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DECUS NO.   8-148

TITLE   PLOTTER SYSTEM

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SOURCE LANGUAGE

ATTENTION

PLOTTER SYSTEM

This program has been in use for about 2 years at The Radiological Research Laboratory of Columbia University. During this time innumerable patches have been made and there seems to be no hope of obtaining a correct symbolic tape in the near future. However, we have tested the system as it exists on binary tape and feel that its usefulness outweighs the lack of documentation. At the end of this system description comments are made for those who may wish to further patch the system.
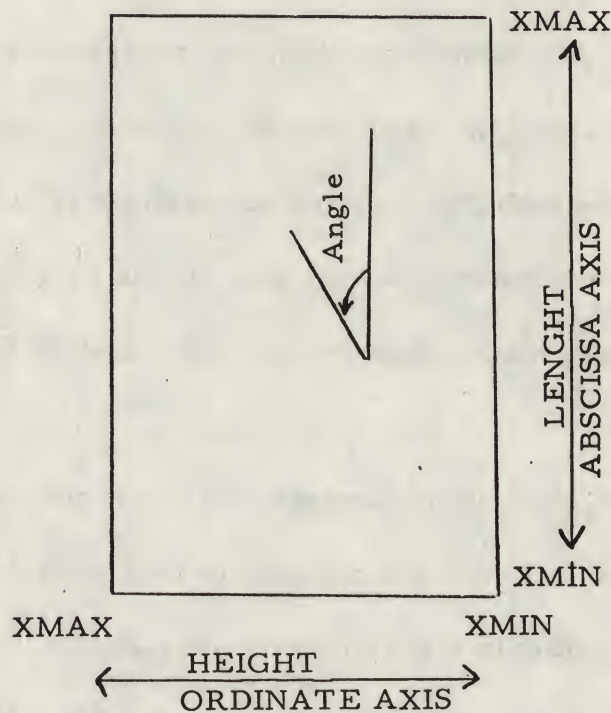
The system consists of a main program tape and two patch tapes. The main program tape accepts all plotting commands and data from the teletype. Patch Tape #1 modifies the basic system so that data is accepted from the high speed reader while the commands are entered from the teletype. Patch Tape #2 modifies the basic system so that all input, commands and data, are inputted from the high speed reader. All versions of the system have a starting address of (0200).

In the following description, the underlined characters are generated by the system, and all other characters are inputted to the system. In the case of high speed I/O, for both commands and data, the system does not output and the underlined characters would not be seen. The following description will be for Teletype

I/O. The extention to the other two systems should be obvious.

The Calcomp plotter for which this system is written has a drum which is 10 inches wide and 100 increments per inch. The system calculates in units of increments and should, therefore, be independent of plotter size and increment size.

```
                              XMAX
        ┌─────────────────────┐ ↑
        │                     │ │
        │             Angle   │ │
        │              ╲      │ │
        │               ╲     │ │  LENGHT
        │                ╲    │ │  ABSCISSA AXIS
        │                 ╲   │ │
        │                     │ │
        │                     │ ↓
        └─────────────────────┘ XMIN
      XMAX                  XMIN
        ←──── HEIGHT ────→
          ORDINATE AXIS
```

The pen motion is taken to be a long the ordinate axis and the drum motion along the abscissa axis. Any angles are referred to the absciss axis and run from $0°$ to $360°$ counter clockwise from the abscissa axis.

NOTE: In what follows $\rangle \downarrow$ means a carriage return/line feed combination.

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Upon starting in location (0200) the system types ORD(, and awaits input information regarding the ordinate axis. The form of this command string is:

ORD(YMIN, YMAX, HEIGHT, MCY, XYTITLE, YYTITLE, SIZEY,) ↓

.... NN H̲ (Ordinate Title))) ↓

In all command strings the ", " is an execute symbol, and as such must appear exactly when expected. If this is not the case the system will understand this to mean that an error in the command string was made and will re-request the entire command string be re-entered.

YMIN: Is a floating point number (terminated by any non-numeric character) and is the value to be ascribed to the right hand edge of the plot region.

