

Management Reporting With Hewlett-Packard's Decision Support Graphics

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Hewlett Packard's Decision Support Graphics System for the HP3000 family computers (DSG/3000) provides an effective tool for preparing line, bar, and pie charts to graphically represent numerical data. Austin Information Systems has implemented DSG/3000 for internal reporting to the Corporate Management of The Austin Company. This is the first of a three phase program to provide graphic reporting as a component of user application systems. This paper details the results of this project.

THE AUSTIN COMPANY

The Austin Company is an international Design, Engineering and Construction Company headquartered in Cleveland, Ohio with offices throughout North America, South America, Europe and Australia. The Company specializes in all types of industrial and commercial construction, providing the owner a single point of contact for all phases of the project from feasibility study through occupancy. This "Austin Method" of integrating design, engineering, and construction provides the client very rapid turnaround, allowing earlier occupancy and providing a faster return on investment.

Throughout its one hundred year history, The Austin Company has delivered 90% of all projects on time and within budget and has built a solid reputation on innovation, reliability, and quality. The Company's motto of "Results, Not Excuses" speaks for itself.

AUSTIN INFORMATION SYSTEMS

To continue to provide its clients the best possible service using state-of-the-art technology, The Company created Austin Information Systems (AIS) in 1978. AIS is chartered with providing computer based applications for The Austin Company. This charter includes Information Systems, Office Systems, and Engineering Systems. The current AIS network of 10 computers and over two hundred terminals serves 12 domestic offices of The Company and over 20 construction field locations. The primary Information Systems are online, interactive applications for Project Management: Cost Estimating, Cost Control, and Scheduling.

A computer assisted approach to project management

applications dramatically enhances the capability of The Company. Multiple alternatives can be evaluated in the cost estimate. Major changes in the preliminary design can easily be priced and evaluated in much less time than was required by manual techniques. The estimate typically provides greater detail than those prepared by hand because of the ability of the computer to comfortably process large volumes of data. The Cost Control System provides a significant improvement in turnaround for the preparation of periodic job condition statements. Cost data is continually collected at the project site and posted to the database and, combined with the Scheduling System, project trackability is noticeably enhanced. This provides the client improved visibility and allows The Company to respond faster to potential cost or schedule problems.

THE REQUIREMENT FOR COMPUTER GRAPHICS REPORTING

Now that these major applications have been in place in most offices for over two years, AIS is actively developing the next evolutionary enhancements. The implementation of graphics to further improve the quality of information presented to the client is considered as one of the next logical steps.

Since graphics hardware is already in place in some offices to meet requirements for engineering applications, this will ease part of the cost burden for implementing the first project management applications.

The ideal operational mode for these applications would allow the user to generate a graph or chart of a predefined format as easily as a numeric report of a predefined format is produced. The majority of the control provided to the user is for the selection of the subset of data to be included in the chart. The specific format, axis conventions, legends, titles, colors, patterns and other specific formatting variables that are part of a typical chart would be predefined in much the same way that report titles, column headings, numerical format and column positions are predefined for numerical reports. This allows the user to concentrate on the data and not be burdened with the intricacies of computer graphics.

INITIAL ALTERNATIVES FOR GRAPHICS REPORTING

While graphics have been used for several one-time requirements in the past, the systems did not lend themselves well to operation in a "production mode" under user control. This would be required to satisfy the design objectives for integration with the interactive Estimating and Cost Control System (ECCO).

An interactive chart preparation system (MULTI-LOT) is provided by Hewlett Packard for standalone operation on the intelligent graphics terminal in use at Austin. While this system was able to generate the desired charts, its mode of operation required the user to prepare the specific data to be graphed and respond to several questions defining chart format. While usable for one-time applications by an operator familiar with the system, it did not provide any reasonable interface to ECCO for the end user.

The development of custom routines to generate the required charts could be designed to provide the necessary user interfaces but the cost involved in this custom programming combined with the inflexibility of the final product did not make this alternative very attractive.

HEWLETT PACKARD'S DECISION SUPPORT GRAPHICS SYSTEM

HP's announcement of DSG/3000 in late 1980 provided a reasonable alternative to meet our design objectives for implementing production graphics with the ECCO System. Additionally, it appeared to be capable of addressing the volume of one-time graphs currently being prepared for other requirements.

