

COMPUTER GRAPHICS FOR MANAGEMENT

An Abstract of Capabilities and Applications of the EIS System

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PREFACE

The object of the Executive Information Services (EIS) System is to change the way businesses are managed. That is being achieved by several hundred business professionals who are using the EIS language to solve their own problems. On the basis of that experience, it is clear that the course of business will change when decision makers regain a measure of control over an appropriate computing resource!

The system provides a wide variety of services including computational, data base, and display capabilities. Computer graphics is only one of those resources. The attractiveness of EIS graphics is in their ease of use and in their relationship to the rest of the system. For that reason, the only practical way to understand the application of EIS computer graphics is to understand the system as a whole.

BACKGROUND

The problems associated with exploring, making and implementing management decisions are among the most challenging assignments in business and government. They are frequently time-constrained, relatively unstructured, and almost always require some degree of participation or direction from management. Although they usually have a big impact on the organization's success, managerial prerogatives are often constrained by the absence of good information and an insufficient number of alternatives.

Historically, computing services have made less of an impact on this area than in the high volume, and repetitious functions of accounting, payroll, scheduling, etc. The reasons are plentiful. One of the principle factors has been tradition. The first computer programs were extensions of work performed on tab and accounting machines and by large organized groups of people. Over

the years, the rapid development of equipment and the opportunity to do a better job in this same area has captured the largest part of the computing work force. With all that experience, systems people have become quite skilled and a bit comfortable working the same set of problems.

Another cause for the slowness of response is communication. Early computing hardware and software were difficult and sometimes frustrating to work with. The groups that gathered to solve the problem were more oriented to computing than the activity of management. The rapid growth of technology has served to further isolate the two groups. Ironically, a third cause of delaying computer service to decision makers is certainly a result of previous attempts in that direction. A history of past failure has produced a community of discouraged computer and business leaders who have convinced themselves that it can not be done.

During the last several years, tremendous changes have been taking place within the computing world. These changes are at the roots of a new relationship which is emerging between the data processing and business sectors. The driving force behind these new relationships is, of course, the accelerated development of hardware technology and the resulting rapid decline in costs. Time-sharing, mini computers, low-cost terminal and graphic devices are among the products of this technology. One of the important by-products of time-sharing and mini's is the interest in computers which is springing up from outside the inner circle. Whether welcomed by the computer fraternity or not, that interest will result in the active participation of engineers and businessmen, in solving their own problems. The combination of events will, without a doubt, create an environment within which some break-throughs in computing service will occur. Among the most important of these will be broad and productive use of the computer by business decision makers.

SYSTEM OVERVIEW

Objectives

The Executive Information Services (EIS) capability was initiated by The Boeing Company in 1969. From the beginning, the emphasis was: (1) to create a system which would extend computer resources to persons involved in the business decision process, and (2) to provide correct and complete information to these persons so they could make good decisions based on fact. After an extensive survey, the following conclusions began to emerge:

- o The system had to be geared to the interactive nature of target problems (which were usually solved by groups of people and desk calculators).
- o The system had to be usable by persons within the business functions. The requirement for specialized knowledge and quick response usually precludes the involvement of a third party.

- o The system needed to be flexible because the problems were varied and unpredictable.
- o The large data collection needed to be organized into specially designed data bases with an emphasis on ease of use and the unique characteristics of the data.

Shortly after the EIS System became available, we discovered the following important facts which shaped all subsequent development:

- o Unless a system is useful on a daily basis to solve a majority of a businessman's problems, his computing skill will quickly fade and his interest in the system will fade with it.
- o A single system should be broad enough to support users across functional and divisional boundaries. Mobility of staff demands it.
- o Development of an effective management support system is never finished. Technology, new opportunities, change in problems and growth in the capacity of users require a continuing response.

General Characteristics

The EIS System was developed to provide a broad spectrum of services for direct use by persons engaged in the various business professions. It is available to users anywhere in the 48 states through Mainstream-CTS (the Boeing Computer Services' commercial time-sharing service) on an IBM 370/168.

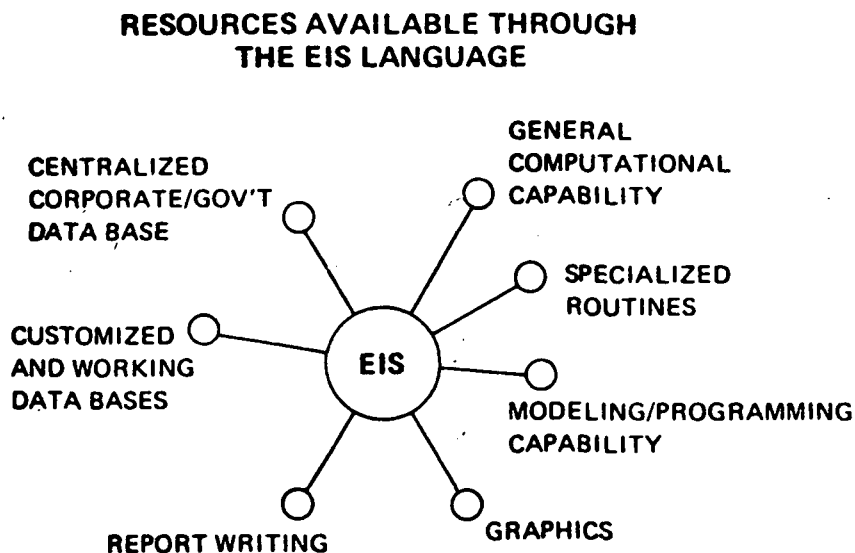


FIGURE 1

EIS resources include a full range of mathematical capabilities, graphics and report writing services, data base capabilities designed for ease of use and the types of information most frequently used in managing resources, and a number of other special features (see Figure 1). All of these are integrated into the system in a complimentary way and are available through the EIS language. Because the system is designed as a language and not a narrowly-defined program the user can combine the instructions to do whatever his needs require. Although the commands referenced in this document are written as full words, all EIS commands can be abbreviated by their first two characters.

