



IBM 1130 Data Presentation System

Application Description

This system provides graphic programming support at three distinct levels of versatility and usefulness. The first level provides the programming necessary for controlling IBM 1130 graphic output hardware. Level 2 provides graphic and coordinate geometry special function routines, while the highest level, the Graphic Report Generator, provides the ability to make many different graphic presentations of data files, without any programming effort by the user.

This manual outlines in general form the requirements a user must fulfill in order to use the IBM 1130 Data Presentation System. Hardware requirements and a general processing flowchart are presented.

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The IBM 1130 Data Presentation System is designed to provide, to users with widely varied graphic processing requirements, the ability to economically produce graphic output by providing the programming support needed by many users.

Graphic outputs vary widely among applications. The IBM 1130 Data Presentation System attempts to meet the needs of most of these varied applications. In order to accomplish this objective, the system is implemented in three distinct levels. The highest support level, level 3, is a very flexible system designed to produce a wide variety of plots from existing data files, regardless of whether the files are generated for plotting or for other purposes. This level of support, known as the Graphic Report Generator, allows an individual to produce graphic output without requiring previous computer experience. No additional programming is required to complete the system. The only requirement is a user-supplied parametric description of the input data files and of the output graphs desired.

Certain applications will be found that will not be adaptable to the Graphic Report Generator. However, the total processing required includes many of the same functions required by the Graphic Report Generator. These functions are separated from the Graphic Report Generator operating complex and are provided as level 1 or level 2 subroutines.

Graphic presentations vary considerably in outward appearance. However, they are generally composed of line segments and char-

acters. Graphic processing prior to the actual plotter operation is composed of the computation necessary to reduce data to the actual plotting medium coordinates. Plotting is the generation of the line segments and characters by the issuance of the proper commands to the appropriate output device. On an incremental plotter or a point plotting device, an algorithm is required to generate the appropriate line approximation. Characters must be generated and scaled from a coded shorthand text. The character and line generator routines as well as plotter pen control routines are provided as level 1 of the 1130 Data Presentation System. A user should never have to involve himself with the issuance of plotter commands.

There are many functions common to graphic operations even though the final outputs may differ much in appearance. Examples of these operations are coordinate conversion, scale and scale annotation generation, circle and spiral generation, automatic scale value generation, and line intersection calculation. Many of these closed-entry subroutines are provided as level 2 of the Data Presentation System.

The modular organization of the Data Presentation System allows the utmost in flexibility to a user, since he may utilize any program module at any program level. Thus, he is assured of the ability to utilize the portion of the Data Presentation System that most nearly satisfies his requirements. The Graphic Report Generator is self-sufficient and does not require additional programming by the user.

GENERAL DESCRIPTION OF APPLICATION

LEVEL 3.- THE GRAPHIC REPORT GENERATOR

Data analysis is perhaps the most easily mismanaged function of many jobs since so often the significant is hidden by the routine. In this function of data management the Graphic Report Generator is a valuable aid. Large volumes of data can be compressed into a single-page graphic presentation. A properly prepared plot then makes it easy to scan over and bypass routine and unimportant areas. Significance and trends are often obvious from graphic presentation. An even more important result is the communication value and the historical value of the graphic output in passing information to associates and successors.

A single display can give valuable insight into the performance of a product over a span of years. The percentage deviation from market index and the trend of sales versus the trend of market index can be dramatically shown. The graphic display provides a fast, convenient means in the interpretation of data and trends.

The sales curves of a product over a span of time may provide the necessary key to the forecasting of seasonal trends. The comparison of the performance of competition or similar products in various marketing areas offers insight into marketing weaknesses. Figure 1 shows a sample of the output obtainable from the Graphic Report Generator to provide an expedient means for pictorially representing performance curves.