DSG/3000 provides the capability to prepare several variations of line charts, bar charts, and pie charts. The chart specification is prepared through a friendly interactive system utilizing "fill-in-the-blank" formatted screens.

Data is extracted from sequential files that can be easily prepared from a database using a report writer. Once a chart is defined, it can be used again and again with different sets of data without the need to redefine the chart parameters. Scaling can be fixed by the user or automatically scaled by the system to fit the data. Output can be displayed on a graphic CRT terminal or routed to any of several HP hard copy devices: pen plotters, thermal plotters or dot matrix printer/plotters.

DSG/3000 provides the user with capabilities to select subsets of the data file to be included on the graph. This allows extreme points to be deleted easily or several different charts to be prepared from a single data file. The user first assigns variable names to the fields of the data file (either fixed or free format). Additional variables can then be defined by expressions using previously defined variables. Finally, conditioned expressions that control which data is actually used can be defined using any of these variables.

For one-time applications, DSG/3000 provides a for-

matted screen that allows the user to enter data interactively. This data can be edited and saved for later use.

The documentation provided with DSG/3000 is very good. A comprehensive User Reference Manual provides the detailed description of the system while a brief User's Guide answers most questions for the user while working at the terminal. An optional self-paced training package leads a user with no previous computer experience through the full capabilities of the DSG/3000 interactive system. This course typically requires about ten hours of reading and terminal time.

DSG/3000 provides the fundamental capabilities to meet the defined requirements because of the distinct separation of data, chart, and output definition inherent in its architecture. The user may independently define the data structure, the parameters which control the type and format of the chart, and the output scaling and destination. Any of these can be updated for the specific requirements independent of the others. This allows the system analyst to develop the required chart format definitions and data interface appropriate for the input file. The user must only define the specific data to be included in the data file and the output destination for the chart.

DSG/3000 can be integrated directly with the ECCO System (or any other user application) because all of the functions of DSG/3000 that are available through interactive, formatted screens are also available as program callable intrinsics. This provides the system designer all the capabilities of DSG/3000 while also allowing the user to be completely insulated from all of the graphics controls. This allows graphics to be implemented in a truly production mode.

A PHASED IMPLEMENTATION PLAN

While DSG/3000 appeared on the surface to provide all the mechanical tools necessary to meet the design objective, several questions regarding types of graphs, data to be graphed, output mechanism, hardware configuration, and user reaction had to be answered for our specific application, environment, and user community. To accomplish this, a three phase plan was defined leading up to the implementation of DSG/3000 with the ECCO System:

Phase I — DSG/3000 to be implemented in an interactive mode to prepare charts for AIS management reporting to Austin Corporate Staff. Data to be charted includes system utilization, revenue and operating costs.

Phase II — DSG/3000 to be implemented in a program callable mode as part of the AIS computer services chargeback system. This will provide clients graphic reports of computer services utilization, distribution, and costs.

Phase III — DSG/3000 to be implemented as a program callable component of the ECCO System as described earlier.

AIS has been using DSG/3000 for several months as

part of our Phase I program. Currently it is being implemented into the next major release of the chargeback system and following that release, DSG/3000 will be incorporated with the ECCO System.

HARDWARE REQUIREMENTS

A surprisingly minimal hardware configuration is required to implement graphics in a production environment. Since the user is not designing charts, but only generating charts based on predefined chart definitions, there is little requirement for a graphics display terminal to preview the output. The application program is operated through standard block mode alphanumeric terminals and the graphic output is routed to a four pen plotter. (HP now sells their plotters with eight pens instead of four but none of these newer models are currently installed at Austin.) The plotter is equipped with a roll paper, automatic chart advance option that allows the device to be operated while unattended. In actual production use, the plotter will require little more attention than a spooled printer serving users with printed output. The HP model 7220S plotter used at The Austin Company costs approximately \$7250.00.