To date, hundreds of people have been trained in the EIS language. These include persons within and outside The Boeing Company and persons with every type of educational and functional experience. Some of the capabilities they use were developed by the EIS Staff for general use, but most routines were developed with the EIS language directly by business, engineering, and management personnel to solve their own problems. The system is written in Fortran and BAL, but the largest volume of activity is serviced by programs written in assembly language so the cost of use is minimized.

Data Types

One of the foundations of EIS is a variety of data types which respond to the unique characteristics of business operations. The three most commonly used are timespread, unit and cum data. Timespread data is defined as a data set for which a beginning date is established and which contains one or a series of values associated with a sequence of months, quarters, half-years, or years. The beginning date is usually established by month and year, although it could also be defined by day or week. Timespread data is often used in estimating and planning, economic or business trends and performance measurements. The Consumer Price Index for example is a set of monthly indices which show the changing cost of goods and services over time.

Unit data are one or a set of values associated with a sequence of events-- usually production articles. They are similar to timespread data except the reference point is a unit position. These data sets are most often used to store the value or schedule date for high-value manufactured goods. In the case of both time and unit data, the reference date or unit makes it possible to perform calculations without any concern for the length or beginning point of the data sets used. Cum data are simple scalar or matrix values without time or unit associations. For example, one cum value could represent the sum of several months or units of activity.

Within the system, all information except that contained in special title files or data bases are identified by names which the user assigns.

CREATING DATA

The principle methods of creating data are: (1) inputting information from a terminal or data files, (2) general and specialized computation capability, (3) data retrieval, and (4) computational services within customized user data bases.

Input

Information can be entered into the computer from either the terminal or a data file through the INPUT command. In each case, the 'IN' instructs the system to accept the associated alpha-numeric information as an EIS data set. The first example is a cum data set with 11 values and is being INPUT into EIS under the name, X1. The second and third are examples of timespread data which were arbitrarily named, HRS and RATE. The TI in the second and third examples defines the data as time ordered. The numbers in parentheses establish the month and year for the first value.

```
IN X1 22 20 33 31 25 24 21 22 25 29 33:
IN HRS TI(1,75) 33 44 55 67 79 87 90 82 63 53 52 58
                64 68 70 66 55 41 33 29 27 26 25 24:
IN RATE TI(8,74) 5*5.26 12*5.91 12*6.47 12*7.10:
```

The asterisks (*) in the last case imply repetition. In the example, 5*5.26, \$5.26 rate applies to the five-month period from August through December 1974.

Computation

The most common method of creating new information is through computation. The COMPUTE command supports the standard operations of addition, subtraction, multiplication, division, and exponentiation, plus a number of special functions. In the first example, a new data set 'COST' is created by multiplying the values of HRS times RATE (both referenced above).

```
COMPUTE COST = HRS * RATE
COMPUTE CTD = CUM(COST)
COMPUTE X2 = X1/TCUM(X1)*100
```

The two data sets being multiplied are time oriented, but differ in both starting data and number of values. The resulting data set (COST) will contain 24 monthly values and begin in January 1975.

In the second example, the functional operator 'CUM' is used to develop the running cum or cum-to-date values for data set 'COST'. The value in the second position of 'CTD' will equal the sum of the first two values of 'COST', the third month value will equal the sum of months one through three of 'COST', etc.

In the third example, each of the nine values in X1 will be divided by the total cum of all X1 values and multiplied by a constant 100. The resulting X2 will contain the percent that each element of X1 is of the whole.

The special functions include many of those available in other programming languages plus a number of others which allow users to perform various cumming operations, to move data sets forward and backward in time and to create moving averages.

Specialized Computation

EIS also provides a number of subroutines to service some of the unique requirements of business and management. In every case, these special routines are activated by the first two characters of the command and followed by the appropriate arguments. With a SPREAD command, for example, a new data set may be created, which has the same expenditure pattern as another data set, but which may differ significantly in magnitude and duration. In the first example, the timespread data set 'NEW' will be created with 50,000 hours (dollars, etc.) distributed over a 36-month period beginning in September 1975.

SPREAD NEW TI(9,75) OLD 50000 36:

LEARN X3 80 1 10000 1 200:

The data sets, 'NEW' and 'OLD', will be the same general shape but may differ in every other respect. In the second example, a unit cost data set, X3, will be created using an exponential formula which approximates the experience observed in some manufacturing processes. X3 will be said to have an 80% slope. The first value of X3 will be 10,000, the second will be 80% of the first, the fourth will be 80% of the second, etc. The last two arguments will result in computation of values for Units 1 through 200. The unit positions and values for the first 15 are shown below. Numerous other special routines are available.

