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# TOOLS FOR BUILDING AN EIS

One of the newest terms in the computer field is 'executive information systems' (EIS), coined because the term 'management information systems' has been given so many different meanings. The purpose of an EIS is to support the information handling and decision making activities of managers through the use of computers. Almost needless to say, there are not many EIS in existence today. In the past several issues, we have been discussing management's information requirements and how they can be determined. In this report, we describe some of the hardware and software tools that are now available (or are just becoming available) for supporting those needs—plus user experiences with a few of these tools.

James Rude, of Rude, Harvey, Schwartz and Associates, Inc., Haddonfield, New Jersey, addressed a conference last year on the subject "Information Needs of the Chief Executive Officer." Rude was formerly the director of information services for the Pillsbury Company and for the past six years has been a consultant to top management at over a dozen companies. He made a number of points that were based upon his experiences at Pillsbury and his consulting.

The types of information that chief executives seem to want are the following, said Rude.

*Comfort information.* This information consists of a few daily figures that tell something about the state of the business, such as yesterday's dollar sales. These figures make the chief executive feel comfortable or uncomfortable, but he does not do much with them, according to Rude.

*Problem information.* This is information about a major crisis or about the progress of a significant project, which deserves the CEO's attention. He wants this information daily until things seem to be going smoothly.

*Information for outside dissemination.* This is information about the company that is to be disseminated to outsiders—for instance, company earnings data that is given to investment analysts. The CEO may be very sensitive about seeing certain of this information before it is released.

*External intelligence.* This is information about the business environment and what competitors are doing. Rude said that at one company he has worked with, they have developed a sophisticated promotion simulation model. With it, the company can predict reasonably well what the effects of specific promotion efforts will be. And it also helps them predict price changes by competitors one month ahead.

*Internal operations*. The CEO typically wants a few key figures that, to him, indicate how things are going. "The chief executive should let his subordinates know that he is following these figures closely," said Rude, "so that they will pay attention to the figures also. Then they will take action to try to make those figures turn out well." These most often are financial figures because money is the 'universal measure.' Also, the CEO wants information about people in the organization, to help him make selections for new assignments.

Today's mechanized information systems do not support such information needs of the chief executive particularly well, said Rude. The CEO deals mainly with directing and motivating people. Fixed reports do not tell him much about the 'people' problems. The financial application systems may not produce the few key figures he seeks. And most mechanized personnel systems do not give him the information he needs for making important assignments.

So, said Rude, whoever is designing an information system to support managers must concentrate on such questions as: What makes this business run? What is the key thing that the chief executive is trying to accomplish? What are the major influences on it? How can an information system help?

## Computers do aid management

Computer support for management activities *does* exist. But it is spotty.

We recently reviewed the subjects we have covered in EDP ANALYZER since the middle 1960s, to see what discussions of computer support for management we had carried. We found that we had interviewed several dozen companies that were using computer services to help support management decisions, at almost all levels of decision making. The decision areas included the following:

*Total market forecasting*. Econometric models are being used for forecasting trends of whole industries, trends of wages and prices, long range changes in the economy, impacts of technological changes, and the effects of possible government actions.

*Specific market planning*. Models are used for projecting total demand and total production for specific types of products, for selecting geographic locations (for warehouses, plants, stores, etc.), for designing transportation systems for serving markets, and so on.

*Operations planning*. Routines are being used for analyzing the company's resources (employees, facilities, customers, suppliers, etc.) by categories, for harmonizing marketing and production plans, for production scheduling, etc.

*Management control*. Computer services are used for showing the work backlog at each facility in order to aid in load leveling decisions, for showing actual progress versus plan, for analyzing trends in revenues, expenses, and overhead, and for projecting future revenues, expenses, and overhead.

As might be expected, the companies did not release much detail about the benefits and the problems they encountered from using these methods, since this is generally considered proprietary information. But they were willing to describe the difficulties they ran into when installing the methods.

Some measure of the success of these decision aids can be found in governmental use, where results sometimes are made public. Cameron (Reference 4) discusses the difficulties that have beset the use of econometric models (by Congress, for instance) for forecasting the economy. Yes, the models take lots of factors into account so as to mirror the real world—but what should the decision makers do when two models give widely differing forecasts, as has happened? Models are based on past relationships (which may be changing), on economic theory (which has some weak spots), and on the availability of data (which may include substantial errors). So, while models have been used to help the decision makers, it is not apparent to what extent they continue to be used.

