if the time
480    PRINT "IS THIS THE CORRECT FILE?"         ! between points is the same
490    BEEP                                       ! for both files. If it isn't,
500    INPUT A$                                  ! the program will try to
510    IF A$="N" THEN File2                       ! correct this.

```

```

520 First_word=38
530 PRINT PAGE
540 IF Data2(37)<>Data1(37) THEN Error_exit
550 Dt=Data1(37)
560 Set_vals: !
570 Last1=ROW(Data1) ! The program sets Last_word
580 Last2=ROW(Data2) ! to the number of points in
590 IF Last1>Last2 THEN ! the shorter of the two files.
600 Last_word=Last2
610 ELSE ! The maximum and minimum of
620 Last_word=Last1 ! each file is found. If an
630 END IF ! AP ROM is not installed, a
640 MAT SEARCH Data1,MIN;Xmax,First_word ! routine to find maximum and
650 MAT SEARCH Data1,MIN;Xmin,First_word ! minimum values is required.
660 MAT SEARCH Data2,MAX;Ymax,First_word
670 MAT SEARCH Data2,MIN;Ymin,First_word
680 PRINT PAGE
690 Parameters: PRINT "CURRENT DATA SPECIFICATIONS ARE:"
700 PRINT TAB(5);"XMIN = ";Xmin
710 PRINT TAB(5);"XMAX = ";Xmax
720 PRINT "DO YOU WANT TO CHANGE THE X-AXIS VALUES?"
730 BEEP
740 INPUT A$
750 IF A$="Y" THEN
760 X_in: PRINT "ENTER THE MAXIMUM AND MINIMUM X-AXIS VALUES:"
770 BEEP
780 INPUT Xmax,Xmin ! The user may change the x- or
790 IF Xmin>=Xmax THEN ! y-axis values.
800 PRINT "XMAX <= XMIN -- TRY AGAIN"
810 GOTO X_in
820 END IF
830 END IF
840 PRINT PAGE,"CURRENT DATA SPECIFICATIONS ARE:"
850 PRINT "YMIN = ";Ymin,"YMAX = ";Ymax
860 PRINT "DO YOU WANT TO CHANGE THESE VALUES?"
870 BEEP
880 INPUT A$
890 IF A$="Y" THEN
900 Y_in: PRINT "ENTER THE MAXIMUM AND MINIMUM Y-AXIS VALUES:"
910 BEEP
920 INPUT Ymax,Ymin
930 IF Ymax<=Ymin THEN
940 PRINT "YMAX <= YMIN -- TRY AGAIN"
950 GOTO Y_in ! The LINPUT command is used in
960 END IF ! lines 1010 and 1080 so the
970 END IF ! labels may use punctuation
980 PRINT PAGE ! marks.
990 PRINT "ENTER THE X-AXIS LABEL (32 CHARACTER MAX):"
1000 BEEP
1010 LINPUT Xlabel$
1020 PRINT "ENTER THE INTERVAL BETWEEN TICK MARKS:"
1030 PRINT "XMIN=";Xmin,"XMAX=";Xmax
1040 BEEP
1050 INPUT Xunit

```