YMAX: Is a floating point number and is the value at the left hand edge of the plot area.

It is not necessary for YMIN< YMAX.

HEIGHT is the length of the ordinate axis in increments.

$$0 < HEIGHT \leq 1000$$

In our case 1000, corresponds to a max height of 10". These three values determine the scaling in the Y direction but it must be remembered that since this plotter system allows "plotter time" modification of the data these values of YMIN and YMAX must correspond to the transformed data.

For example, if the Y axis values run from 4.0 to 100.
and it is intended to plot the square root of the data then:

YMIN and YMAX should be 2 and 10.

These comments also apply to the abscissa setup to be
described shortly.

MCY = 0 if the next two numbers are to refer to the first letter
of the ordinate title

= 1 if the next two numbers are to refer to the center of
the ordinate title.

XYTITLE These are floating point numbers, determining the
XYTITLE

location of the ordinate title.

If MCY=1: then the center of the title will be located at this
point (XYTITLE is the X coordinate in increments of the center
of the Y title etc). Otherwise the first letter will be located at
this point.

XYTITLE refers to the number of increments along the abscissa
axis (-50.0 is a good choice).

YYTITLE refers to the number of increments along the ordinate
axis (if HEIGHT = 1000 and MCY = 1 then 500 is a likely choice)

SIZEY is a two digit octal number indicating the size of letter to
be used. Referring to the plotter test graph, size 03 was used for

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the ordinate and abscissa labels. After the termination "," the

system CR/LF's and types 10 spaces and waits for NN which is

a 2 digit OCTAL number indicating the octal number of letters in

the title. If no title is wanted 01 should be requested and a space

printed. Under no circumstance should 00 be given as this causes

much grief, and will probably require restarting of the systems

at 0200.

After accepting the number of characters the system out-

puts H and waits for the character string to be typed in. When

typing from the teletype keyboard the next character should not

be typed until the last character is echoed. When NN octal

digits are entered the system types) ⤋ ABSC (

and awaits the input of a similar command string for the abscissa.

(All commands are summarized at the end of this description).

When the ordinate and abscissa command strings are complete the

plotting area defined is outlined, on completion of which the system

asks

PLOT (

and waits the input of information regarding the data format and the

plotting variable.

The expected for is

PLOT (ORDCOL, ORTTRN, ABSCOL, ABSCTRN, PLOTCHR,

PLSIZE, CON, NEXT -----)

The data format can be any input acceptable to the D.E.C. Floating

Point Package i.e., with a decimal point or in E format. The data

is expected to be in columns. Each column separated from the

next by at least one space and not more than 9 spaces. The end of

any row must contain a carriage return line feed combination.

As may as $(77)_8$ columns are allowed in any row ORDCOL is a

two digit octal number indicating the column in which the ordinate

data is to be found ABSCOL is a two digit octal number indicating

the column in which the abscissa data is to be found (these can be

the same column).

ORDTRN⎫ is a single octal digit indicating the transformation to be
ABSTRN⎭

applied to the data. The transformations possible are given in the

summary data. The two special transformations should be noted

as these allow hand coding of any transformation (using the calcu-

lational techniques described in the Dec. floating point package

manual).

It should be noted at this point that a binary punch program is

included with starting address (3465) and can be used to make a

permanent copy of any special transformation needed or in fact of

the entire system (0001 to 7577). In order to dump on the H.S. punch

the following changes are required.

C(3466) = 6026

C(3562) = 6021

C(3564) = 6026

PLOTCHR is a two digit octal # specifying the plotting character

to be used (see summary) and PLSIZE is a two digit octal # giving

the size to be used. (sizes 01 and 02 are reasonable although

larger sizes may be used).

CON = 0 if all plotted points are to be connected by straight lines

      1 if plotted points are <u>not</u> to be connected.

To obtain a line plot, plotting character 00 with size 00 can be used.

NEXT is a single digit either 0 or 1

      When 0, then the system is informed that when the current

data set is processed, control should be returned to PLOT(, for

further plots. The end of a data set is indicated by the presence of

<u>EXACTLY 10 SPACES</u>

If NEXT = 1 then the system will expect no further data after the

current data set.