Almost all of these cases of management support involved stand-alone systems; they had not been constructed as part of the regular data processing application systems. And in about one-half of our cases, the companies were using outside time sharing services for these management uses.

So computer services *are* being provided for management. But the impression we get is that such usage is quite spotty. It has developed in answer to specific problem areas. The questions that Rude suggests be addressed have not, in general, been addressed. Only a small portion of a manager's information needs is supplied by a computer-based system, in the cases we are familiar with.

But this situation may be changing.

### What is coming?

In our recent reports, we have been discussing the computer environment that we foresee for the 1980s. And it looks to us as though computer support for managers will be a key aspect of this environment.

In our last three reports, we have discussed the nature of managerial work, the types of decisions that managers make, how managers' information needs can be determined, and the need for protecting that information. We indicated where computer support for managers might be both helpful and realistic in the years just ahead.

In this report, we discuss the state of the art, as we see it, in computer support for managers. This support involves both the information handling activities and the decisions of the manager. We will start the discussion with the decision making function.

## Decision activities

We see four types of tools to help support the manager's decision making activities. These are: (1) query systems, for retrieving information, (2) the use of graphics, to aid comprehension, (3) the use of analysis routines, for analyzing the data, and (4) the use of decision models that either describe or prescribe solutions.

### Query systems

Today's query systems have been designed to provide a means to retrieve data from files according to a set of criteria and then to either display it on a terminal or print it out as a report. Further, this is done without the need for the user to write special programs; the query systems themselves provide the programs.

Companies are making effective use of this facility. Consider, for instance, the case of Hughes Aircraft Company.

***Hughes Aircraft Company***, with headquarters in Culver City, California, is a large manufacturer of electronic and industrial products. The company employs some 35,000 people, mainly in the Southern California area.

The corporate communications and data processing department has acquired a number of commercial query packages to support a variety of information retrieval needs within the divisions of the company. These include the following four packages.

*ASI-INQUIRY*, supplied by Application Software, Inc., of Torrance, California, is the main query package used, in terms of the volume of queries. HAC uses it in conjunction with production data files stored under IMS/DC. These queries are mainly pre-defined, standard queries and have replaced a number of printed reports. Retrieval is generally based on a key value or a range of key values.

*SYSTEM 2000*, supplied by MRI Systems Corp. of Austin, Texas, (a subsidiary of Intel Corporation) is a secondary index type of data management system, with a powerful query language. HAC uses it for 'open shop' situations, where end user departments wish to set up their own applications and enter their own queries. A catalog of pre-defined update routines, queries, and reports has been developed, as an aid to the users.

*MARK IV QUERY*, supplied by Informatics, Inc., of Woodland Hills, California, is used for queries that require an analysis of all records in a file. HAC finds it particularly useful for analyzing personnel files (for such queries as "How many employees do we have in each of the following categories?"). This package can handle multiple reports (up to 255) on one pass through a file, so HAC handles whole-file queries of this type in batches, for economy.

*HIMAX/DMS*, supplied by CSS, Inc. of Denver, Colorado, is a query package that HAC considers to be quite well structured and reasonably suitable for high level management use. It is used for accessing certain special decision-oriented data files. Some top executives of the company have terminals in their offices for accessing these files. Queries go through two steps—they are first interpreted to FORTRAN statements and then compiled and executed.

In all, HAC makes heavy use of these query packages. Total queries number over 6,000 per week, and this quantity continues to grow. There are several reasons for this growing usage, they pointed out to us.

*Replace printed reports.* Printed reports have a number of shortcomings. At peak load times, the printing often is the bottleneck and reports can be days late. Printing, bursting, collating, binding, and distribution are slow and costly. Users may look at out-of-date reports by mistake. Data items may be spread through a number of reports, making it difficult to pull total figures together. These are just some of the shortcomings.

So HAC is encouraging the use of query systems to replace many of their printed reports. The reports are prepared in the usual manner, but are stored on disk instead of being printed out. Managers and staff members can access desired report pages from terminals. What is displayed looks just like the page of a printed report. When we watched the system in use, an overall project expense report for the current period was first retrieved. Then one of the expense categories was probed, by retrieving lower and lower level reports, to track down the cause of an expense variance from budget. The bulk of HAC's queries were of this general type, we were told.