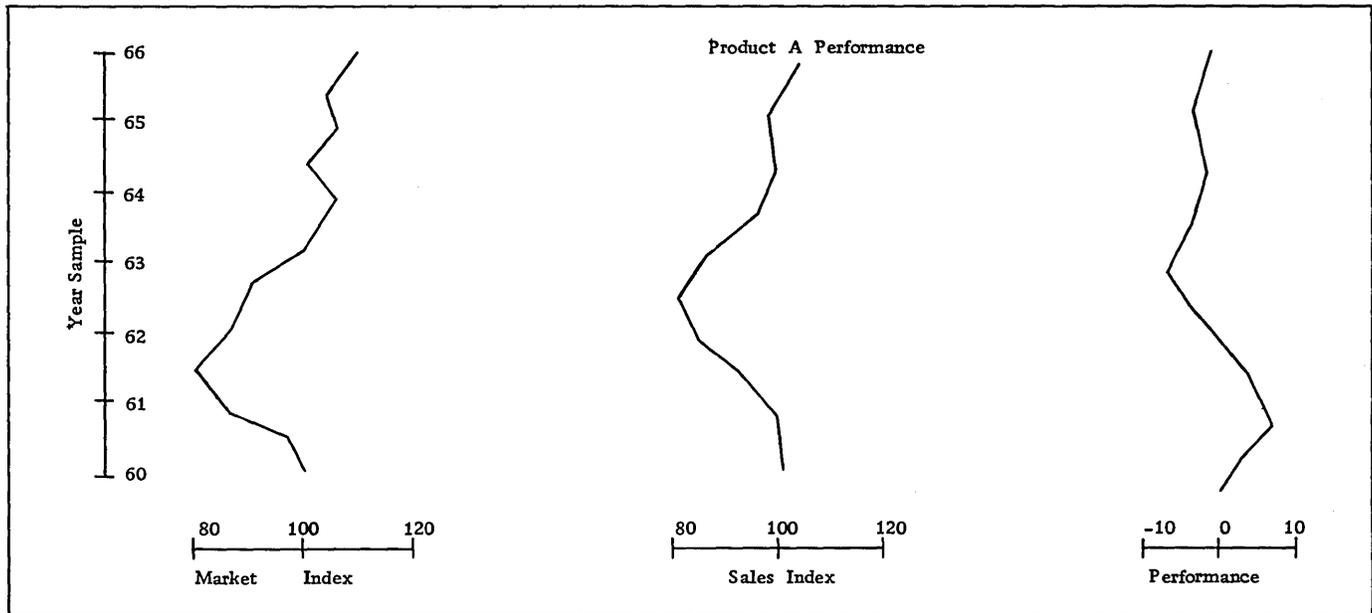


Figure 1. Typical Graphic Report Generator Output

Engineers and engineering analysts must constantly simulate and analyze the performance of their designs in order to predict performance and guarantee reliability. Plots are extremely beneficial in showing operating characteristics over an entire operating range. Such plots indicate areas requiring redesign and reevaluation. A typical graph of this type would show

torque and current produced versus speed attained in an electric motor. Graphic Report Generator presentations offer a ready reference to actual results obtained from a test stand and may on the same plot compare design standards or computed analysis. A typical engineering graph obtainable from the Graphic Report Generator is shown in Figure 2.

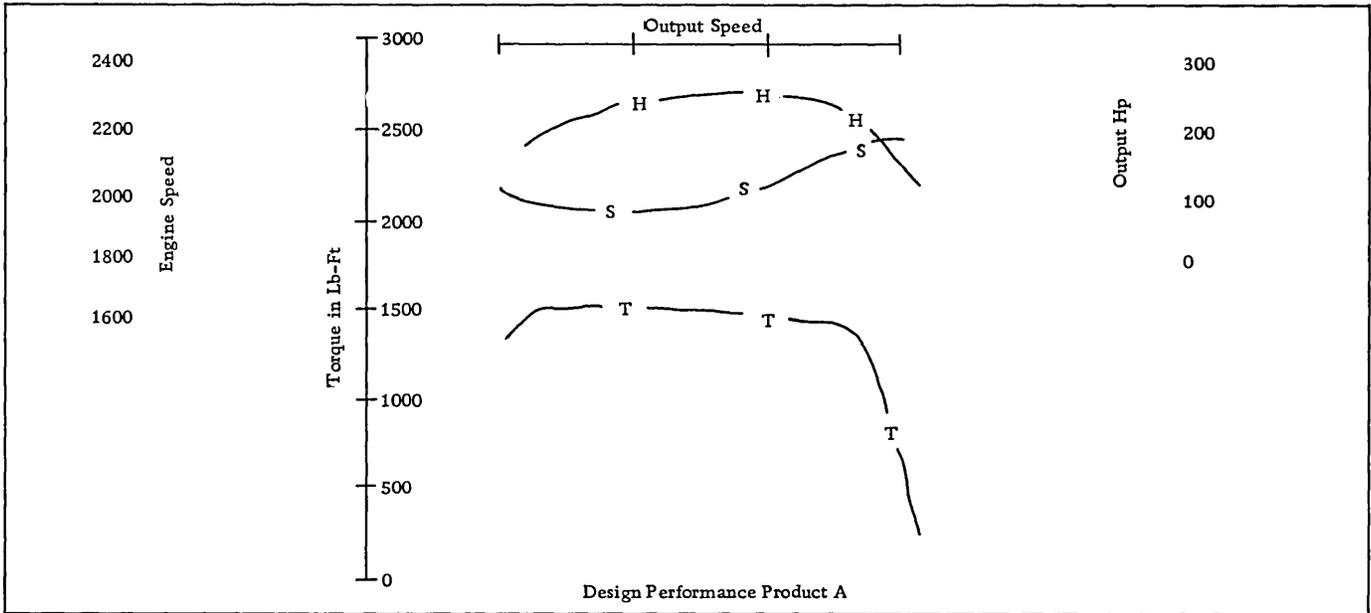


Figure 2. Typical Engineering Graph

Management policy changes must be timely and meaningful. The power of the electronic computer has introduced an era where simulation and forecasting of large systems becomes feasible. A graph of the forecast in a manager's hand allows posting of actual results as they occur for an immediate evaluation of the validity of the forecast and immediate reaction to deviations from the reaction forecast.

Inventory control is an important function to any company required to carry a product inventory. The interrelationships of stockouts, average inventory level and sales can be clearly shown graphically. Combined use with an inventory management simulator can lead to better inventory management.

The use of master haul diagrams in highway construction, of cut and fill diagrams and of sales curves has long demonstrated the advantages to be gained by presenting information in graphic form to "data managers". "Data Managers" far outnumber "Non Data Managers". The electronic age is presenting data to be analyzed and managed at a consistently faster pace. The 1130 Graphic Report Generator provides the tool with which to shorten the analysis and interpretation phases.