X3

| | | | | | | | | | |
|----|--------|----|-------|----|-------|----|-------|----|-------|
| 1 | 10000. | 2 | 8000. | 3 | 7021. | 4 | 6400. | 5 | 5956. |
| 6 | 5617. | 7 | 5345. | 8 | 5120. | 9 | 4929. | 10 | 4765. |
| 11 | 4621. | 12 | 4493. | 13 | 4379. | 14 | 4276. | 15 | 4182. |

Work Functions

A third type of computation service is known as work functions. Several dozen are available. These provide services ranging from the creation of random numbers to return on investment and depreciation routines. An especially important feature of work functions is that users may also write (or have written) work functions in Fortran or BAL to do any task which their work requires. These routines may be independent or they may operate in combination with any other part of the EIS software. These user-written routines then become an integral part of the user's personal EIS version. The availability of work functions gives the user considerable control over the efficiency and versatility of the system to handle unique problems.

Data Bases

Another method of creating information is through interface with an EIS data base. This can be done through the retrieval of information from an existing data base or by inserting information into a hierarchical data base. In the latter case, additional information may be generated within the data base itself. These will be discussed in a later section.

DATA STORAGE

All of the information created in a terminal session through data input, computation, data base retrieval, is preserved in core and on disk for the duration of the EIS computer session. These are available through their user assigned names for further computation and display. At the end of each terminal session, these data sets are automatically purged to avoid confusion with work done at a later time.

Information can be saved permanently or for use in a later session by identifying the data sets to be preserved and a file in which they will be stored. The command:

```
SAVE /XYZ/ HRS RATE COST:
```

would result in three data sets, 'HRS', 'RATE', and 'COST', being saved in a file named, XYZ. If no data set names are identified, all of the information currently defined will be saved in the specified file.

Information can be reclaimed from a SAVE file for use through a READ instruction. The READ command:

```
READ /XYZ/ HRS COST:
```

will bring data sets, 'HRS' and 'COST' into active core from file, XYZ. If no data names are listed, all of the information within the identified file will be brought into active core.

A third form of data storage are structured EIS data bases.

EIS DATA BASES

Retrieval

A data base is a collection of information stored in a systematic way for use in one or more applications. EIS data bases are multi-dimensioned structures, especially designed to support business and management applications and within which time, unit, or cum data sets are stored. Data bases for each of these data types are organized in a similar way. For that reason, the capabilities of EIS data bases will be illustrated with timespread data.

EIS data bases vary from a few hundred to several million combinations and from simple two-dimension to complex multi-dimensioned structures. In every case, however, data is defined through the selection of element(s) from each dimension. To illustrate the process, it is convenient to consider the retrieval of data from a cubic structure whose dimensions we will call HEIGHT, WIDTH, and DEPTH. The user could then recall information as follows:

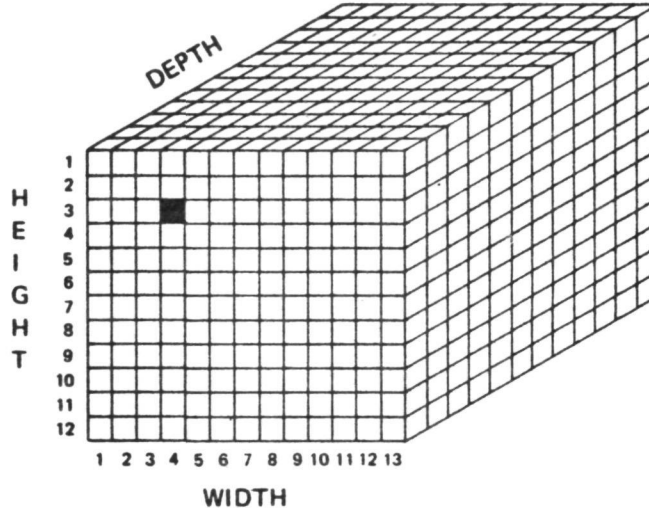


FIGURE 2

HEIGHT 3

WIDTH 4

DEPTH 1

GET A1:

The first three instructions define the characteristics of the required information. The fourth command causes information to be retrieved and stored under the name, A1. Time or unit data would be retrieved as follows:

GET A2 TIME:

GET A3 UNIT

Normally, it is more convenient and meaningful to assign names to the dimensions and elements which are more descriptive of the data base content. Consider, for example, a multi-product, profit center for which we wish to measure profit, cost, and revenue over time. The relevant factors might include the following products and financial factors:

| <u>PRODUCTS</u> | | <u>FINANCIAL FACTORS</u> | |
|-------------------|-------------|--------------------------|-------------|
| <u>TITLE</u> | <u>CODE</u> | <u>TITLE</u> | <u>CODE</u> |
| TOTAL COST CENTER | TOT | PROFIT | PROFIT |
| PRODUCT GROUP A | GR-A | REVENUE | REV |
| PRODUCT A1 | A1 | UNITS PRODUCED | UNITS |
| PRODUCT A2 | A2 | UNIT COST | UC |
| PRODUCT A3 | A3 | TOTAL COST | COST |
| PRODUCT GROUP B | GR-B | LABOR | LABOR |
| PRODUCT B1 | B1 | HOURS | HOURS |
| PRODUCT B2 | B2 | LABOR RATE | LR |
| PRODUCT B3 | B3 | OVERHEAD | OH |
| | | OVERHEAD RATE | OR |
| | | MATERIAL | |