While not required for all users, a graphics display terminal can be made available in each office to facilitate the use of DSG/3000 as an interactive tool as well as allow charts to be previewed before plotting when required. At Austin, we are currently using HP 2647A Intelligent Graphics Display Terminals. Configured with the required options and interfaces, the HP 2647A costs just under \$10,000.00. The primary use for these devices is currently for engineering applications; several unique requirements justify the cost of this sophisticated terminal. Hewlett-Packard recently announced that their 2623A Graphics Terminal provides the ideal capability set for the Austin environment. At \$3750.00 this terminal provides extensive graphics capabilities for the same price of an alphanumeric terminal of 2 years ago. Also available is an integral thermal printer option for \$1210.00.

AIS is currently using an HP 7310A thermal printer/plotter to produce fast, black & white graphics output for both preview and reporting. While this particular product has been discontinued by HP, there are other devices within the product line that provide similar capabilities.

The chart in figure 1a was produced on the 7220S pen plotter (the original used 5 different colors) while figure 1b shows the same chart displayed on the 7310A thermal printer/plotter.

PHASE I RESULTS

Because of its use on an interactive basis during the first phase, DSG/3000 has not truly been implemented in a production mode. While many standardized charts are produced monthly, some charts are still produced on an as-required basis. However, the exercise has provided insight to many of the issues that must be ad-

dressed to implement graphics as a component of an online, user-based application system. The charts produced required minimal effort once the initial definitions were established and have been very well received by the target audience: Corporate Staff members. The operation of an Information Systems Division within a construction company introduces unique management problems and graphics has provided better insight at the Corporate level. The enhanced clarity of the data yields measurable improvements in the ability to effectively report on the operations of the division. Graphic reports have also been instrumental in a current AIS project re-evaluating and redefining the entire computer services cost chargeback procedure.

The project has uncovered several avenues by which graphics can overburden or obscure the decision making process. Like any other tool, graphic reporting must be used intelligently to be effective. The user must understand the capabilities and limitations of the media to secure any reasonable advantages.

HOW, WHAT, WHO, WHEN

Significant in the effective use of any tool is an understanding of how to use it, what it should be used on, who it should be used for, and when it is appropriate to be used. Computer Graphics offers no exceptions.

Virtually any type of data will lend itself to attractive graphic representation. Common sense provides the best guideline to choosing the type of chart to use. Data plotted against time can best be represented with a line or bar chart. Stacked bar segments can show an additional dimension of distribution within each period. Multiple dependent variables can be represented with multiple lines plotted on a common axis or with clusters of bars at each discrete period defined by the independent variable. The former allows comparisons of trends while the latter allows comparison within each period. Care must be exercised in using line graphs with a discrete independent variable because the chart will tend to show trends that imply the data is continuous. Pie charts show percentage distribution of a single data element. The pie chart can be misused if it is not appropriate to describe the total data set as the sum of the discrete data elements represented.

While certain classes of data may lend themselves to an attractive graphic portrayal, it may not be appropriate to graph if it provides no new insight to the data. This is best described by considering

Crow's First Maxim of Graphic Reporting:

"Graphing certain classes of data is like teaching a gorilla how to speak . . . It can be done, but will it tell you anything you didn't already know?"

A graph that offers no new information can only add confusion to a decision making process.

The use of colors and fill patterns can be used to dramatically enhance the aesthetic appeal of a graph but

again, common sense must dictate their use. If the graph will be reproduced for distribution, it must not depend on colors to convey vital information. While different line patterns and fill textures can be used to differentiate data, an excessive use may generate more confusion than clarity. One must maintain simplicity in the data to use colors and textures effectively in a production mode. Too much information portrayed on one graph soon becomes meaningless. The age old T-SHIRT rule of presentations holds true:

"If it's too much information to fit on the front of a T-SHIRT, it's too much information to put on a presentation graph."

The goal of graphics is to lend clarity and insight into otherwise confusing or involved data. An effective graph will make its point at first glance and not require the user to study it in detail.

The choice of chart type, colors, textures, and data scaling can be powerful tools in controlling the desired reaction to the data. Charts can exaggerate, emphasize, diminish, or obscure the information but they will not change the basic facts presented. While it may be desirable to use these tools to create an intended response, sometimes the attempt only yields confusion. In a production mode, where each graph is not given individual design consideration, the choice of these display parameters must be made carefully to be effective. The best chart is one that relies on the data for the message, not the surrounding clutter of legends, colors, fill patterns and titles.