***Customizing reports***. As more and more of the reports are accessed by end users in this manner, the queries and reports can be (and are) tailored to the specific end user desires. The information that is shown, and the format in which it is shown, can be customized to a greater extent than is practical with printed reports.

***Ad hoc analyses*** and ad hoc queries can, in theory, be accomplished with any of the query packages that HAC uses. In practice, most of the ad hoc queries and analyses occur in connection with personnel data.

For instance, the personnel data is analyzed for a wide variety of purposes. These uses range from situations involving individuals (say, looking up an employee's benefit date) to large statistical analyses (say, a study of the corporate profile of management turnover due to retirement). There are almost as many reasons for these queries as there are queries.

The personnel files must also be analyzed frequently to meet government requests for information. A variety of reports must be filed with the various government agencies on the status and recent changes in different categories of employees.

Password control of access is used for some files, and passwords are issued on a need-to-know basis. Some managers use the terminals themselves, but most work through intermediaries, since some of the terminals are somewhat demanding for casual users. However, for accessing particularly sensitive information, managers use the terminals themselves and, in fact, may have their own simpler, hard copy terminals in their offices.

At Hughes Aircraft Company, then, the use of query systems is beginning to work its way up through the various levels of management.

***System Development Corporation***, with headquarters in Santa Monica, California, is a major software development and computer services company. Sales exceed $133 million annually and the company employs about 3,600 people.

One software development project that SDC has been engaged in is the End User Friendly Interface to Data Management Systems—or EUFID. This is a 'friendly' query system designed to be used by the casual user who is unfamiliar with the system. For instance, EUFID uses no cryptic input commands or cryptic output error messages, of the type that are so annoying to the casual users of many of today's on-line systems.

EUFID is an 'intermediate language, table driven' system. The English-like queries are first translated into an intermediate language and then into the query language of the particular data management system being used. EUFID uses one set of tables for defining the language used to ask questions about the application, another set for defining the DMS structure, and a third to map between the first and second sets. Thus, both the applications and the DMS can be changed without the need to recode EUFID.

Queries are very English-like. An example is, "What is the average salary in the research division?" Or consider the query, "What companies shop goods to the research division?" EUFID responds to this query with, "Do you mean 'ship' instead of 'shop?' Answer 'Yes' or 'No'."

As the user enters the query, EUFID first checks the words against a user-defined list of synonyms. Thus, within an application, a user can have his/her own synonyms, if desired. If one or more synonyms are found, they are translated into the 'regular' words.

Then EUFID checks the words against the application (semantic) dictionary. All words that are used to ask questions about the application must be defined in this dictionary as to how they connect with each other. There are seven types of words: nouns, verbs, prepositions, functions, parts of a phrase or idiom, words that refer to words in previous queries, and system words.

If the input word cannot be found in the dictionary, or if it violates the connection definition in the application dictionary (as did the word 'shop' in the example above), the spelling corrector is called in. It attempts to determine what word was meant and then asks the user to indicate whether it was right or wrong.

As its next step, EUFID interprets the question; this is a complex process that we will not attempt to describe. Then it checks the authority of the user to access the requested data. If the person does not have the authority, EUFID says that it does not understand the query; it does *not* say that the query is 'not authorized.'

Then EUFID translates the query, through a series of steps, into the formal query language statements for the data management system being used. So far, EUFID interfaces with network (CODASYL-type) and relational databases.

EUFID also provides the 'help' facility that explains what it can do and not do, and the types of responses that it makes when it is unsuccessful in fulfilling a request. EUFID is portable (it can be used on machines with a FORTRAN compiler, for instance) and can run on front-end mini-computers.

EUFID was developed for a government application and is not yet released as a commercial product. For more information, see Reference 5.

*The role of query systems*. These examples illustrate what we think will be the role of query systems in the computer environment of the 1980s. Let us briefly summarize the main points, because of the important role these systems will play.

*Replace printed reports.* By providing management with direct access to regular report data by way of terminals, query systems will encourage managers themselves to make use of computer services. The advantages will be: reduced costs, more up-to-date report information, and one standard place where managers can look for information.

*Broaden the types of data.* As management becomes more and more familiar with the direct use of the computer, managers will see that it is practical to store a wide variety of types of information in the computer, and access that information by terminals. This will include historical, current, and future projection information, and external as well as internal information.

*Encourage ad hoc queries.* As the variety of the data in the system grows, and since access to that data is easy, ad hoc queries will proliferate and may well surpass the accessing of standard report data.