There will be 99 combinations of product and financial data and useful time-oriented information that could exist for each of them.

| | PROFIT | REVENUE | UNITS PRODUCED | UNIT PRICE | TOTAL COST | LABOR COST | HOURS | LABOR RATE | OVERHEAD | O.H. RATE | MATERIAL |
|--------------|--------|---------|----------------|------------|------------|------------|-------|------------|----------|-----------|----------|
| TOTAL | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| PRODUCT GR A | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| PRODUCT A1 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| PRODUCT A2 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| PRODUCT A3 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| PRODUCT GR B | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| PRODUCT B1 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| PRODUCT B2 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| PRODUCT B3 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |

FIGURE 3

Using the code defined previously, the total profit could be retrieved in the following way:

```

FF CC PROFIT:          (FINANCIAL FACTOR -- PROFIT WITHIN
PRODUCT TOT:          COST CENTER CC)
GET P TI DI:

```

The 'TI' identifies our interest in timespread data and the 'DI' option would produce the following titled display:

```

FIN FACTOR  PROFIT
PRODUCT     TOTAL

P
MO/YR      (MONTHS)

1/74       195.    260.    325.    396.    467.    514.
7/74       532.    485.    372.    313.    307.    343.
1/75       .        .        .        .        .        .

```

All retrievals produce a new data set (in this case, 'P') which can be displayed, graphed, or used in a variety of computations.

Data Base Input

New information can also be created through the insertion of data into hierarchial EIS data bases. In the above matrix of 99 cells only 36 contain basic information (the non-shaded areas within Figure 3). The other 63 combinations can be created through a series of pre-defined arithmetic operations which are executed when and only when new information requires it. To illustrate the process, consider the effect of a change in the number of hours required to produce Product B2. Fourteen of the 99 elements are effected by that one change (profit, total cost, total labor cost, hours and overhead for total cost, product group B and product B2). This illustrates the problem often experienced in planning, budgeting and estimating operations when assumptions change or alternatives are being explored. The problems of 'keeping track' grow rapidly as the size, inter-relationships and number of dimensions increase. Unfortunately, what often happens in the absence of effective computer resources is that problems are 'cut down' to a size which an army of persons with desk calculators can support. The results are almost always less than satisfactory.

The EIS System supports not only retrieval, but also accepts on-line or off-line entry into these same structured data bases. The entry process is the exact reverse of data retrieval. First, the appropriate elements of each dimension are defined, then the new information is 'assembled' into the file.

Finally, the system automatically develops and inserts whatever additional information the new data and the data base logic require.

In summary, users have a great deal of flexibility in defining EIS data bases. They may be multi-dimensional collections whose elements are defined, named, and related as the application requires. In most cases, the work to set up a customized data base can be accomplished in a matter of days. For that reason, these data bases are used in a wide variety of business, government, managerial and technical applications where time, unit, or cum data are required.

INFORMATION DISPLAY

The simplest form of display within EIS is handled by the DISPLAY command. In the example below, the display for X1, HRS and COST would produce the following result. (The first two of these were created through the INPUT command and the third was developed through a COMPUTE instruction.)

DISPLAY X1 HRS COST /2/:

X1

| | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|
| 22.00 | 20.00 | 33.00 | 31.00 | 25.00 | 24.00 | 21.00 |
| 22.00 | 25.00 | 29.00 | 33.00 | | | |

HRS

MO/YR (MONTHS)

| | | | | | | |
|------|-------|-------|-------|-------|-------|-------|
| 1/75 | 33.00 | 44.00 | 55.00 | 67.00 | 79.00 | 87.00 |
| 7/75 | 90.00 | 82.00 | 63.00 | 53.00 | 52.00 | 58.00 |
| 1/76 | 64.00 | 68.00 | 70.00 | 66.00 | 55.00 | 41.00 |
| 7/76 | 33.00 | 29.00 | 27.00 | 26.00 | 25.00 | 24.00 |

COST

MO/YR (MONTHS)

| | | | | | | |
|------|--------|--------|--------|--------|--------|--------|
| 1/75 | 195.03 | 260.04 | 325.05 | 395.97 | 466.89 | 514.17 |
| 7/75 | 531.90 | 484.62 | 372.33 | 313.23 | 307.32 | 342.78 |
| 1/76 | 414.08 | 439.96 | 452.90 | 427.02 | 355.85 | 265.27 |
| 7/76 | 213.51 | 187.63 | 174.69 | 168.22 | 161.75 | 155.28 |

The number between the slashes defines the decimal significance requirement. Additional options allow the user to restrict output to selected time or units.

Form Processor

The EIS Form Processor gives users full control over printed output at the terminal or on a high-speed printer. Report generation is greatly simplified by a number of special features which have been incorporated in the three form commands. These include automatic time and date, word centering, optional bracketing of negative numbers, automatic month and year titling, internal sub-totaling, modification of time interval definitions and inclusion of graphics. Most importantly, it was written so it can be used easily by non-computer professionals, and it eliminates the constraint of 'standard reports'. Examples of output produced through the Form Processor are included with graphs in Figures 14 through 19.