Knowing the intended audience for graphic reporting is essential in preparing an effective chart. A skilled manager familiar with the data that is to be presented can digest far more information in a single chart than can a client to whom one is presenting new and complex information for the first time. While computer graphics can be very impressive, if they present confusion then the overall result will be negative. In some environments, graphic reports may not be appropriate at all. A senior executive that is skilled in interpreting periodic numeric reports may not gain any significant benefit from graphs of the same data. This individual's management style and mode of operation is well defined and most likely very effective. Unless there is a recognized difficulty in digesting data in a numeric form, a graphic report may not be appropriate. This situation is typically much more pronounced if the user is to use a system interactively to produce graphics on an ad-hoc basis. The best target users for this type of tool are young executives or middle managers who have not developed a complete management style and are receptive

to tools that can improve their performance. A senior executive has already developed an effective management style using the tools currently available. Unless there is difficulty with the present management approach, the senior executive is not likely to adopt new tools or techniques.

The decision of when to use graphic reports need only address the cost effectiveness of the intended application if the aforementioned issues have been analyzed properly. The cost of preparing the graphs, including one time costs and operating expenses, must be weighed against the value of the graphic reports. This analysis is no different than assessing the value of any other computer based application. If it provides a direct replacement for a task previously done by manual techniques then it can most likely be expressed in a firm cost comparison. If the graphics reports provide a new resource to the organization, the value of this resource must be assessed objectively to be compared against the cost of implementation.

DSB/3000 LIMITATIONS

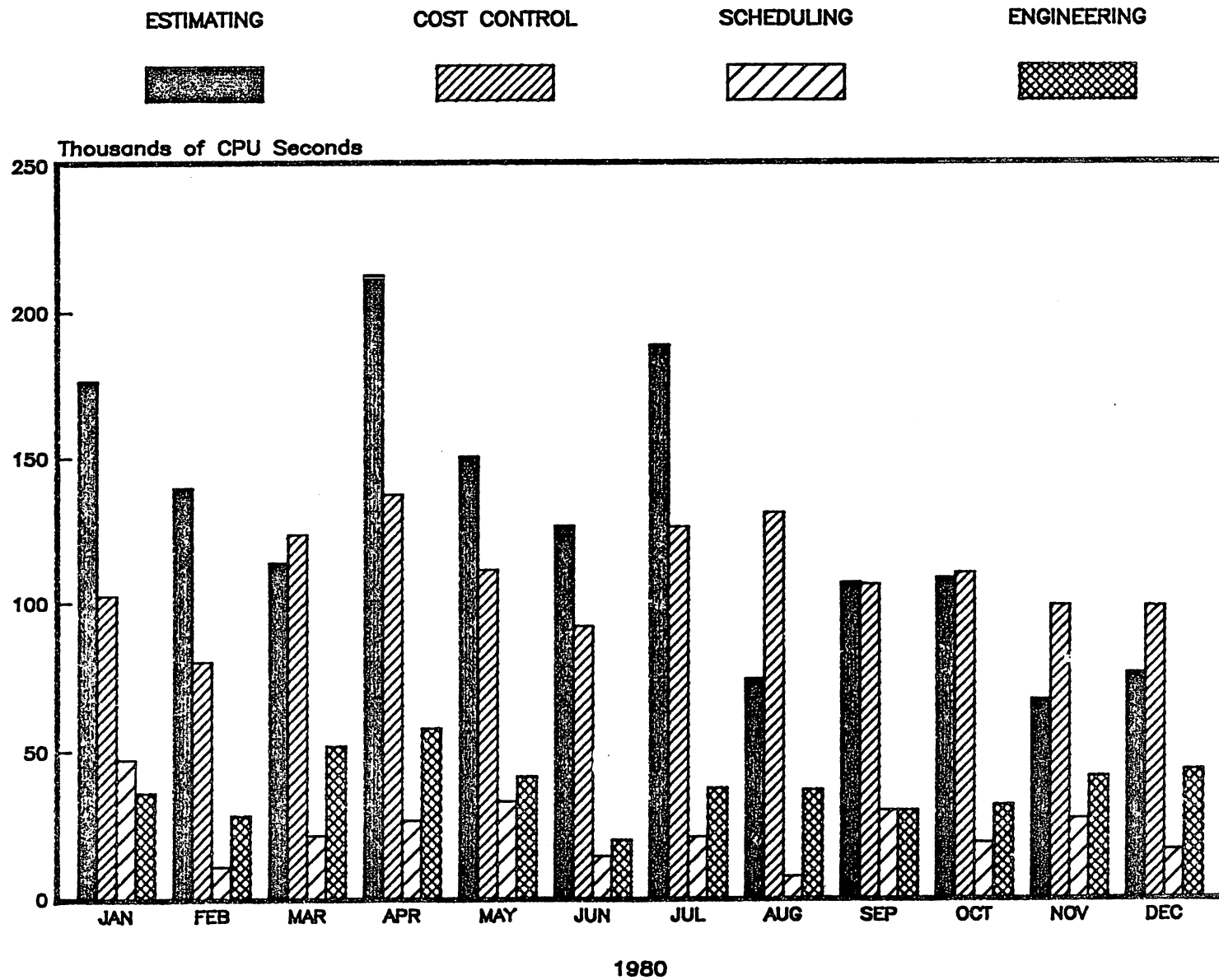
While DSG/3000 provides the fundamental tools required, it has limitations which reduce its potential effectiveness. As a system designed to be used either as an interactive application for ad-hoc reports or a production system for presentation graphs, it has compromised at both extremes by positioning in the middle ground. The volume of forms that must be completed to produce a single chart is confusing for the first time or casual user. The effort of preparing the graph soon eclipses the usefulness of the final product. DSG/3000 lacks sophisticated capabilities for easily preparing multiple charts on a single page, overlaying line and bar charts, or utilizing a variety of character fonts; these are vital functions for preparing formal presentation graphics. The data selection and qualification capability of DSG/3000 is very useful, but too limited. The user must typically extract specific data for each graph. It would be very useful to provide DSG/3000 a direct interface to the HP/3000 IMAGE database system and eliminate the need of a report writer to extract the data to a sequential file.