In summary, the following areas are suggested as applications that could advantageously use the Graphic Report Generator:

1. Engineering Analysis
2. Statistical Studies
3. Highway Networks
4. Sales Analysis
5. Machine Performance
6. Efficiency Studies
7. Quality Control
8. Inventory Control
9. Mathematical Analysis
10. Manufacturing Load Schedules
11. Data Reduction
12. Wage Incentives
13. Regression Analysis
14. Salesman Performance
15. Cross-Sectional Charts
16. Schematics
17. Data Verification

The following points illustrate the power and versatility of the Graphic Report Generator:

1. Up to 8 scales may be drawn in any orientation at any chosen location on the graph. Figure 3 illustrates a sample scale arrangement.

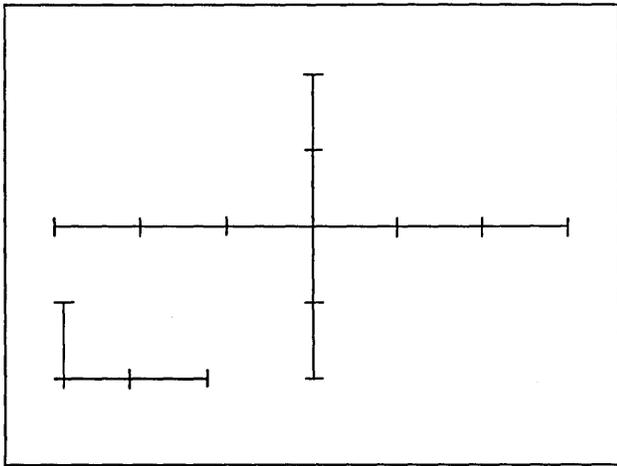


Figure 3. Variations of Scale Arrangements

2. Several graphs may be plotted from the information contained in a single data file. Figure 4 illustrates three plots drawn from a single set of data.

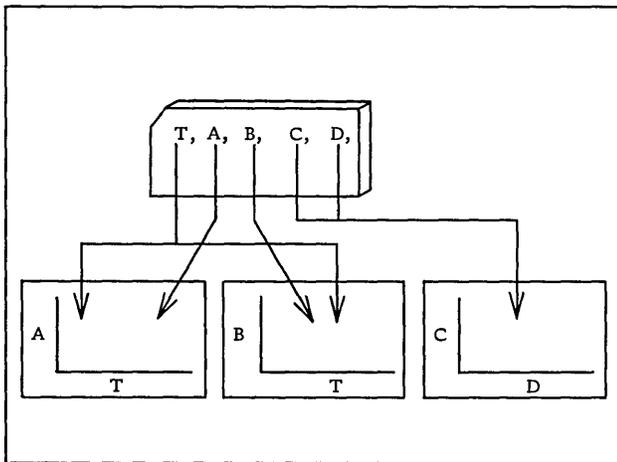


Figure 4. Multiple Graphs

3. Data may be extracted from several sources to be plotted on the same display. Figure 5 illustrates a graph drawn from data in three different files.

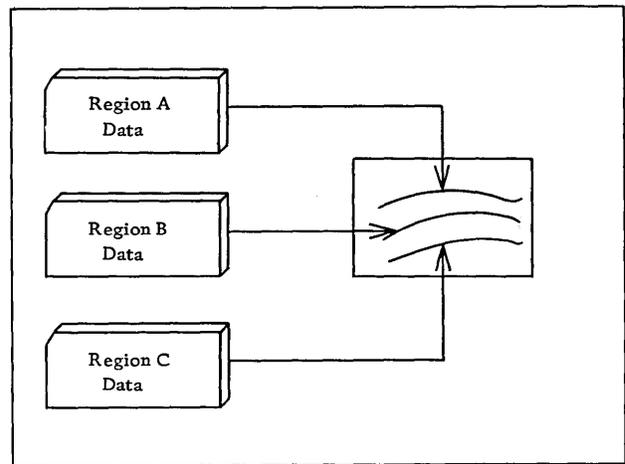


Figure 5. Multiple Data Sets

4. The automatic scaling feature of the Graphic Report Generator System will automatically determine the high and low data values to be plotted against a scale and select the minimum value and per-inch increment that keeps all data on the plotting grid and that is easy to work with. Figure 6 illustrates sample autoscale output.

M=ACTUAL DATA MINIMUM
 X=ACTUAL DATA MAXIMUM
 S=LENGTH OF SCALE
 N=VALUE SELECTED AS THE SCALE MINIMUM BY THE AUTOSCALE ROUTINE.
 D=VALUE SELECTED BY AUTOSCALE ROUTINE AS THE SCALE DELTA.

M	X	S	N	D
1001	4799	8	1000	800
.454	.62	4	.450	.05
-.544	.032	6	-.55	.10
-1.218	1.559	715	-1.3	.4
1	9	5	0	2

Figure 6. Automatic Scaling Results

5. The minimum and per-inch increment values for a scale may be given by the user. In such a case, data points outside the limits established will not be plotted.