```

1060 PRINT "ENTER THE Y-AXIS LABEL (32 CHARACTER MAX):"
1070 BEEP
1080 LINPUT Ylabel$
1090 PRINT "ENTER THE INTERVAL BETWEEN TICK MARKS:"
1100 PRINT "YMIN = ";Ymin,"YMAX = ";Ymax
1110 BEEP
1120 INPUT Yunit
1130 PRINT PAGE
1140 PRINT "FOR FILE "&File2$&": START = 0 STOP = ";Dt*(Last1-First word)
1150 PRINT LIN(1),"FOR FILE "&File2$&": START = ";0;" STOP = ";Dt*(Last2-
First word)
1160 PRINT LIN(1),"DO YOU WANT TO PLOT THE FILES:"
1170 PRINT TAB(5),"0 - OVER THE ENTIRE INTERVAL"
1180 PRINT TAB(5),"1 - OVER PART OF THE INTERVAL"
1190 BEEP
1200 INPUT Int ! Data files which contain more
1210 IF Int=0 THEN ! information than necessary may
1220 Xbegin=0 ! be viewed over a restricted
1230 Xend=Dt*(Last-1) ! time frame. If the user wants
1240 END IF ! to view all the data, he may.
1250 IF Int=1 THEN
1260 PRINT LIN(2),"ENTER THE START AND STOP TIMES OF THE PLOT INTERVAL:"
1270 BEEP ! The starting and ending
1280 INPUT Xbegin,Xend ! points are calculated before
1290 IF Xbegin>=Xend THEN ! plotting begins.
1300 PRINT "STOP <= START --- TRY AGAIN"
1310 GOTO 1260
1320 END IF
1330 Last=Xend/Dt+First-1
1340 IF Xbegin>0 THEN First=Xbegin/Dt+First-1
1350 END IF
1360 PRINT PAGE,"ENTER THE PEN COLOR (1-8):"
1370 BEEP ! The plot could be highlighted
1380 INPUT Pen ! by drawing it in a color other
1390 IF (Pen<1) OR (Pen>8) THEN 1360 ! than black. NOTE - the pen
1400 Plot_data: ! numbers of the screen are not
1410 PLOTTER IS "GRAPHICS" ! necessarily the same as those
1420 Xplus=.15*(Xmax-Xmin) ! for the plotter!
1430 Yplus=.15*(Ymax-Ymin)
1440 GRAPHICS
1450 EXIT ALPHA
1460 LINE TYPE 1
1470 PEN Pen
1480 SCALE Xmin-Xplus,Xmax+.5*Xplus,Ymin-Yplus,Ymax+.5*Yplus
1490 CLIP Xmin,Xmax,Ymin,Ymax
1500 MOVE Data1(First),Data2(First) ! The two files are plotted
1510 FOR J=First TO Last ! point by point from the start
1520 PLOT Data1(J),Data2(J),-1 ! and stop computed earlier.
1530 NEXT J
1540 PENUP
1550 Labels: ! The axes and labels are always
1560 PEN 1 ! written with pen 1, usually a
1570 UNCLIP ! fine line black pen.
1580 FRAME

```

```

1590 CLIP Xmin,Xmax,Ymin-.25*Yplus,Ymin
1600 LAXES Xunit,Yunit,Xmin-10*Xunit,Ymin,-1,-1
1610 UNCLIP
1620 Xcenter=(Xmax-Xmin)/2+Xmin
1630 Ycenter=Ymin-.75*Yplus
1640 MOVE Xcenter,Ycenter
1650 LORG 5
1660 LABEL Xlabel$
1670 CLIP Xmin-.35*Xplus,Xmin,Ymin,Ymax
1680 LAXES Xunit,Yunit,Xmin,Ymin-10*Yunit,-1,-1
1690 UNCLIP
1700 Xcenter=Xmin-.75*Xplus
1710 Ycenter=(Ymax-Ymin)/2+Ymin
1720 MOVE Xcenter,Ycenter
1730 LDIR PI/2
1740 LABEL Ylabel$
1750 LDIR 0
1760 GSTORE Array_t(*)
1770 GSTORE Array_b(*),0,227
1780 PRINT PAGE
1790 ALPHA
1800 EXIT GRAPHICS
1810 PRINT "PRESS CONT WHEN READY TO TYPE LABELS ONTO THE PLOT. "
1820 IF Device=0 THEN
1830 PRINT "IF YOU MAKE A MISTAKE, PRESS SOFT KEY k5 TO RE-ENTER LABELS."
1840 END IF
1850 PRINT "WHEN YOU ARE FINISHED, PRESS CONT AGAIN."
1860 PAUSE
1870 PRINT PAGE
1880 GRAPHICS
1890 EXIT ALPHA
1900 CSIZE 3.3
1910 ON KEY #5 GOTO 1920
1920 GLOAD Array_t(*)
1930 GLOAD Array_b(*),0,227
1940 LETTER
1950 OFF KEY #5
1960 GSTORE Array_t(*)
1970 GSTORE Array_b(*),0,227
1980 ALPHA
1990 EXIT GRAPHICS
2000 IF Device=0 THEN
2010 PRINT PAGE,"ENTER THE NUMBER OF COPIES DESIRED:"
2020 BEEP
2030 INPUT Num
2040 IF Num>0 THEN
2050 PRINT PAGE
2060 GRAPHICS
2070 EXIT ALPHA
2080 GLOAD Array_t(*)
2090 GLOAD Array_b(*),0,227
2100 PRINTER IS 0
2110 FOR I=1 TO Num
2120 DUMP GRAPHICS

```

! GSTORE saves the contents of
! the graphics screen in temporary
! memory. The screen is displayed
! again when the GLOAD command is
! executed.

! Additional labels may be
! typed on the plot. The labels
! are stored in the graphics
! array, but they must be
! re-typed on the plot drawn
! to the peripheral plotter.

! Copies of the plot may be dumped
! to the internal printer or a
! peripheral plotter - in this
! case, an H-P 9872C eight pen
! plotter.