Graphics

Computer graphics has been one of the glamorous subjects of data processing for many years, but to date, graphics has failed to make the impact on business decision making that is needed. Until recently, the cost of equipment has been a major deterrent to wide spread use, but cost is no longer a big factor. The real problem is that the potential of business graphics has been 'contained' within the computing fraternity. Much of the work in graphics has been an outlet for the creative instincts of systems programmers as an end in itself. Moreover, the development of graphics has generally required a programmer capable of combining the necessary subroutines from complex graphics library.

Graphics, like all of the other capabilities within EIS, was developed for use by persons in business and management, not computing. For that reason, nearly all EIS graphs can be created by a single, one-line instruction. (Throughout this section, the command used to produce each graph will be superimposed on each example. All graphs are shown approximately one-third scale.) The command GRAPH HRS will result in a line drawing of data set 'HRS' in which the scaling,

GRAPH HRS

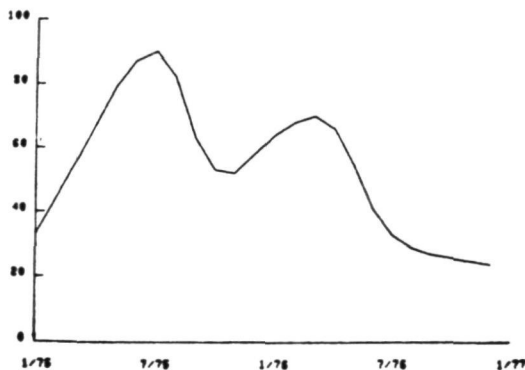


FIGURE 4

GRAPH ABC

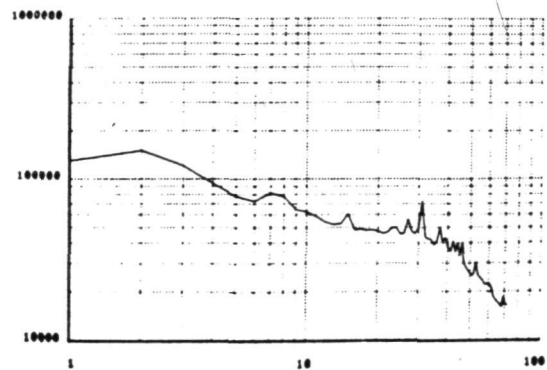


FIGURE 5

line type, graph, and character size, and selection of graphic form take place automatically (see Figure 4). In this example, the system selects a linear scale with time defined on the horizontal axis because timespread data is usually presented in that way. The unit costs of manufactured goods are often related to one another exponentially so the system defaults the display of unit data to a logarithmic scale (see Figure 5). In both cases, the selection of a graphic form is made possible because the data itself is identified as being time or unit oriented.

Cum data is presented in a variety of ways depending on the nature of the information and the audience for which it is being prepared. The standard response is a series of connected points drawn on a standard time grid (see Figure 6). The only difference between this and a time graph is that the horizontal axis is labeled with the sequence number of positions for a cum data set.

GRAPH X1

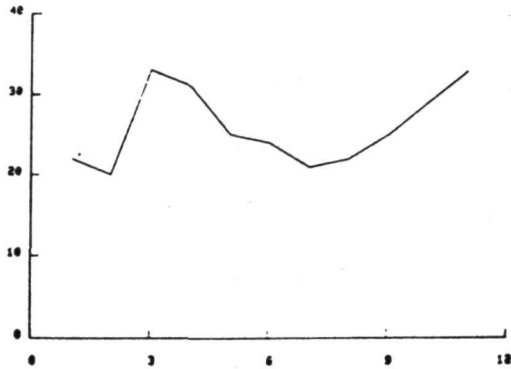


FIGURE 6

GRAPH X1 /PIE/

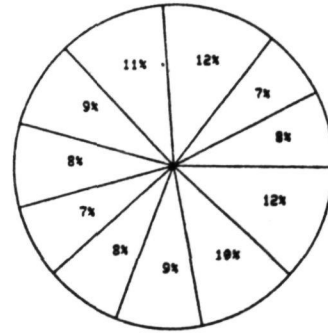


FIGURE 7

GRAPH X1 /HB/

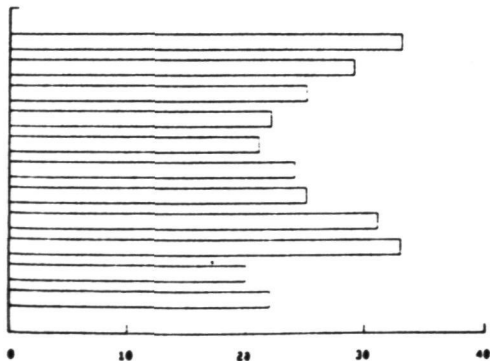


FIGURE 8

GRAPH X1 /VB/

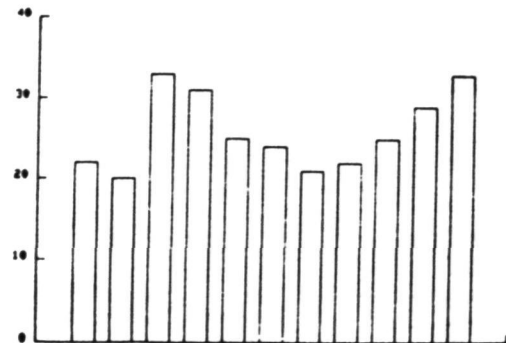


FIGURE 9

The same cum data is displayed in Figures 7 through 9. In each case, a different option is exercised. The 'PIE' in Figure 7 causes data set X1 to be represented by a pie chart. The numbers in each sector represent that sector's percent of the whole. An additional option would supervise the placement of titles in each of these sections in addition to the numeric values. Figures 8 and 9 are produced through the horizontal and vertical bar options.