6. Scales may be linear, logarithmic, polar or calendar date. Figure 7 illustrates some types of scales.

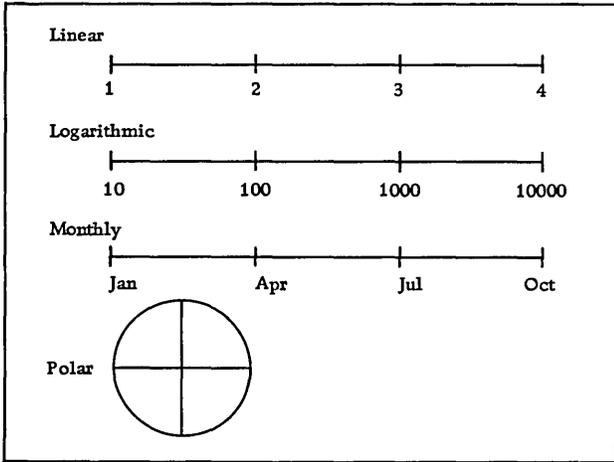


Figure 7. Scale Types

7. Scales and/or scale labels are automatically generated by the Graphic Report Generator, but may be suppressed as desired.
8. Scales may be subdivided at specific length increments or specified data increments. Figure 8 illustrates the two types of scale subdivisions.

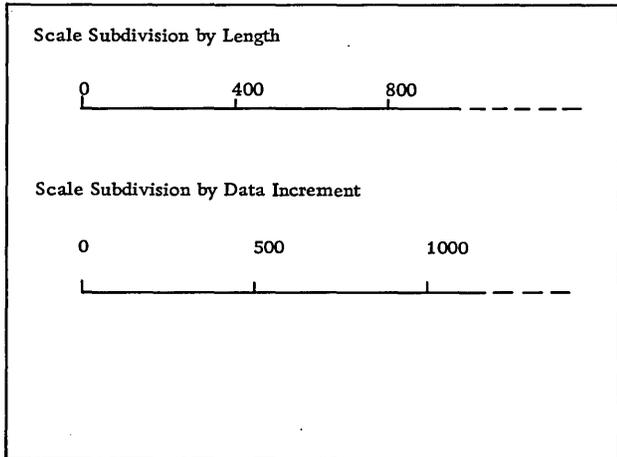


Figure 8. Scale Subdivision

9. The per-inch increments for automatic scaling can be selected so that data is plotted over a minimum of 75%, 50% or 40% of the scale length. Figure 9 illustrates the scales which would result from sample data autoscaled with the three selection tables.

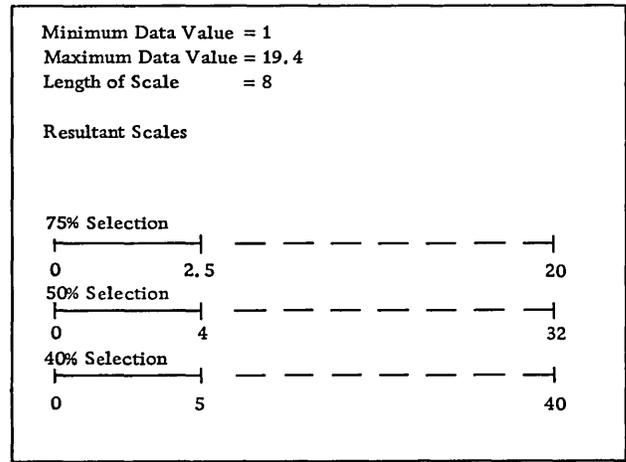


Figure 9. Automatic Scale Selection

10. Data may be plotted as point plots, line plots (first or second order), logarithmic plots, horizontal or vertical bar graphs, or histograms.
11. Lines may be solid or broken. Figure 10 illustrates a few line classes available. The dash length for broken lines may be user-specified.

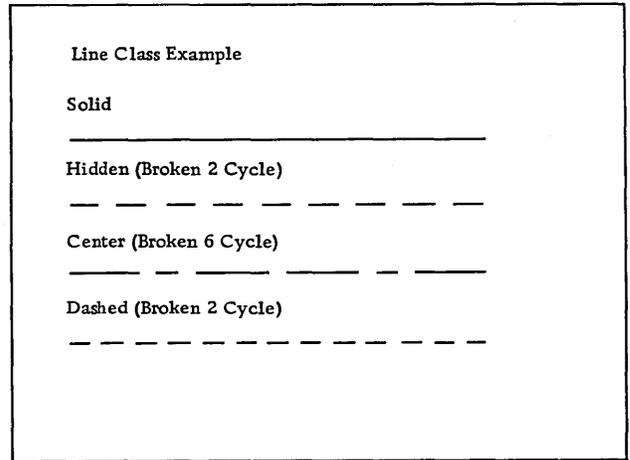


Figure 10. Line Classes

12. Identifying characters, known as tags, may be generated at uniform increments along a curve.
13. Given data points may be identified by coordinate-centered plus signs.
14. Data may be extracted from existing card or disk files. The format is user-specified.
15. Data may be in any external format that is acceptable to 1130 FORTRAN or

may have the sign as a zone overpunch or be in internal fixed or floating text. Variables may also be generated by the system. Each successive data record results in the addition of a specific increment to the previous data value. Figure 11 illustrates acceptable input data formats.

```

12.34
1234
-.0073
123D (sign as zone overpunch)
-1.23 E-7
.015E15
+12E6
J234 (sign as zone overpunch)

```

Figure 11. Data Formats

16. Pen control information may be supplied within each data record to control raising and lowering of the plotter pen.
17. Figures composed of straight-line segments may be easily generated with a description of the composite vector lines.
18. Circular and spiral entries may be generated at any specified coordinate.
19. Special reference axes may be requested at any data coordinate. Such axes are useful in separating positive and negative areas.
20. Alphameric commentary may be placed at any coordinate (data or paper coordinate) and may be scaled independently in the X and Y dimension.
21. Alphameric commentary may be extracted from existing data files.
22. Several user exits are provided that enable the user to incorporate special function processing into the capability of the Graphic Report Generator.
23. Data resulting from the evaluation of equations may be plotted.
24. Perspective views of shapes are obtained as line sketches. Input is X, Y, and Z coordinates in any scalar system. Figure 12 illustrates a simple perspective line drawing.