```

2130     PRINT LIN(5)
2140     NEXT I
2150     PRINTER IS 16
2160     ALPHA
2170     EXIT GRAPHICS
2180 END IF
2190 Plotter: PRINT "DO YOU WANT A COPY ON THE FLAT BED PLOTTER?"
2200 BEEP
2210 INPUT A$
2220 IF A$="Y" THEN
2230     PRINT "RESET THE FLAT BED PLOTTER. PRESS CONT WHEN READY."
2240     PAUSE
2250     Device=1                                ! The peripheral plotter is
2260     PLOTTER IS 7,5,"HPGL",1,8                ! activated and plot is re-drawn.
2270     GOTO Plot_data                            ! Line 2260 may be changed to
2280 END IF                                       ! specify another plotter.
2290 PRINT PAGE,"DO YOU WANT TO CHANGE ANY PLOT PARAMETERS?"
2300 BEEP
2310 INPUT A$
2320 IF A$="Y" THEN Parameters
2330 PRINT PAGE,"DO YOU WANT TO PLOT ANOTHER PAIR OF FILES?"
2340 BEEP
2350 INPUT A$
2360 IF A$="Y" THEN 150
2370 LOAD "PLTDRV:D12",150
2380 File_error:                                ! If a file is the wrong type
2390 PRINT "ERROR ON FILE READ --"                ! or cannot be found on the disc,
2400 PRINT LIN(1),TAB(8),ERRM$,LIN(1)            ! the program jumps to this
2410 PRINT "DO YOU WANT A DISC CATALOG?"         ! section. The error type is
2420 BEEP                                         ! listed and a disc catalog may
2430 INPUT A$                                    ! be printed to the screen.
2440 IF A$="Y" THEN CAT ":C12"
2450 DISP "PRESS CONT WHEN READY TO RE-ENTER FILENAME"
2460 PAUSE
2470 ON Flag GOTO File1,File2
2480 Error_exit: !
2490 PRINT PAGE,"TIME BETWEEN POINTS IS NOT THE SAME FOR EACH FILE."
2500 PRINT LIN(1);"DELTA TIME FOR FILE "&File1$&" IS ";Data1(37)
2510 PRINT "DELTA TIME FOR FILE "&File2$&" IS ";Data2(37),LIN(2)
2520 PRINT "DO YOU WANT TO RECONCILE THE TIME BETWEEN POINTS?"
2530 BEEP                                         ! The time difference is resolved
2540 INPUT A$                                    ! by entering the desired time
2550 IF A$="N" THEN 2330                          ! between points. One or both
2560 Delta_t1=Data1(37)                          ! files are incremented to this
2570 Delta_t2=Data2(37)                          ! common time, Dt.
2580 PRINT "ENTER THE DESIRED TIME BETWEEN POINTS:"
2590 BEEP
2600 INPUT Dt                                    ! Check Dt; if its's the same as
2610 IF Delta_t1=Dt THEN Fix2                    ! either Delta_t1 or Delta_t2,
2620 IF Delta_t2=Dt THEN Times=1                ! fix only one file. If Dt is
2630 Fix1: Inc=Dt/Delta_t1                       ! not equal to either, fix both
2640 I=K=First_word                             ! files and return to the main
2650 Count=1                                     ! body of the program.
2660 Inci: I=I+Inc

```