The command string will expect one further piece of command data,

SPACE, (see summary) .. This is the number of increments from

the end of this graph to the start of the next.

NOTE: LENGTH + SPACE $\leq$ 2047.

As each data set is processed the system types $\langle * \rangle$ and returns
to Plot.

In the case when NEXT = 1 after $\langle * \rangle$ is outputted, the system responds
LABEL (X1, X1, SIZE1, ANGLE1, ↓↓

---------- LL H LABEL

X1 and Y1 are floating point numbers indicating the _starting_ locations
of the label.

SIZE1, is the size to be used

ANGLE1, is a floating point number between 0° and 360° indicating
the angle at which the label is to be plotted.

LL is again the _octal_ number of characters for the label. The label
routine is reentered after every label is plotted. However: when
LL = 00 no further labeling is allowed in the present plot and the
plotter advances to the location for the next plot.

HELPFUL COMMENTS?

All locations in memory not used by the system contain 7402:HLT
except those few places where it is a legal instruction or data. Any
set of 2 or more HLT instructions in a row will be free memory space.

The special transformation regions 3600 to 7677 and 3700 to

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3777 also contain 7402 with the exceptions of

3600	XXXX			?
3601	5600	JMP	1	. -1
3700	XXXX			?
3701	5700	JMP	1	. -1

So that inadvertant use of the special transformation will produce

no observable effect on the data or system.

Note the special transformations are subroutine calls therefore 3600

 3700 should be left unused and the last instruction of a transformation

should be an indirect jump to 3600 or 3700.   The binary punch region

from 3465 to 3577 is also available if necessary.

Blank tape is disregarded by all input routines and can be used to

help format tapes.

ASCII with 8 level punches as output by PDP-8 fortran or

        ASCII as output by PDP-9 fortran are equally acceptable to

the system.

Additional memory space is available by overwriting those parts of

the floating point package which are not needed. (see floating point

manual)

It is possible to add or even change the character set acceptable to

the system.

The character plotting system is based on a 4 x 8 grid
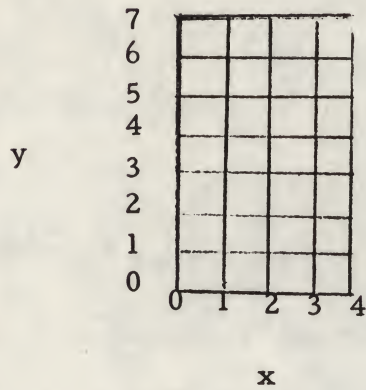
Each computer word used for character storage is divided into two

six b'it parts

$$(Y_2 \ X_2 \ Y_1 \ X_1)$$
$$\underbrace{}_{L} \ \underbrace{}_{R}$$

The six bits have the following effect

L or R	Action
07	Raise Pen
06	Lower Pen
05	End of character (automatic raise pen and go to next plotting location)

For any other combination

The action is to move the pen to the X and Y location specififed.

Thus to plot the character 5 as described in the following chart.

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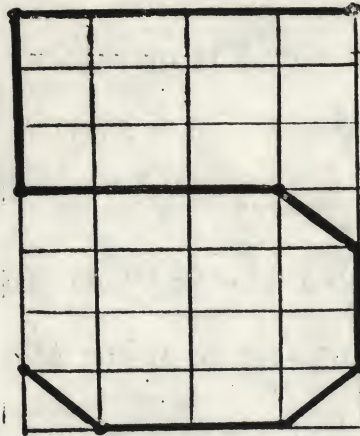
	NEXT	FIRST
1007	Move to X=0 Y=1	Raise Pen
0106	X=1, Y=1	Lower Pen
1403	X=4 Y=4	X=3, Y=0
4334	X=3 Y=4	X=4, Y=0
7040	X= 0 Y=7	X=0, Y=4
0574	End of Plot	X=4, Y=7

It should be mentioned that the Calcomp can only move 8 directions

and only lines between grid points are possible

The Code Table to translate between teletype input code and a plotter

character is in location 3200 to 3277.