SUMMARY

DSG/3000 has opened a significant door in allowing a straightforward implementation of graphics reporting a successful first step toward implementing this system as a powerful enhancement to existing online, interactive applications.

AIS Computer Usage Summary — 1980

Monthly Usage by Application — All Users



Prepared by: Austin Information Systems

7/81

Figure 1a

AIS Computer Usage Summary - 1980

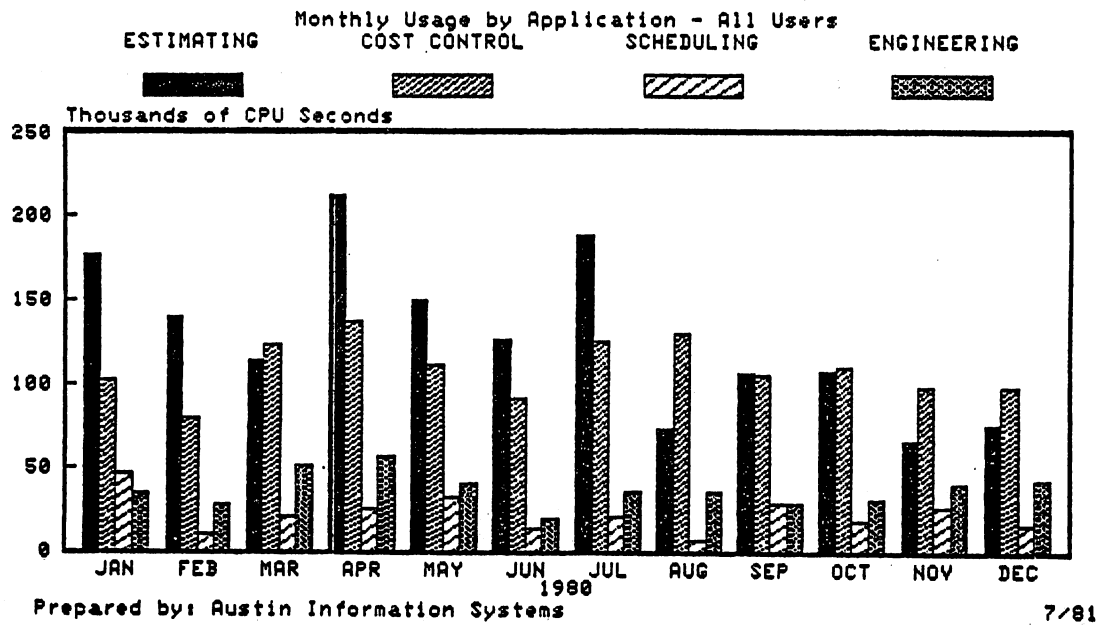


Figure 1b

TOTAL	ESTIMATE	6	126020
TOTAL	ESTIMATE	7	188450
TOTAL	ESTIMATE	8	73933
TOTAL	ESTIMATE	9	106439
TOTAL	ESTIMATE	10	107962
TOTAL	ESTIMATE	11	67009
TOTAL	ESTIMATE	12	76091
TOTAL	ESTIMATE	0	12628020
TOTAL	COSTCNTL	1	102265
TOTAL	COSTCNTL	2	79981
TOTAL	COSTCNTL	3	123160
TOTAL	COSTCNTL	4	137017
TOTAL	COSTCNTL	5	111038
TOTAL	COSTCNTL	6	91635
TOTAL	COSTCNTL	7	125674
TOTAL	COSTCNTL	8	130609
TOTAL	COSTCNTL	9	105769
TOTAL	COSTCNTL	10	109804

A Portion of data file DATAPLT3

Figure 2

Operation	Chart Name	Chart File Name
[M]	[TOTBAR2]	[CUSHGE]
A - Add new chart		B - Browse chart file
M - Modify or recall chart		Q - QUERY.PUB.SYS
P - Purge chart		F - Build/modify data file
I - Display/supply chart information		E - Exit
D - Draw chart(s)	([] - No pauses)	
Device ID	[]	
HP-IB #	[]	
C - Copy chart from:		
Chart name	[]	
Chart file	[]	

f1

f2

f3

f4

f5

f6

f7

f8

CONTINUE

REFRESH

HELP

Figure 3a

Enter Selection: []

--DATA TO BE GRAPHED-----

F - Create/modify data file
 D - Select data file to be graphed
 T - Transform data file

--CHART AND DATA SELECTION-----

C - Choose chart type: [B]

P - Pie
 L - Line or Scattergram
 B - Barchart
 S - Slide

[] - Initialize chart

--ENHANCEMENTS-----

X - Axes scaling, ticks, grids
 L - Legends, colors, textures
 I - Titles
 A - Annotations

--OTHER-----

G - Graphics device selection
 and control
 E - Exit

f1

f2

f3

f4

f5

f6

f7

f8

DRAW

REFRESH

PREVIOUS

CONTROL

HELP

Figure 3b

Data File Name [DATAPLT3]

Missing Data Value [-9999]

VARIABLE NAME	DATA TYPE	DATA FORMAT	
		(FREE) Field	(FIXED) Offset Length
[ACCOUNT]	[T]	[]	[0] [18]
[APPLICATION]	[T]	[]	[10] [18]
[MONTH]	[N]	[]	[28] [2]
[USAGE]	[N]	[]	[30] [10]
[]	[]	[]	[] []
[]	[]	[]	[] []
[]	[]	[]	[] []
[]	[]	[]	[] []
[]	[]	[]	[] []
[]	[]	[]	[] []

Data types: N=Numeric, T=Text

f1 f2 f3 f4 f5 f6 f7 f8
DRAW REFRESH PREVIOUS NEXT CONTROL HELP

Figure 3c

New variable	Mathematical expression of old variables
[LCPU]	[USAGE/1000]
[]	[]
[]	[]
[]	[]
[]	[]
[]	[]
[]	[]
[]	[]
[]	[]
[]	[]

Operators:
+, -, *, /, **
MOD

Common Functions:
LOG (expr) ABS (expr)
LN (expr) SQRT (expr)