```

2670     IF I<=ROW(Data1) THEN
2680         K=K+1
2690         Data1(K)=Data1(I)
2700         Count=Count+1
2710         GOTO Inci
2720     END IF
2730     REDIM Data1(K)
2740     Nwords1=Count
2750     IF Times=1 THEN Set_vals
2760 Fix2: Inc=Dt/Delta_t2
2770     J=K=First_word
2780     Count=1
2790 Incj: J=J+Inc
2800     IF J<=ROW(Data2) THEN
2810         K=K+1
2820         Data2(K)=Data2(J)
2830         Count=Count+1
2840         GOTO Incj
2850     END IF
2860     REDIM Data2(K)
2870     Nwords2=Count
2880     GOTO Set_vals
2890     END

```

Multiple Y-Axis Program

```

10     OPTION BASE 1                ! FILE "YSPLT:C"
20     !
30     ! SHORT indicates a short-precision variable (up to six significant
40     ! digits).
50     !
60     ! The variables are:
70     !   Data - array containing the currently plotting data file;
80     !   Plot - array to which files are drawn;
90     !   Xmin, Xmax - beginning and ending times for a data file;
100    !   Xbegin, Xend - start and stop times for the final plot;
110    !   Ymin1, Ymax1 - lower and upper bounds for the first file plotted;
120    !   Ymin2, Ymax2 - lower and upper bounds for the second file plotted;
130    !   Flag - indicates which file is being retrieved or plotted;
140    !   Xunit, Yunit1, Yunit2      >
150    !   Xplus, Yplus1, Yplus2     >   Plotting parameters.
160    !   Xlabel$, Ylabel1$, Ylabel2$ >
170    !
180    SHORT Data(4133),Delta_t,Xmin,Xmax,Ymin1,Ymax1,Xplus,Yplus1,Yplus2
190    SHORT Xbegin,Xend,Xunit,Yunit1,Yunit2,Ymax2,Ymin2
200    SHORT Plot1(10922,3),Plot2(10922,3)
210    INTEGER Nwords,First,Last,Flag
220    DIM Xlabel$(32),Ylabel1$(25),Ylabel2$(25),File1$(10),File2$(10)
230    DIM Label$(64)
240    File1: PRINT PAGE,"ENTER THE NAME OF THE FIRST FILE:"
250    BEEP
260    Flag=1                        ! Let program know this is the
270    INPUT File1$                  ! first file to be retrieved
280    File1$=File1$&"C12"          ! and plotted.
290    ON ERROR GOTO File_error     ! If the file cannot be found
300    FREAD File1$,Data(*)         ! or it cannot be read, go to
310    OFF ERROR                    ! the error recovery section.
320    ENTER Data(1) USING "#,64A";Label$ ! Check the file label to see
330    PRINT LIN(2),TAB(8),Label$,LIN(1) ! if the right file was read.
340    PRINT "IS THIS THE CORRECT FILE?" ! If not, go back and try it
350    BEEP                          ! again.
360    INPUT A$
370    IF A$="N" THEN File1
380    Set_vals: Delta_t=Data(37)    ! Find the number of points in
390    First=38                      ! the file, the number of data
400    Last=ROW(Data)                ! points and the time between
410    Nwords=Last-37                ! data points for each of the
420    IF Flag=1 THEN                ! two files. Initialize the
430        Xmin=0                    ! start and stop the first time,
440        Xmax=Delta_t*(Nwords-1)   ! but not the second time.
450    END IF                        ! Lines 460 and 470 require the
460    MAT SEARCH Data,MAX;Ymax,First ! AP ROM. A sorting routine
470    MAT SEARCH Data,MIN;Ymin,First ! must be written if it is not
480    PRINT PAGE                    ! installed.
490    PRINT "CURRENT DATA PARAMETERS ARE AS FOLLOWS:"
500    PRINT TAB(5);"YMAX = ";Ymax
510    PRINT TAB(5);"YMIN = ";Ymin

```