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The teletype input character is marked with 0077 and 3200 is added to the number. The contents of this address is a pointer to the address of the start of the plot codes.

The fourth tape supplied labeled PLOTTER TEST TAPE can be used with which the TTY I/O system on the ASR-33 or the H.S. system. This tape could result in the type of plot shown and if the teletype is used the listing should appear as shown below.

```
ORD(-8. ,2. ,1000. ,1,-50. ,500. ,03,
     21HORDINATE . Y-AXIS .)
ABSC(0. ,12.566 ,1000. ,1,500. ,-40. ,03,
     21HABSCISSA . X-AXIS .)
PLOT(01,0,02,0,02,02,0,0,)
-8.  0.
-7.5   .628
-7.  1.256
-6.5  1.885
-6.  2.513
-5.5  3.142
-5.  3.769
-4.5  4.398
-4. 5.026
-3.5  5.655
-3.  6.283
-3.5  6.911
-4.  7.5396
-4.5  8.168
-5.  8.796
-5.5  9.425
-6. 10.0528
-6.5  10.681
-7.  11.309
-7.5  11.938
-8.  12.566
            <*>

PLOT(01,4,01,0,03,01,0,0,)
0.
 .3491
 .6981
1.047
1.396
1.508
1.7453
2.0944
2.4435
2.7926
3.1416
3.4907
3.897
4.1886
4.5376
4.7124
4.8869
5.2360
5.5851
5.9342
6.2832
            <*>
```

```
PLOT(01,5,01,0,03,01,1,1,200.,)
6.2832
6.6323
6.9664
7.3302
7.6792
7.8540
8.0285
8.3776
8.7267
9.0758
9.4248
9.7739
10.1229
10.4718
10.8208
10.9956
11.1701
11.5192
11.8683
12.2174
12.5664
            <*>

LABEL(425.,975.,03,0.,
       14HPLOTTER TEST
LABEL(125.,925.,02,0.,
       76HABCDEFGHIJKLMNOPQRSTU WXYZ0123456789#$%&'()*  =><\ ↑--+![]/".:,;
LABEL(500.,200.,02,0.,
       10HABCDEFGH
LABEL(500.,200.,02,90.,
       10HABCDEFGH
LABEL(500.,200.,02,180.,
       10HABCDEFGH
LABEL(500.,200.,02,270.,
       10HABCDEFGH
LABEL(500.,200.,02,45.,
       10H01234567
LABEL(500.,200.,02,135.,
       10H01234567
LABEL(500.,200.,02,225.,
       10H01234567
LABEL(500.,200.,02,315.,
       10H01234567
LABEL(700.,650.,02,0.,
       23HPLOTTING CHARACTERS
LABEL(700.,600.,03,0.,
       04H00 .
LABEL(700.,570.,03,0.,
       04H01 #
```

```
LABEL(700.,540.,03,0.,
      04H02 $
LABEL(700.,510.,03,0.,
      04H03 %
LABEL(700.,480.,03,0.,
      04H04 &
LABEL(700.,450.,03,0.,
      04H05 '
LABEL(700.,420.,03,0.,
      04H06 (
LABEL(700.,390.,03,0.,
      04H07 )
LABEL(700.,360.,03,0.,
      04H10 *
LABEL(50.,650.,02,0.,
     ,13HLETTER SIZE
LABEL(50.,625.,01,0.,
      15HABCD  SIZE 01
LABEL(50.,600.,02,0.,
      15HABCD  SIZE 02
LABEL(50.,575.,03,0.,
      15HABCD  SIZE 03
LABEL(50.,545.,04,0.,
      15HABCD  SIZE 04
LABEL(0.0,0.0,00,0.0,
      00)

ORD(
```

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Plotter System Summary

SA(0200).

Instruction Sequence.