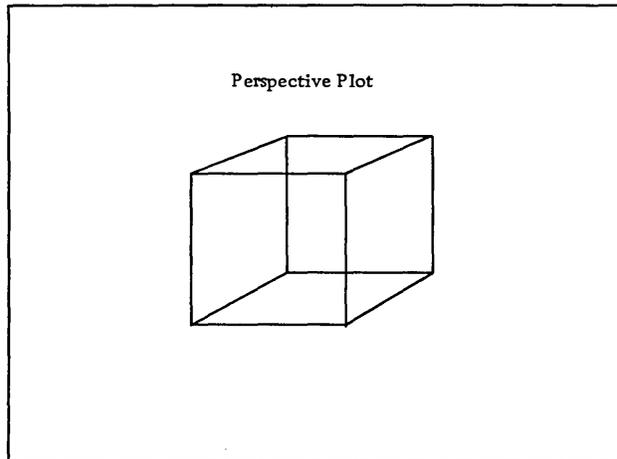


Figure 12. Perspective Drawing

25. Most user options have a standard system-supplied alternative that is used if the user chooses not to provide the parameter. These standards are fully available to the user so that they may be altered to values most meaningful for a particular installation without any program recompilation.

All data is available for modification and manipulation by the user at all times through the use of the user exit. Each data file is located through use of a common file organization table that locates the first entry of any control type and gives the next available storage entry.

DESIGN OBJECTIVES

Several objectives were established as being of foremost importance in the design of the Graphic Report Generator:

1. Input to the system must be in a meaningful form that does not require previous computing experience in order to prepare it.
2. Educational requirements must be minimal. A few hours is ample training time for an individual before starting to use the Graphic Report Generator.
3. The system must have the ability to process existing data. This is important since most data files are generated primarily for purposes other than plotting.
4. The system must have the ability to automatically generate scales on the basis of the data to be plotted. This

is important when it is realized that many data files are generated by computers in various types of analysis. The plot of the file may be desired before the individual has the opportunity to examine the data.

5. In effect, data must be unlimited as to range, quantity, number of variables, number of sets of data for any graph, and the number of graphs that may be generated from any data.
6. A large number of options must be provided the user but the system must be so organized that a user is required to learn only those features of the system of use in his applications.

Any individual can use the Graphic Report Generator simply by giving the parameters that describe the data to be processed and the output he wants. Thus, any department of a company in which a plot would reduce pages of information into an easily interpreted, single page display, will find this system feasible and desirable.

CONTROL PARAMETERS

The control parameters to be supplied are similar to those that would be established if the data were to be hand-plotted. This similarity can be seen in the following general descriptions of some input record types:

Graph Control

Defines the physical layout of the graph to be drawn. Information included is the X and Y plotting grid size, the number of scales to be drawn on the graph and an indication as to how many graphs are desired.

Scale Control

Gives for each scale to be produced on a graph, the length, location, orientation, minimum, per-inch increment, scale type, print control for the scale and scale annotations, and scaling control information. Scales may be defined by starting and ending coordinates or by starting coordinates, length, and angular rotation. The minimum and per-inch increment may be given as actual data values or the program can be instructed to determine the values from the given data. Scale labels can be generated on either side of the scale and may represent the scale as linear, logarithmic, or calendar.

Curve Control

Defines the manner in which data is to be displayed on the graph. Factors that must be given are the scales against which the data is to be plotted, the variables that are used to define the point coordinates, the curve type, the line type and the control that defines the manner in which special identifying information is associated with a curve. Curves may be displayed as point plots, line (first and second order) plots, histograms, horizontal and vertical bar graphs, or logarithmic curves.

File Control

Defines the location of data files, the location of variables within the file, optional plotter pen control information, and size of the field for each variable. Files may exist as card decks or disk files.

Vector Control

Gives the coordinates for points that determine figures bounded by straight-line segments. Vectors may be plotted against any data scale or a paper scale. They are a convenient way of defining any regular-shaped straight-line figure.

Arc Control

Defines circular or spiral sections. The radii and angle of rotation at the beginning and end of a segment are the defining parameters.

Refer Control

Defines coordinates for special reference axes. The axes may be drawn against any data or the paper scale. Reference axes are a convenient means of indicating limits or of dividing negative and positive areas.

Label Control

Provides the alphanumeric commentary and the information necessary to locate the information on the graph. Labels may be located at any coordinate against any scale. Characters may be plotted in varying sizes.

Header Control

Defines a data file from which labels are to be extracted. The alphanumeric text is extracted from the file. The locating coordinates may be given in the header control record or may be extracted from the data file.

Title Control

Provides the text for titles, which are special purpose labels used to define the function to the scales. Locating coordinates are automatically generated by the system.

Perspective Control

Defines the variables and relative viewing point from which a perspective view is to be drawn.