```

520 PRINT "DO YOU WANT TO CHANGE THE Y-VALUES?"
530 BEEP                                     ! The user may change the values
540 INPUT A$                                ! of the maximum and minimum for
550 IF A$="Y" THEN                          ! each file.
560     PRINT "INPUT NEW MAXIMUM AND MINIMUM:"
570     BEEP
580     INPUT Ymax,Ymin
590     IF Ymax<=Ymin THEN
600         PRINT "YMAX <= YMIN -- TRY AGAIN"
610         GOTO 560
620     END IF
630 END IF                                  ! Ymax and Ymin are assigned to
640 IF Flag=1 THEN                          ! Ymax1 and Ymin1 or Ymax2 and
650     Ymax1=Ymax                          ! Ymin2, depending on which file
660     Ymin1=Ymin                          ! is being plotted. Ymax and Ymin
670 END IF                                  ! are used to plot each file to
680 IF Flag=2 THEN                          ! the screen, but the other values
690     Ymax2=Ymax                          ! will be used when drawing the
700     Ymin2=Ymin                          ! data to the peripheral plotter.
710     GOTO Plot_two
720 END IF
730 PRINT "CURRENT START AND STOP VALUES:"
740 PRINT TAB(5),"START =";Xmin
750 PRINT TAB(5),"STOP =";Xmax
760 PRINT "DO YOU WANT TO CHANGE THESE VALUES?"
770 BEEP
780 INPUT A$
790 IF A$="Y" THEN
800     PRINT "ENTER THE NEW START AND STOP:"
810     BEEP
820     INPUT Xbegin,Xend
830     IF Xbegin>=Xend THEN
840         PRINT "STOP <= START -- TRY AGAIN"
850         GOTO 800                         ! Lines 910, 990 and 1000 use the
860     END IF                               ! LINPUT command instead of INPUT
870 END IF                                  ! so punctuation characters may be
880 PRINT PAGE                              ! written into the labels.
890 PRINT "ENTER THE X-AXIS LABEL (32 CHARACTER MAX):"
900 BEEP
910 LINPUT Xlabel$
920 PRINT "ENTER THE INTERVAL BETWEEN TICK MARKS:"
930 PRINT "START = ";Xbegin,"STOP = ";Xend
940 BEEP
950 INPUT Xunit
960 PLOTTER IS "GRAPHICS"
970 Plot_two: PRINT "ENTER THE Y-AXIS LABEL (25 CHARACTER MAX):"
980 BEEP
990 IF Flag=1 THEN LINPUT Ylabel1$
1000 IF Flag=2 THEN LINPUT Ylabel2$
1010 PRINT "ENTER THE INTERVAL BETWEEN TICK MARKS:"
1020 PRINT "YMAX = ";Ymax,"YMIN = ";Ymin
1030 BEEP
1040 IF Flag=1 THEN INPUT Yunit1             ! Flag keeps the plot parameters
1050 IF Flag=2 THEN INPUT Yunit2           ! separate for each file.

```