A large number of options are available with which special graphic effects can be obtained. These include the selection of graphic form, line control, shading, placement on the page, multiple images on a page, control of scaling and labeling, plotting of cum data sets, optional grid lines and stack charts. Most of these are activated through a two-character abbreviation. Various possibilities are illustrated in Figures 10 through 13. Three data sets of five elements each are graphed in a comparative bar chart shown in Figure 10.

GRAPH B1 B2 B3 /VB/

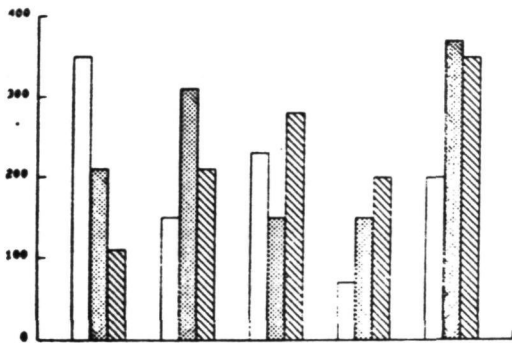


FIGURE 10

GRAPH A1 A2 A3

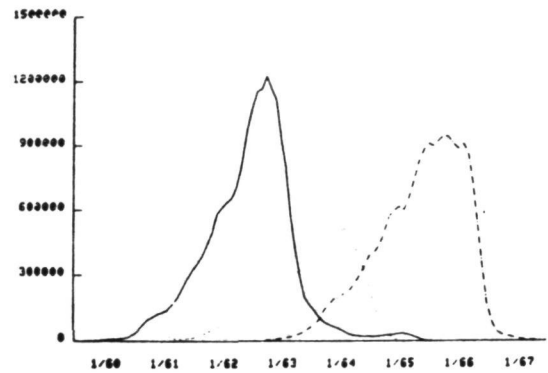


FIGURE 11

GRAPH B /BAR TX (ML) CUM/

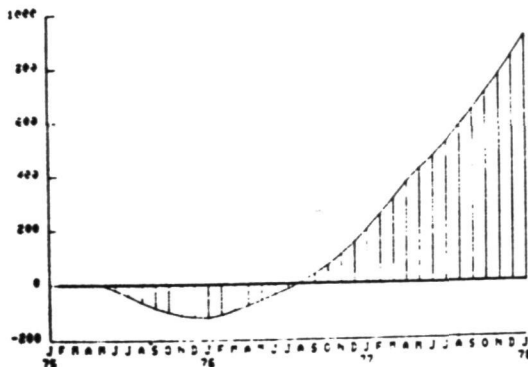


FIGURE 12

GRAPH HRS /BAR/ HRS /GR TX (M QL) /
HRS/GR CUM TX (Q QL) /HRS/BA SQ SE/

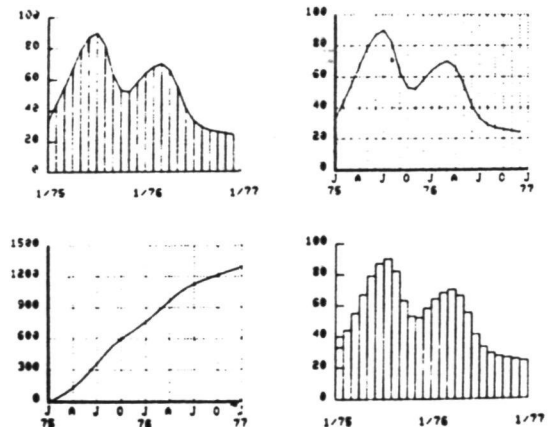


FIGURE 13

The VB option is used to position the respective elements of data sets, B1, B2 and B3, next to one another in a vertical bar chart. The shading is taken care of automatically. Similarly, the system automatically selects a different line type for each of the timespread data sets shown in Figure 11.

The cum and bar options referenced in Figure 12 automatically computes and plots the cum of cash flow line CFL and shades in the space between the curve and the zero reference line. The TX(ML) option in this same example causes the time axis to be labeled for each month.

The SE option was used to produce the separate charts shown in Figure 13. Otherwise, the data sets (all of which are the same) would have been plotted in the same space. The other options illustrate, again, the variety of ways in which the same information can be presented.

Charts are used in a variety of ways, sometimes for quick reference to data and other times, as a part of formal reports. In the latter case, the graph command is usually used in combination with alpha-numeric information produced by the form processor. The graphics are produced in exactly the same way as shown above except they are reduced in size to permit the addition of alpha-numeric information. Since the alpha-numeric data produced by the form processor are related to column and row, graphic grid positioning is defined in the same way. The graph in Figure 14 was bounded within columns 12 and 60, and rows 15 and 30. This information is included in the graph command between parentheses (e.g., GRAPH (15 30 12 60) B1 B2 B3.