Equation Control

Defines equations and limits of the variables for data that is to be derived through evaluation of an equation.

The number of parameters that a user must provide is far less than the number described. Parameters that are not appropriate for the specific graph need not be given. A large percentage of the parameters have standard options that are automatically supplied by the Graphic Report Generator processor if the parameter is not supplied by the user. Each user facility will have the option of establishing standard parameters that best suit the requirements of the installation.

INPUT FILE CONSIDERATIONS

All input to the Graphic Report Generator Processor is in free form. This means that the information may be in any column of the input record. Two formats are used for control information input. The named data format is used in records where a large number of parameters are possible but only a small number of parameters are likely. A name is associated with each field to identify the data item. This format makes order unimportant, and unneeded parameters are disregarded. The second data format, used when more parameters are required and the likelihood of occurrence is predictable, is the ordered list. Data names are not required since order determines identity. When data items following in the list are not required, all remaining data items may be eliminated. The combination of named data and listed data allows easy use of the system.

Input errors can be defined by the user for automatic input editing. Standard options may be defined that the system provides when the user does not provide the parameter.

ERROR HANDLING

Errors encountered in processing are treated in the following manner:

1. An error diagnostic message is generated.
2. The offending parameter is changed to a value which will not inhibit processing and which is logical for the situation encountered.
3. Processing is continued or bypassed, depending upon the nature of the error.

This approach to error processing allows the user to correct errors easily but does not interfere with any correct processing in the run.

CONTROL AND AUDIT TRAIL PROCEDURES

No audit trail is provided because an individual graph is in effect a job entity and is therefore not of a magnitude to require audit controls. All data files (work files) carry pointers to other key positions within the files to allow reconstruction.

PRECISION

All computation within the 1130 Data Presentation System is to at least .001 inch and therefore is more than sufficient to control the 1627 plotter to .01 inch.

SAMPLE INPUT-OUTPUT

The following narrative describes generally the procedures that would be completed in order to cause the Graphic Report Generator to produce the plot illustrated in Figure 14 from data contained in Figure 13. This illustration utilizes only a few of the features of the system available to the user. The input listing gives the general format of the Graphic Report Generator, whereas the narrative explains the function of each entry.

```

PAR, ILC'N' ;
GRAPH, XGS6.5, YGS5 ;
SCALE, SN1, LOS5, ROT0 ; SN2, LOS5, ROT90;
CURVE, CDA '120102F84' ;
KFILE, NOV2, FDA 'N1003', 'N0604';
LABEL, LXC1.5,LYC4.5,LTX'THE 1130 GRAPHIC
      REPORT GENERATOR/ IS A POWERFUL MANAGE-
      MENT TOOL';
TITLE, TIN1, TTX'TITLE ONE';TIN2, TTX
      'TITLE TWO';
FINISH, RX8, RY0;
/*DATA
      Data Deck
      .
      .
      .
UREND
/*DATA
Next Set Graph Control Records
      .
      .
      .