<u>ORD(</u>YMIN, YMAX, HEIGHT, MCY, XYTITL, YYTITL, SIZEY,↙ ↓

NN<u>H</u> (ORD, TITLE)

ABSC(XMIN, XMAX, LENGHT, MCX, XXTITL, YXTITL, SIZEX, ↙ ↓
        MM<u>H</u> (ABSC. TITLE))

PLOT(ORDCOL, ORDTRN, ABSCOL, ABSTRN, PLOTCHR, PLSIZE, CON, 0<u>)</u>

<u>∠*></u>

<u>PLOT (</u>   as above

<u>∠*></u>

<u>PLOT (</u>   as above

<u>∠*></u>

LABEL (X1, Y1, SIZE1, ANGLE1, ↙ ↓

.... L1<u>H</u> (LABEL 1)) ↙ ↓

LABEL (X2, Y2, SIZE2, ANGLE2, ↙ ↓

.... L2<u>H</u> (LABEL2)

LABEL(X3, Y3, SIZE3, ANGLE3↙ ↓

.... 00 <u>)</u>

ORD(

Underlined characters are computer generated.

If a symbol other than, appears at the expected place an error

return takes palce to ORD(; ABSC(; PLOT (; or LABEL (

In what follows

XX. XX@:   indicates a floating point input, @ can be any illegal

             character. (can be any number)

X   :   indicate a single octal number 0 to 7

XX   :   indicate a two digit octal number 00 to 77.

Data tape format.

Data can be in any   floating point format.

Columns are separated by 1 to 9 spaces.

Lines are terminated by CR/LF combination.

End of data is indicated by exactly 10 spaces in a row.

The symbols in the instruction sequence have the following meaning:

YMIN, XX. XX@ : minimum ordinate value

YMAX, XX. XX@: minimum ordinate value

HEIGHT, XX. XX@: height of ordinate axis in hundredths of inches
                 (max, height = 1000.0 i.e., 10")

MCY, if = 0 then the next two numbers refer to the first letter of the

        title

     if = 1 then the next two numbers refer to the center of the title

XYTITLE, XX. XX@ X coordinate of the ordinate title in hundredths of
                 an inch

XYTITLE, XX. XX@ Y coordinate of the ordinate title in hundredths of an
                 inch

SIZEY, XX   size of the letters in the Y ordinate title.

NN, XX   octal number of characters in ordinate title

(TITLE) , XXX...XX character string for ordinate title.

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Symbols for ABSC. have similar meanings to the above

LENGHT XX. XX@ : Lenght of abscissa axis (max. lenght = 36. 96
Inches)

———————

ORDCOL, XX , octal number of column in which ordinate will be found.

ORDTRN, X , transformation to be applied to the above data.

ABSCOL, XX octal number of column in which abscissa will be found

ABSTRN, X transformation to be applied to the above data.

PLOTCHR, XX, octal number giving plotting character to be used.

PLSIZE, XX octal number giving size of the plotting character

CON, X   if = 0 then points are to be connected by a straight line

              if = 1 then points are not to be connected by a straight line

NEXT, X   If 0 then it is assumed that further data will be plotted on

              this same graph. Plotting will occur after ", " following

              0 if = 1 then it is assumed that no further data will be

              plotted on this graph and a new location will be gone

              to for the next new graph. The spacing between graphs

              is given by the next entry. (The sum of lenght and NEXT

              must be less than 2048.)

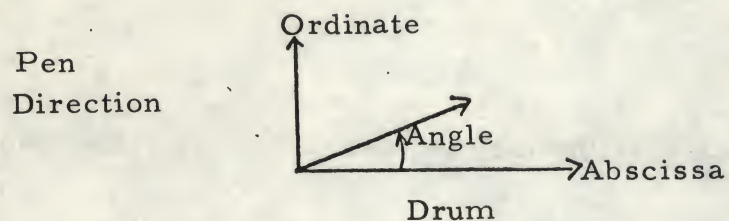SPACE, XX. XX@ Distance to next graph in hundredths of an inch.

The label subroutine is entered before the old graph is moved.

X1, XX. XX@ : X coordinate in hundredths of an inch of first letter of label.

Y1, XX. XX@ : Y coordinate as above

SIZE, XX   : size of letter in label.

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ANGLE,   XX.XX @ angle of letter in label in degrees

Pen
Direction

L1, XX   :   octal number of letters in label.

Label is re-entered after each line is completed until L1 = oo

when a new graph location is gone to.