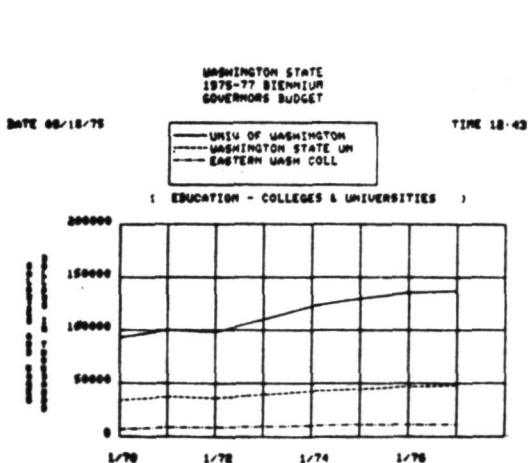


FIGURE 14

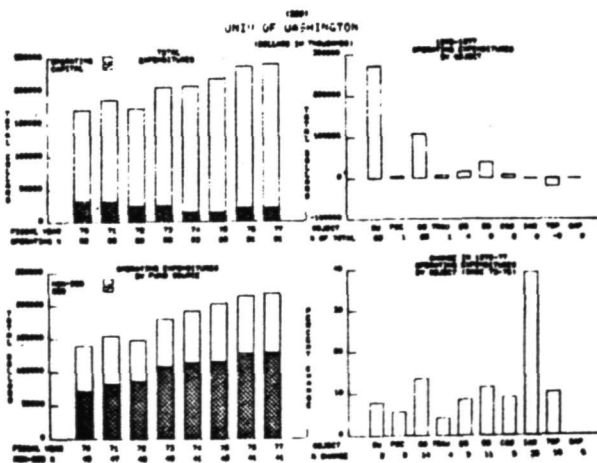


FIGURE 15

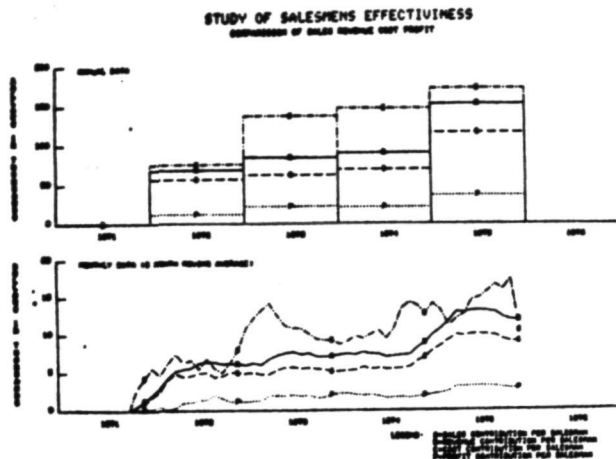


FIGURE 16

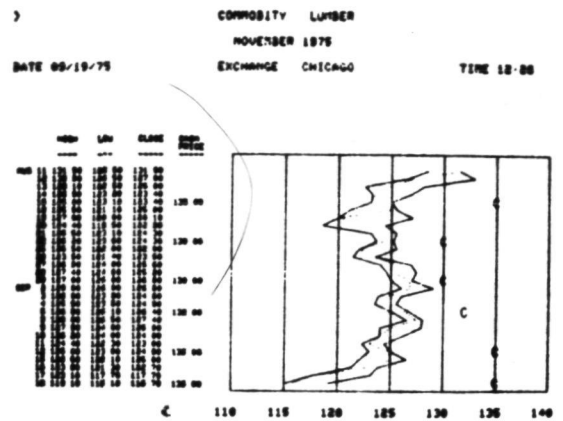


FIGURE 17

The examples shown in Figures 14 through 17 are representative of the form processor/graphic output from the various budget, performance measurement and analysis applications written in the EIS language. Even in these more formal charts, the graphic portion is almost always completed with a single graphics command of one or two lines.

EIS graphics are available on-line through Tektronics 4010 or 4014 terminals or off-line on the Stromberg Carlson 4020 system. The off-line service extends graphics capability to persons without convenient access to graphic terminals and provides an economical alternative for large volume work. In either case, the graphs are produced with the same commands and include all of the same options.

EIS APPLICATIONS

Interactive Use

New users are introduced to the system in three-day classes during which they learn to use each EIS instruction by typing them one at a time at the computer terminal. The system interprets the instruction and either performs the task or responds with a brief, but clear diagnostic.

A great number of EIS services are initiated, one instruction at a time, because in many cases, each step may depend on the result of a previous instruction. Each EIS command can accomplish a great deal, however. With one simple COMPUTE instruction, for example, a user can multiply a time-phased estimate of hours by day, month, quarter, etc., by a labor rate which also varies by time period. The answer can be available by period, in total or cummed forward or backward in time, through that one instruction. The special functions provide an even greater service. With a single command, a user can compute the return on investment on a data set of unlimited length or extend the assumption of a complex learning curve over hundreds of units.

Data retrieval is heavily used by persons engaged in cost research and managers comparing expenditure against plans. Interactive use of the EIS System also provides new users with a good vehicle to develop and extend their EIS skills.

EIS Programs

The largest percent of EIS applications are tasks which are performed many times--often with slight variations from one use to the next. These are customarily entered into a program file and stored on the computer disk under a name assigned by the user. The obvious advantage of pre-programmed files is that they can be executed more quickly and for less cost than equivalent services requested from the terminal. In addition, programmed files are available to several other persons. In either case, the commands are expressed in an identical way.