```

Figure 13. Sample Input Language

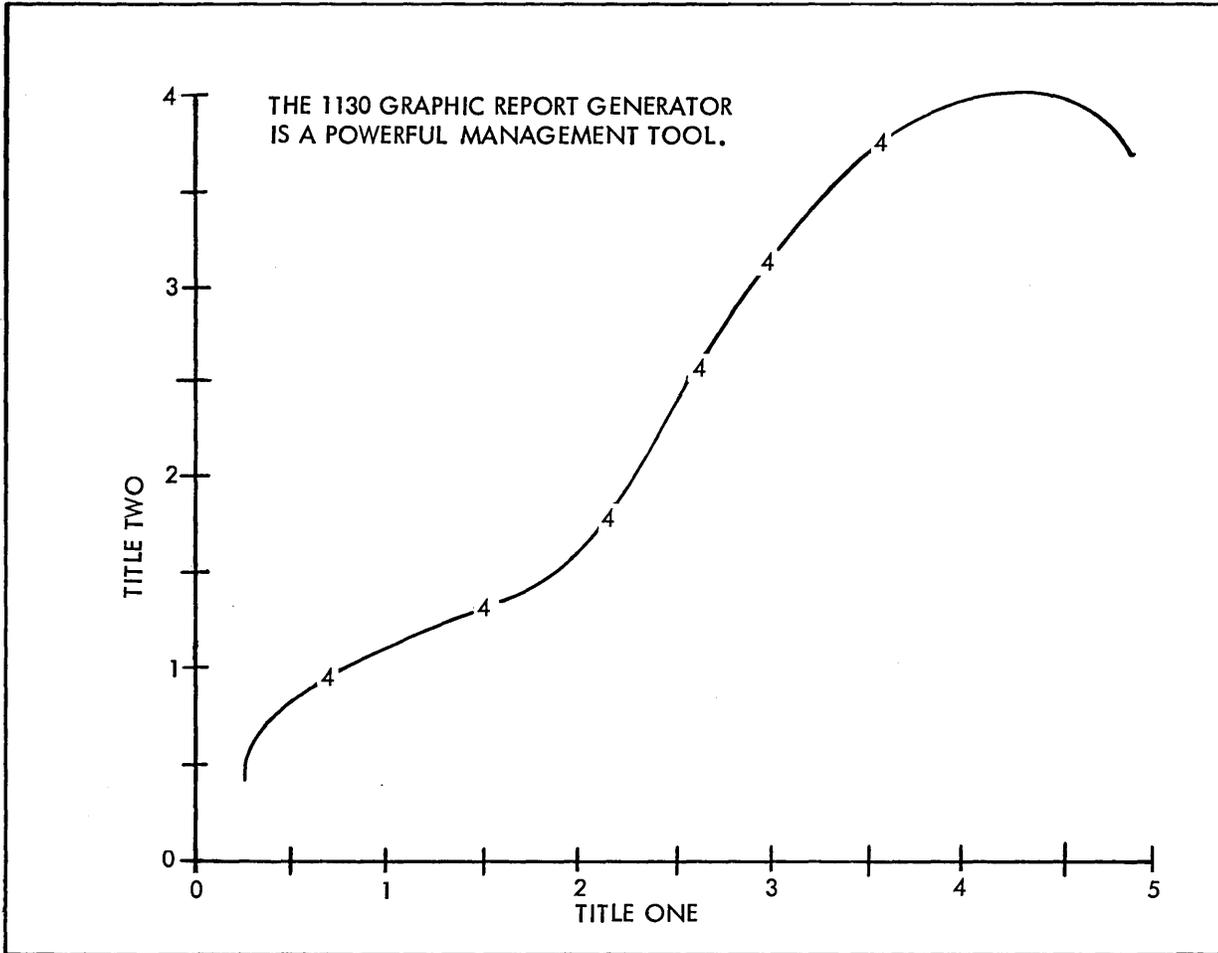


Figure 14. Graphic Report Generator Output

The Parameter command establishes run mode parameters. No analysis of input control information is desired, so the input list control parameter is set to NO.

The Graph command sets the general physical makeup of the graph. The X grid size is set to 6.5 inches and the Y grid size to 5 inches.

The Scale command establishes the form of the scales. Scale 1 is to be five inches long and horizontal (rotation 0 degrees). Scale 2 is to be four inches long and vertical (rotation 90 degrees).

A Curve command gives a curve definer for each curve to be displayed. Only one curve is displayed on this graph and will be plotted against scale 1 and scale 2 using

variable 01 and variable 02. Straight-line segments connect given data points through fill points that are computed on second-order polynomial segments. A numeral 4 is to be placed along the curve at periodic intervals as an identifying tag.

A card file is defined as containing two variables. The first variable starts in column 10 and is 03 positions long. The second variable starts in column 06 and is 04 positions long.

A label is to be placed where the X coordinate is 1.5 inches and the Y coordinate is 4.5 inches. The text to be printed is THE 1130 GRAPHIC REPORT GENERATOR IS A POWERFUL MANAGEMENT TOOL.

A title is desired to define each scale. Therefore, since scales 1 and 2 were used, titles 1 and 2 are required. The appropri-

ate text to be centered along each scale is indicated.

At the finish of plotting the pen will be reset for a new graph at X = .8 inches and Y = 0 inches relative to the start of this graph.

The card deck from which the data is to be extracted is included along with an indication of the end of the file.

Several important points illustrated above should be reemphasized:

1. Many parameters and options are allowed with this system but probably a small percentage will be used with any one application.
2. Standard (system-supplied) options reduce even further the number of parameters that must be supplied by the user.
3. Each installation has immediate and easy capability to change the standard parameters to values more meaningful.
4. Parameters to be supplied are logically and symbolically similar to those that would be generated during the planning and layout stage for hand plotting by a draftsman or chart maker.
5. The logical entries are conducive to ready learning by a user.
6. Few stringent regulations must be learned. A table of variable names (XGS = XGRID SIZE) and standard values (XGS = 8.5) will be the only required reference needed for continued use of the system.

LEVEL 2

Other approaches to computer-drawn graphic support are tailored to rather specific customer needs. The advantage of this approach is a more efficient processing capability than possible with a level 1 type approach. The obvious disadvantage is the more limited output obtainable from one particular programming effort. Different types of output often require almost complete reprogramming. Implementation of this approach is often accomplished with a set of specific function subroutines that work with the coordinate system of the output medium. The subroutines may be called out by a user-written master program at the appropriate time to achieve the desired graphic result. The routines require storage space to be available along with the calling program. Examples of this type of routine are an axis generation routine and a scale annotation generation routine. The approach outlined above is quite often improved by the incorporation of additional routines. The advantages and disadvantages as set forth above still hold true except that the amount of user-

supplied programming effort is reduced. These additional routines perform two types of functions. First, they may return calculated results to the calling routine. An example is an automatic scaling routine that examines a data array to determine the range of data so that a minimum and increment value may be selected for the scale. Second, these routines often work with coordinates that have not been converted to those of the output medium. A data conversion routine to convert raw data to output medium coordinates is an example. Many of the functions listed above are incorporated as the intermediate level, level 2, of the Data Presentation System.