*Support special analyses.* With the data in the computer system and accessed easily by the query facility, the next logical step will be to start making use of routines for analyzing the retrieved data. We will have more to say on this below.

*Provide data security* on a need-to-know basis. As more and more types of management data are put into the system, the need for access controls will become apparent. At the outset, password control will be the primary method. However, as we have discussed in previous reports, password control has a number of shortcomings and will have to be supplemented with other measures. Last month, we discussed ways for determining security needs for managers' information.

And how are all of these good things going to come about? We think that one of the essential features of the new query systems will be 'a friendly user interface.'

*'Friendly user interface.'* The query system must be easy to learn and easy to use. It must guide the casual user through the proper steps and away from the incorrect steps. It should not be too demanding; for instance, query statements should not have to begin with capital letters. At the same time, it must be very tolerant of the common types of human errors. That is one reason we included the discussion of EUFID; its friendly user interface represents the way that query systems for managers will develop, we believe.

### Graphics for comprehension

Most of today's query systems, of the types just discussed, display or print responses in numerical or textual form. But some organizations are beginning to use methods that convert numerical responses into graphical output, for better comprehension.

***Information Sciences Institute***, which is a part of the University of Southern California, is located in Marina del Rey, California, in the Los Angeles area. ISI performs research and development in information systems. In our September 1978 report, we discussed ISI's own use of automated office technologies.

One research and development project that ISI has been conducting concerns a device independent color graphics system. The particular application area for which it has been developed is for military command and control. But the same principles can be applied in commercial applications.

The system has the following characteristics. It runs on one of ISI's Digital DEC-10 computers, which in turn is connected to the ARPA Net. Queries are entered in a subset of English to LADDER, a database query package developed by SRI International, of Menlo Park, California. As the query is interpreted, LADDER checks the words against a grammar. If a word is not acceptable at some point in the query, a spelling correction algorithm is called upon. It tests the word against each word that could possibly occur at that point in the sentence, by checking for transpositions of adjacent letters and for the substitution, addition, or deletion of letters. If the unacceptable word is close enough to some acceptable word, the substitution is made (with notification to the user) and LADDER continues.

After the query is interpreted, LADDER creates a program in the query language of the data management system with which the system is working. In the present example, the database is located on a computer in the Boston area, so LADDER sends the program over the ARPA Net to that computer.

When the data is retrieved, it is sent back to ISI over the network. LADDER gathers the data and passes it to the graphics system that converts the data for graphical output and displays it. The system has been designed so that the output can be displayed on a wide range of graphic terminals. We saw the same output displayed on three types of CRT displays—black on white, white on green, and on a color TV monitor. The purpose of this design requirement was so that the same graphic application could work with a variety of display devices.

In the following example of use—a commercial analog of the military scenario that we saw (which used simulated data, not real data, by the way)—the system was asked to draw a map of the North Atlantic, extending from the east coast of North America to the west coast of Europe. A map of almost any other portion of the world could have been requested, we were told. Then came the first query: "Where are all the U.S. oil tankers?" Several green triangles appeared at various points on the ocean, and each had an identification number attached. Then the next query: "Which of these are over 100,000 tons and are loaded?" A couple of the green triangles started to flash. Then another query: "Give name, ownership, last port of call, next port of call." Along side the map, this textual information was provided. Then still another query: "Where are the British oil tankers?" Yellow triangles appeared for these. And so it went.

This type of system should be very easy for managers to use. The interface is friendly, it tolerates spelling errors, and it guides the user in the proper use. The messages it displays for the user are understandable.

But the system does much more than that. It provides a way to comprehend patterns and relationships that exist in masses of data, in a way that numerical lists just cannot do. Further, data is retrieved so relatively quickly and the graphical output produced so quickly that the penalty for asking the 'wrong' question is almost trivial. However, we are not saying that trial-and-error analysis will become proper with these systems. Rather, as the user sees the results of a query and gains understanding, he or she may see that it is necessary to rephrase the query. The cost of re-doing the query will not be great.

The system is in experimental use at one government installation, we understand. As yet, there are no plans for making it into a commercial product. At the moment, the hardware to support this graphic capability is expensive. But both micro-computer and graphic terminal technologies are developing so fast that we believe the prices for such a capability will drop rapidly in the next year or so.

For more information, see References 6 and 7.