Transformation Table

0 - No transformation

1 - LN

2 - Log

3 - exp

4 - sin

5 - cos

6 - special # 1

7 - special # 2.

The area from 3600 to 3677 is provided to program any special

transformation. This is special # 1. Special # 2 is in area 3700 to

3777.

The abscissa variable may be operated on by direct addressing of
location 0136.

The ordinate variable may be operated on by indirect addressing of
location 0133.

Binary Punch SA(3465)

System Dump (0001-7577)

00 - .   Plotting point

01 - ⊡

02 - ⬡

03 - △

04 - +

05 - x

06 - ◇

07 - ⊔

10 - *

Characters from Teletype of Title:

Teletype	Title
0-9	0-9
A-Z	A-Z
#	⌑
$	⬡
%	△
&	+
'	x
(	◇
)	⬚
*	*
SPACE	space
=	=
>	⊐
<	<
FORM, SHIFT	≤
↑	≥
-	≠
-	-
+	+
!	±
VT, SHIFT	[
M, SHIFT	]
/	/
"	√

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Teletype	Title
.	.
:	:
,	,
;	Σ

Any comments or questions may be addressed to:

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212 PL1-1310
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PLOTTER TEST

ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789□◌○△+×◇¤¥ =><≤≥≠-+±[]/√.;.Σ

ORDINATE, Y-AXIS.

LETTER SIZE

ABCD SIZE 01

ABCD SIZE 02

ABCD SIZE 03

ABCD SIZE 04

PLOTTING CHARACTERS

00 ⸱
01 □
02 ○
03 △
04 +
05 ×
06 ◇
07 ¤ ¥ 00. .36
10 ✳

ABSCISSA, X-AXIS.

PATCH TO DECUS NO. 8-148 - PLOTTER SYSTEM
AND
DECUS NO. 8-168 - CALCOMP PLOTTING PACKAGE

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The DECUS No. 8-148 Plotter System by Dr. Bruce J. Biavati is an excellent general purpose plotting system. This program, linking up with the Calcomp Plotting Package (DECUS No. 8-168), is flexible enough to allow a variety of plots, with the laborious numerical conversion and scaling done automatically. Also, because the axis maximum, minimum and length in increments are all inputted, the program is compatible with numerous manufacturers' plotters. However, because the Calcomp Plotting Package routines are utilized as drivers, a problem may arise restricting the program's universal advantage.

The plotter driver routine PLOTX contained in the 8-168 package is intended for use with the DEC 305B plotter interface. The 305B interface has a unique characteristic in that the +X (drum down) and +Y (pen left) commands may not be micro-programmed due to hardware decoding ambiquities. In other interface devices such hardware ambiguity may not exist. This difference in interface characteristics can render the 8-148 Plotter System useless on other than type 305B interface. The reason for this is that in order to compensate for the 305B hardware, routine PLOTX will issue two consecutive plotter commands (PLDD and PLPL) back to back. The 305B interface will accept and execute this command string; however, other plotter interface devices may only accept the first command and not respond to the second. The results are distorted characters and inability to plot in a +X, +Y direction.

Fortunately, only a small change is necessary to make routine PLOTX compatible with devices which will not accept back to back plot commands. A patch is inserted which changes the consecutive commands to a "no operation" instruction and a micro-programmed "+X, +Y." In the 8-148 Plotter System the patch would be as follows:

| LOC | 2154 | From | 6514 | to | 7000 |
| LOC | 2155 | From | 6521 | to | 6535 |

In the 8-168 Calcomp Plotting Package the patch would be:

| LOC | 5144 | From | 6514 | to | 7000 |
| LOC | 5145 | From | 6521 | to | 6535 |

Symbolicly this would be:

| PLDD | to | NOP |
| PLPL | to | PLDD PLPL |

for locations PLOTT3+6 and PLOTT3+7 respectively.

Since implementing this change, our installation (utilizing an Astrodata TA000714 computer coupler and Houston Instrument DP-1 Plotter) has been able to utilize to full advantage the DECUS NO. 8-148 Plotter System and DECUS NO. 8-168 Calcomp Plotting Routines.