```

1060 PRINT "ENTER THE PEN COLOR (1-8):"
1070 BEEP
1080 INPUT Pen
1090 IF (Pen<1) OR (Pen>8) THEN 1060
1100 Begin:                                     ! Position the pen at the first
1110 Xloc=Xbegin                                 ! point in the file.
1120 Yloc=Data(First)
1130 Xplus=.15*(Xend-Xbegin)
1140 IF Flag=1 THEN Yplus1=.15*(Ymax1-Ymin1)
1150 IF Flag=2 THEN Yplus2=.15*(Ymax2-Ymin2)
1160 PRINT PAGE                                 ! Scale the graphics screen
1170 GRAPHICS                                  ! differently for each file,
1180 EXIT ALPHA                                 ! using each file's separate
1190 Scale:                                     ! parameters.
1200 IF Flag=1 THEN SCALE Xbegin-Xplus,Xend+Xplus/2,Ymin1-1.5*Yplus1,1.4*(Ymax1
-Ymin1)+Yplus1/2
1210 IF Flag=2 THEN SCALE Xbegin-Xplus,Xend+Xplus/2,2*(Ymin2-Ymax2)-Yplus2,
Ymax2+Yplus2
1220 CLIP Xbegin,Xend,Ymin,Ymax
1230 IF Flag=1 THEN PLOTTER IS Plot1(*)         ! Draw the first file to the
1240 IF Flag=2 THEN PLOTTER IS Plot2(*)         ! array Plot1, the second to
1250 PEN Pen                                     ! array Plot2.
1260 MOVE Xloc,Yloc                             ! Increment the time by Delta_t
1270 FOR I=First TO Last                       ! and see if it lies in the
1280     Xloc=Xloc+Delta t                      ! interval Xbegin to Xend. If
1290     IF Xloc<Xbegin THEN Nexti             ! it occurs before Xbegin,
1300     IF Xloc>Xend THEN Cont                ! increment the time to the
1310     Yloc=Data(I)                          ! next point. If it occurs
1320     PLOT Xloc,Yloc,-1                     ! within the interval, the data
1330 Nexti: NEXT I                             ! point is plotted and the loop
1340 Cont: PENUP                                ! is continued. If it occurs
1350 IF Flag=2 THEN                             ! after Xend, the loop is exited.
1360     PLOTTER Plot2(*) IS OFF
1370     GOTO Y2                                 ! The first or second plot array
1380 END IF                                     ! is turned off (depending on
1390 PLOTTER Plot1(*) IS OFF                   ! which file was plotted) and
1400 Label one: UNCLIP                          ! the appropriate labels drawn.
1410 CSIZE 2.75
1420 PEN 1
1430 CLIP Xbegin,Xend,Ymin1-.15*Yplus1,Ymin1
1440 LAXES Xunit,Yunit1,Xbegin-10*Xunit,Ymin1,-1,-1
1450 UNCLIP
1460 Xcenter=.5*(Xend-Xbegin)+Xbegin
1470 Ycenter=Ymin1-1.125*Yplus1
1480 MOVE Xcenter,Ycenter
1490 LORG 5
1500 LABEL Xlabel$
1510 CLIP Xbegin-.1*Xplus,Xbegin,Ymin1,Ymax1
1520 LAXES Xunit,Yunit1,Xbegin,Ymin1-10*Yunit1,-1,-1
1530 UNCLIP                                     ! After the first set of labels
1540 LDIR PI/2                                  ! is drawn to the screen, the
1550 Xcenter=Xbegin-.75*Xplus                  ! second file is retrieved and
1560 Ycenter=Ymin1+.5*(Ymax1-Ymin1)          ! plotted. If the labels are
1570 MOVE Xcenter,Ycenter                      ! being drawn on a peripheral