*Wharton School*, at the University of Pennsylvania, in Philadelphia, has developed DAISY, a Decision Aiding Information System, that has some unusual characteristics. We mentioned a few characteristics of this system in our April 1979 issue. For a further discussion, see Reference 1a.

If one observes a manager in the process of making a decision, one generally finds that the manager's work space is cluttered with various paper media, say the developers of DAISY. These might include reference books, maps, reports, computer printouts, and so on. Somewhere nearby are notes that the manager has developed. This is the not-untypical scene in paper media systems, say the DAISY people.

But what does one generally find in the relatively few computerized decision support systems that exist today? One finds a terminal that the manager (or an intermediary) uses for accessing the computer, and this terminal displays just one type of information at a time. This is *not* the way decision makers are accustomed to working.

So DAISY provides *multiple concurrent logical terminals*. It does this by dividing the total display area of the CRT into an arbitrary number of 'windows,' and the user can assign each window to whatever purpose is desired. For instance, one window might be used for entering queries, and the results displayed in another. Errors of input can be shown in a third window, so as not to confuse the input and output material. And because the manager wants to be notified of urgent messages or alerting signals, another window might be set aside for these notifications.

As a further point, an output window can display information either in alphanumeric form or in graphical form. When we witnessed the DAISY terminal in operation, each of these windows was assigned a different background color, on a color graphics terminal. Hence the different types of information stood out vividly. Further, where desired, response data could be in graph form.

Yes, we think graphics—and particularly color graphics—are 'here' technologically. Graphics can aid tremendously in comprehending information extracted from masses of data. You will be seeing a lot of color graphics terminals in the early 1980s.

**Analysis routines**

In our May issue, we discussed the ideas of Keen and Morton (Reference 2) on the general types of decisions that managers make. They described three general types: structured, semi-structured, and unstructured. In structured decisions, such as many types of inventory reordering, all of the rules are known. Such decisions can be programmed. Human judgment can still override the programmed decisions, but there is seldom a need to do so. With semi-structured decisions, such as budgeting, some rules are known and can be programmed, but the remainder of the decision relies on human judgment. And with unstructured decisions, human judgment is paramount.

Where in this spectrum of decisions is computer technology likely to help? Let us look at what the First National Bank of Chicago is doing.

*The First National Bank of Chicago*, with headquarters in Chicago, is the tenth largest U.S. bank, according to *Fortune* magazine. It has assets of over $22 billion and employs about 9,000 people.

In the early 1970s, bank management decided to seek ways to better meet the information needs of its executives. So a joint project with IBM was set up and got underway in early 1973. An in-depth study of the information needs of executives and managers was conducted, and over 60 managers and executives at all levels were interviewed.

A number of requirements became apparent from the study. Managers needed external information as well as internal, but the then-mechanized systems dealt mainly with internal information. Better analysis techniques were needed, and data had to be made more accessible. For instance, when staff members were given assignments to do analyses in support of decisions, an average of 86% of their time was spent in gathering data, 10% in analyzing it, and 4% in formatting the results. The small amount of time used for analysis was due mainly to the large amount of time needed for data gathering; there was time for only the minimum amount of simple analyses.

Another requirement dealt with trend data as opposed to status data. Most of the mechanized systems produced only current status information. But most managers wanted to see trends—and the higher one went in management, the more this became apparent. And the higher one went, the greater the interest in external data as well as internal data.

Another requirement was for the 'consistency' of data. Conflicting data only leads to confusion. A central repository for data helps achieve consistency.

Still another requirement was the need for data to be shown in graphical form. The study team found that the manually maintained 'big black book of charts' showed them the way the managers wanted to see information displayed. And the team soon discovered from the interviews that there was no way to anticipate how any individual manager would interpret the data, and concluded that "We should just present the data, not try to interpret it."

The system that was developed has been given the name 'Executive Information System' (EIS). It features ease of access to both internal and external data, routines for analyzing the data, and flexible, graphic means of presentation. The system hardware includes four IBM 3270 terminals with light pens, a mini-computer, a video display generator, a color TV monitor, and graphics copiers. Special EIS data files have been set up, and are stored on one of the bank's IBM 370/168 computers and managed under IMS/VS. Security is provided by password controlled access to different portions of the data. The passwords are issued on a need-to-know basis, since some of the data is of a sensitive nature and only a few officers have authorized access.