Many of the programmed files contain a small number of instructions. The output shown in Figures 18 and 19 are examples of this process. The learning curve program is produced by instructions in a file named LEARNING CURVE. The 11 commands supervise the retrieval of the requested unit cost data for airplane XYZ, determine the best fit curves for units 1 through 40, and units 41 through 70, and display the results with companion form generator file which was also written by the user with the EIS language (see Figure 18). The service is initiated by the CALL instruction. The four arguments

```
CALL LEARNING CURVE PROGRAM COST WBS BREAK  
                                NAME ELEMENT POINT
```

define the program name, organization, hardware component and breakpoint at which different learning curves are to be developed. This simple example combines the

use of computation, the graphics and form processor and retrieval from a structured data base. The arguments which may be substituted in this example allow this file to be used for thousands of combinations.

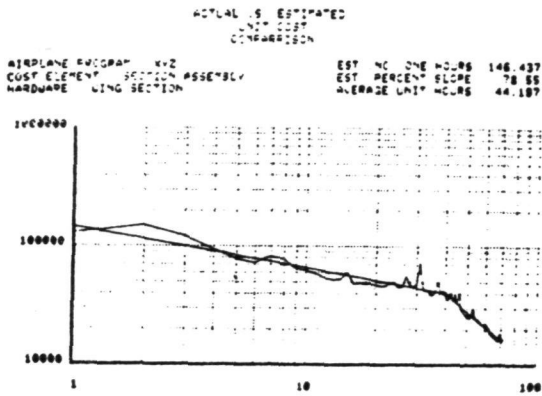


FIGURE 18

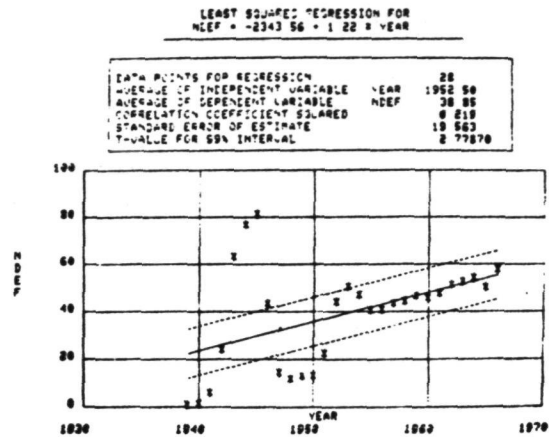


FIGURE 19

The output shown in Figure 19 is provided by a small file which accepts two variables for which it performs a linear regression to determine a least-squares fit. All that is required to initiate the process is to call file 'LINEAR REGRESSION' and identify the two variables and a confidence boundary. If transformations are required (e.g., changing the values to current dollars) they can be performed easily through a COMPUTE command before the regression program is called.

Some of the applications require several thousand instructions. One such application is a complex airplane estimating model that was developed by a cost research group of Boeing Airplane Company. The extensive and continuing cost research has been accelerated by the interactive active environment of the system. The availability of specialized commands and large historic data bases eliminated much of the work which would otherwise have been required.

Examples

Without any attempt to be complete, the following are examples of areas in which the EIS System is being used.

Research. - One of the major objectives of EIS was to promote cost research. Large data bases provide ready access to organized collections of information. The special commands and high-level language simplify user access to computing resources. The time-sharing environment and interactive graphics accelerate the discovery of fact.

Estimating Services. - Major (and minor) proposals involving hundreds of hardware components, numerous cost centers and multi-time periods are developed within the system. The cost of service is low because the interactive environment, structured data base and user involvement are ideally suited to estimating requirements.

Planning, Budgeting, and Performance Measurement. - EIS is the vehicle for planning and performance measurement for many organizations. The Washington State Legislature, for example, used EIS as the principle resource for analyzing, comparing and constructing the six billion dollar state budget. The expenditure history and recommendations for 600 agencies and programs were stored in EIS data bases. Alternate proposals were introduced into the system from staff offices, committee hearing rooms and off the floor of the Senate and House. The impact at all levels of government was known immediately. The near-term availability of monthly expenditures from each agency will allow the same system to be used to monitor performance.

National Computer Hook-Up. - Boeing Computer Services uses EIS to communicate information between its separate divisions which are located throughout the United States. Plans and monthly actuals for a large number of product lines are entered into the system at each divisional location. The data is automatically summarized for use at both the remote and headquarters locations. Besides the usual benefit, the application shortens the time spent in financial consolidation by several days. Communication between cities is a no-cost benefit of operating on a national time-sharing network.

Negotiations. - EIS programs are used to negotiate prices and overhead rates with customers and subcontractors. A versatile set of support programs can usually accomplish more than a large group of people. Negotiators at work any place in the country can still be in touch with the home office and large data bases through the system.

In every case, users created the capability or played a big part in their development.

SUMMARY

Extending the capabilities of decision makers and their staffs is one of the great challenges for management and computing alike. As a class of problems, managerial decisions have an enormous impact on the profit and future prospects of an organization. Unfortunately, all too often, those choices must be made within impossible time constraints and in the absence of sufficient information. Historically, because of the need for quick response, the continuing variability of requirements over time and the necessity for managerial involvement, the contribution of computing has been limited.

For more than five years, hundreds of persons within the traditional business functions have used EIS to solve their own problems. As a result, the computer

is now an accepted part of many activities previously regarded as too specialized for computer service. There is every reason to expect this process to continue. Toward that end, EIS is continually being extended to respond to the growing opportunity for service to management.