Examples of routines included in this level are:

- Linear data scale conversion
- First order coefficient calculations
- Second order coefficient calculations
- Linear automatic scale value calculation
- Logarithmic automatic scale value calculations
- Logarithmic data scale conversion
- Minimum-maximum array extraction
- Scale parameter function calculations
- Line intersection calculation
- Plot histogram cycles
- Polar data scale conversion
- Plot bar graph cycle
- Draw linear scale
- Annotate linear scale
- Annotate monthly scale
- First order line class control
- Second order line class control
- Line tagging routine
- Locate quadrant routine
- Arc-Spiral generation
- Draw logarithmic scale
- Annotate logarithmic scale

LEVEL 1

Many approaches have been designed to produce computer-generated and controlled graphic output. The most basic approach provides a line generation routine. This approach has the distinct advantage of the ultimate in flexibility as to the output obtainable. The user does not have to learn plotter control programming and does not concern himself with preparing line generation algorithms. He does, however, provide all the programming necessary to process and convert raw data files into paper coordinates of line segment and character locations. The price of ultimate flexibility is therefore a large and often repetitious programming investment. This basic level of program support is obtainable as level 1 of the IBM 1130 Data Presentation System. Pen raising and lowering routines are also included.

SYSTEM REQUIREMENTS

MACHINE REQUIREMENTS

FOR USE OF LEVEL 1 OR 2 SUPPORT

Core capacity sufficient for inclusion of the required routines with the user's program. Each subroutine has a maximum of 100 FORTRAN statements.

FOR USE OF THE GRAPHIC REPORT GENERATOR

- 1131 Central Processing Unit - Model 2B
- 1442 Card Read Punch with appropriate attachment
1442 Attachment --#4454
- 1627 Plotter with attachment for plotted results
1627 Attachment --#7187

- 1132 Optional Printer may be added for increased production of diagnostics and listings
Expansion Adaptor -- #3854
1131 Attachment -- #3616

PROGRAMMING SYSTEMS REQUIREMENT

The 1130 Data Presentation System is programmed in the 1130 FORTRAN language and the 1130 Symbolic Assembly Language and operates within the framework of the 1130 Monitor System. Principal areas that are coded in the assembly language are the level 1 routines and the input decoding and conversion routines. Symbolic Assembly Language routines are also used for the purpose of packing and unpacking information into 1130 words for decreased file requirements and increased processing efficiency.

Figure 15 illustrates the flow of logic between programs of the 1130 Data Presentation System. It should be noted that all levels of programming are available to any user program as well as to the Graphic Report Generator.

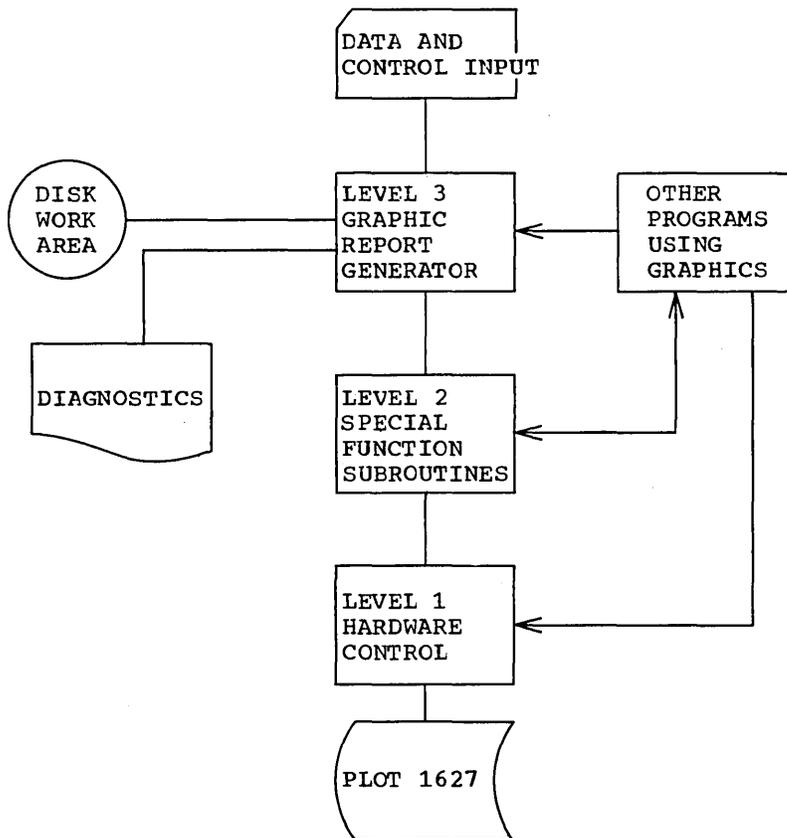


Figure 15. System Logic Chart

GLOSSARY

Curve

The graphic representation of the relationship between two variables (line, point, bar graphs, histograms).

Graph

A sheet of paper onto which have been placed curves, lines, points and explanatory alphabetic and numeric information representing numeric data.

Label

A string of alphameric information placed at any location for information and instructional purposes.

Plotting

The process of placing any type of information on the graph.

Reference Axis

A line drawn across the plotting grid at a selected coordinate value such as the zero value of a scale.

Scale

A ruler-like drawing placed on the graph to aid in the interpolation of values within the plotting grid.

Scale Label

A numeric label placed next to the scale to indicate the value of the scale at that point.

Set of Data

The X and Y values representing coordinates on a set of curves. All variables in a set of data have common file residence.

Title

A label with program-assigned coordinates and size, used to define the function of scales.

Vector

A series of contiguous straight-line segments.

BIBLIOGRAPHY

IBM 1627 Plotter (A26-5710). Describes operation, operating controls, and physical components of the 1627 Plotter.

of interest to users of the IBM 1130 Data Processing System.

IBM 1130 Bibliography (A26-5916). Provides an abstract of all available publications

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