Special Functions:
MOVEAVG (var,n)
CUMULATE (var)

f1 f2 f3 f4 f5 f6 f7 f8
DRAW REFRESH PREVIOUS NEXT CONTROL HELP

Figure 3d

Y Axis Variables		X Axis Variable	
Plot	[TCPU]] [TCPU]] [TCPU]] [TCPU]] []] []] []] []]	vs	[MONTH]]
		Options:	
		☒ - Clustered Bars ☐ - Horizontal Bars	

Data Subset Specification (optional)

[ACCOUNT=TOTAL AND MONTH<>0 AND TCPU<1000]
[]]

f1	f2	f3 DRAW	f4 REFRESH	f5 PREVIOUS	f6 NEXT	f7 CONTROL	f8 HELP
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Figure 3e

Variable	Qualification
[TCPU]]	[APPLICATION=ESTIMATE]
[TCPU]]	[APPLICATION=COSTCNTL]
[TCPU]]	[APPLICATION=SCHEDLNG]
[TCPU]]	[APPLICATION=ENGINRNG]
[]]	[]]
[]]	[]]
[]]	[]]
[]]	[]]
[]]	[]]

f1	f2	f3 DRAW	f4 REFRESH	f5 PREVIOUS	f6 NEXT	f7 CONTROL	f8 HELP
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Figure 3f

Y AXIS

X AXIS

Type (L=Linear, O=Log) [L]
 Minimum [10]
 Maximum [1]
 Interval size [1]

Variable = MONTH
 Minimum [1]
 Number of bars [12]

Number of minor per major ticks [1]
 Draw ticks on right axis [1]
 Draw grid lines [1]
 Draw minor grid lines (logs only) ... [1]
 Number of tick marks per label [1]
 Label type (N,P) [N]

Number of bars between grid
 lines (default=0) [1]
 Bar label type (N,P,W,M,Q,Y) ... [M]
 Calendar Label Start [1]
 Calendar Label Length [F]
 (A=Abbreviated, F=Full)

Valid Label Types:

N - Numeric (calculate)
 P - Prompt for labels

W - Weekdays (1-7)
 M - Months (1-12)

Q - Quarters (1-4)
 Y - Years

f1 f2 f3 f4
 DRAW REFRESH

f5 f6 f7 f8
 PREVIOUS NEXT CONTROL HELP

Figure 3g

Variable	Color (0-4)	Texture (0-8)	Legend Text
TCPU	[11]	[11]	TESTING
TCPU	[11]	[11]	COST CONTROL
TCPU	[12]	[14]	SCHEDULING
TCPU	[13]	[17]	ENGINEERING
TCPU	[14]	[17]	
TCPU	[14]	[17]	
TCPU	[14]	[17]	
TCPU	[14]	[17]	
TCPU	[14]	[17]	

f1 f2 f3 f4
 DRAW REFRESH

f5 f6 f7 f8
 PREVIOUS NEXT CONTROL HELP

Figure 3h

Main Title: [AIS Computer Usage Summary - 1980]

Subtitle: []

or using smaller text

[Monthly Usage by Application - All Users]

Left Y Axis Title:

[Thousands of CPU Seconds]

X Axis Title:

[1980]

Footnote:

[Prepared by: Austin Information Systems 7/81]

f1 f2 f3 f4 f5 f6 f7 f8
DRAW REFRESH PREVIOUS NEXT CONTROL HELP

Figure 3i

Add/Modify/Delete annotation (A or M or D) []

If Adding or Modifying then:

Type (A=Arrow, L=Line, B=Box, T=Text) []

Color (0-4) []

Texture (0-8) []

If Text then:

Text []

Size (1-50) []

Angle (0-359) []

Text justification (L,C,R) []

f1 f2 f3 f4 f5 f6 f7 f8
PRV ANOT NXT ANOT DRAW REFRESH PREVIOUS NEXT CONTROL HELP

Figure 3j

Device:

ID [2647A]
 Speed [F] (F=Fast, S=Slow)
 Text [H] (S=Software, H=Hardware)

HP-IB Address []
 Copies [1]

Plotting Area:

Boundary type [] (E=English, M=Metric, D=Data, C=Chart)
 Lower left [] (millimeters)
 Upper right [] (millimeters)

Suppress Options:

[] - Titles [] - Labels [] - Axes
 [] - Legends [] - Data [] - Frame
 [] - Chart Advancement

f1 f2 f3 f4 f5 f6 f7 f8
 DRAW REFRESH PREVIOUS NEXT CONTROL HELP

Figure 3k

GRAPH (A.00.00) HELP Facility: Chart Design Control

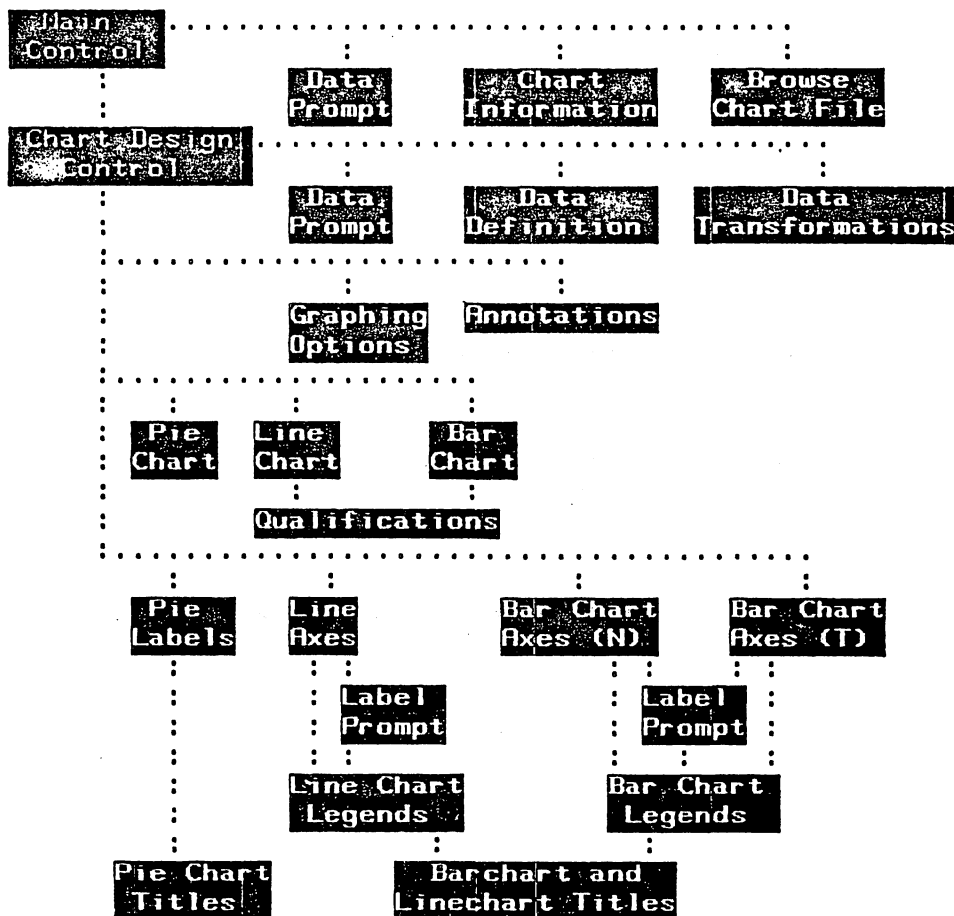


Figure 4a

GRAPH (A.00.00) HELP Facility: Chart Design Control

GRAPH's purpose is to visually display information in a data file. Piecharts, linecharts, and barcharts can NOT be made without a data file !!!

To make a chart, complete the following steps:

- 1) If you do not already have a data file then you should select the "F" operation and press ENTER to build a data file.
- 2) ENTER "D" to attach GRAPH to a particular data file to be graphed.
- 3) After the data file has been attached then you can ENTER "C" to make a chart, and choose "P", "L", or "B" as the chart type. Marking the initialize option will clear all variables, qualifications, axis settings, legends, titles, and annotations for the chart.

ENTER "G" to select another graphics device (like a plotter). All other operations are optional and described on other help menus.



Figure 4b