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1580 LABEL Ylabel1$           ! plotter, the second file is
1590 IF Device=1 THEN        ! drawn, then the second set of
1600 UNCLIP                  ! axes.
1610 SCALE Xbegin-Xplus,Xend+Xplus/2,2*(Ymin2-Ymax2)-Yplus2,Ymax2+Yplus2
1620 CLIP Xbegin,Xend,Ymin2,Ymax2
1630 MAT PLOT Plot2
1640 UNCLIP
1650 GOTO Y2
1660 END IF
1670 WAIT 1000
1680 ALPHA
1690 EXIT GRAPHICS
1700 File2: PRINT "ENTER THE NAME OF THE SECOND FILE:"
1710 BEEP                    ! After the first file has been
1720 INPUT File2$            ! drawn to the screen, the second
1730 File2$=File2$&" :C12"  ! file is retrieved. Flag is
1740 Flag=2                  ! updated to 2 and the program
1750 ON ERROR GOTO File_error ! goes to line Set_vals, where
1760 FREAD File2$,Data(*)   ! the second plot's parameters
1770 OFF ERROR              ! are set.
1780 ENTER Data(1) USING "#,64A";Label$
1790 PRINT LIN(2),TAB(8),Label$,LIN(2),"IS THIS THE CORRECT FILE?"
1800 BEEP
1810 INPUT A$
1820 IF A$="N" THEN File2
1830 GOTO Set_vals
1840 Y2: !
1850 PEN 1
1860 CLIP Xbegin-.35*Xplus,Xbegin,Ymin2,Ymax2
1870 LAXES Xunit,Yunit2,Xbegin,Ymin2-10*Yunit2,-1,-1
1880 UNCLIP
1890 Xcenter=Xbegin-.75*Xplus
1900 Ycenter=Ymin2+.5*(Ymax2-Ymin2)
1910 MOVE Xcenter,Ycenter
1920 LABEL Ylabel2$
1930 FRAME
1940 WAIT 1000
1950 PRINT PAGE
1960 ALPHA
1970 EXIT GRAPHICS
1980 PRINT "PRESS CONT TO TYPE IN LABELS."
1990 CSIZE 2.75
2000 LDIR 0
2010 PAUSE
2020 GRAPHICS
2030 PRINT PAGE
2040 EXIT ALPHA
2050 LETTER
2060 ALPHA
2070 EXIT GRAPHICS
2080 IF Device=1 THEN Flat_bed
2090 PRINT "ENTER THE NUMBER OF COPIES DESIRED:"
2100 BEEP
2110 INPUT Num                ! The plot may be dumped to the

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2120 IF Num=0 THEN Flat_bed          ! machine's internal printer or
2130 PRINT PAGE                      ! to a peripheral plotter-- in
2140 GRAPHICS                        ! this case, an H-P 9872C eight
2150 EXIT ALPHA                      ! pen plotter.
2160 PLOTTER 13 IS ON
2170 PRINTER IS 0
2180 FOR I=1 TO Num
2190     DUMP GRAPHICS
2200     PRINT LIN(5)
2210 NEXT I
2220 PRINTER IS 16
2230 ALPHA
2240 EXIT GRAPHICS
2250 Flat_bed: IF GSTAT(1)=7 THEN
2260     PLOTTER 7,5 IS OFF
2270     PLOTTER 13 IS ON
2280 END IF
2290 PRINT PAGE,"DO YOU WANT A COPY ON THE FLAT BED PLOTTER?"
2300 BEEP
2310 INPUT A$
2320 IF A$="Y" THEN
2330     Device=1                    ! Line 2340 may be changed to
2340     PLOTTER IS 7,5,"HPGL",1,8    ! specify another plotter.
2350     PLOTTER 13 IS OFF
2360     PRINT PAGE,"RESET THE FLAT BED PLOTTER.  PRESS CONT WHEN READY TO PLOT."
2370     PAUSE
2380     GRAPHICS
2390     PRINT PAGE
2400     EXIT ALPHA
2410     UNCLIP
2420     SCALE Xbegin-Xplus,Xend+Xplus/2,Yminl-1.5*Yplusl,1.4*(Ymaxl-Yminl)+Yplus/2
2430     CLIP Xbegin,Xend,Yminl,Ymaxl
2440     MAT PLOT Plotl
2450     UNCLIP
2460     GOTO Label_one
2470 END IF
2480 PRINT PAGE,"DO YOU WANT TO PLOT ANOTHER PAIR OF FILES?"
2490 BEEP
2500 INPUT A$
2510 IF A$="N" THEN LOAD "PLTDRV:D12",10
2520 GOTO Filel
2530 File_error: PRINT PAGE,"ERROR ON FILE READ:",LIN(2),TAB(8),ERRM$
2540 PRINT LIN(1),"DO YOU WANT A DISC CATALOG?"
2550 BEEP
2560 INPUT A$
2570 IF A$="Y" THEN CAT ":C12"
2580 ON Flag GOTO Filel,File2
2590 END

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