The EIS data on the bank's internal operations is selected from the regular data processing applications. Some of the data on the external environment is purchased, and is not unlike stock market information—sales, earnings, and so on, for individual companies, and summarized by industry groups. Also, the bank enters information from the published financial reports of publicly held companies with which it deals, plus financial reports submitted to the bank by privately held companies (and kept in secure files).

Analysis, retrieval and display are 'menu driven.' That is, the system displays a list of options and the user, using the light pen, selects which option is desired. These lists of options are frequently enhanced, so as to meet the needs of the users.

When data is retrieved, it is displayed on the 3270 terminal—and, if desired, on the graphics display device. If, after examination, the user feels that it is the desired data, then the user may call on one or more analysis routines, for gaining more insight into the data.

Some of the analysis is basically 'status' in nature. For instance, if a possible merger of two companies is being studied, pro-forma balance sheets may be developed through the use of available routines. But most of the analysis deals with time series data—monthly, quarterly, or annual figures on, say, sales, earnings, expenses, operations, and so on. The simplest case is just displaying one or more time series, either in numeric or graphical form. Or two or more time series may be compared on a bar chart, as a series of different colored bars. Or arithmetic operations can be performed on time series data, such as adding expense types to give total expenses for a series of time periods, or subtracting expenses from revenues to give income. Finally, more sophisticated calculations can be made on time series, such as computing ratios, compound growth rates, variances, and linear regressions.

For each desired analysis, the user can call for a graphical output on the color TV monitor. The graphical outputs are basically bar charts or line graphs, and are produced by the system in about five seconds. In appearance, they are very similar to the charts used in many companies' 'management chart rooms.'

Originally, the system dealt only with current and historical information. But EIS has recently been enhanced to provide forecast data, by projecting recent trends; projections may be modified by user judgment. Projections are helpful in preparing plans, and the resulting plan data can also be stored in the system. Graphs of actual versus plan can be displayed.

The bank encountered some familiar start-up problems with EIS. It was originally oversold to upper-level managers, for instance. And, in the early days of use, some operating problems occurred which took awhile to clear up. But now use of the system is starting to accelerate, we were told. Most use so far has been by middle level managers. Many of the managers use the system via intermediaries, but some managers (even up to the vice presidential level) use the terminals themselves, particularly in cases of credit analyses of major loan requests; it takes only about one hour to learn to use the system. As managers discover the usefulness of the system, they begin to look for different ways to use it.

The system provides not only faster access to, and analysis of, data but also gives more consistent interpretation of data, they told us. With previous manual methods, it was not unusual for different data items to be interpreted differently by the various staff analysts. Now EIS provides one source of the data and a standard set of data definitions.

IBM, as a partner in the development of EIS, is marketing portions of it under the name Trend Analysis/370.

For a more detailed discussion of EIS, see Reference 1b.

*American Airlines*. We discussed the American Airlines AAIMS system in our May 1976 report and so will discuss it only briefly here, to indicate what has happened in the interim. In the past two years or so, major changes have been made to the system.

AAIMS is a matrix oriented decision support system that uses data supplied to the Civil Aeronautics Board by the airlines. On a monthly, quarterly, and annual basis, the U.S. airlines submit data on traffic, capacity, operations, revenues, expenses, and so on, much of it down to the individual route level. This information becomes publicly available, and American inputs it into AAIMS.

While AAIMS was originally planned as a forecasting tool, the initial use by management was for status reporting. That is, it was used for the daily reporting of traffic and capacity performance of the airline.

Then, as management grew accustomed to using the system, time series analysis began. To illustrate by a simple example, a manager might want to examine the time series data of traffic, revenues, and expenses for, say, sets of city pairs (such as New York to Los Angeles and New York to San Francisco). The manager might want to see this data not only for American but also for competing airlines, in order to make performance comparisons.

Since 1976, two significant changes have been made. American management found that the limitation to time series data was just too restrictive. So, in addition to the time series data, the database now contains 'transaction' data, for which there is four years worth of monthly data, for all U.S. scheduled carriers. To illustrate, for each city pair and for each scheduled flight between those two cities, monthly statistics are given for passengers carried, revenues, variances in departure and arrival times, and so on.

Secondly, the ability to manipulate data in matrix form has been added. In a sense, a set of time series can be thought of as a matrix, where one of the axes is time. But now 'time' has been removed as a requirement. For instance, the matrix might consist of airlines versus the aircraft types used, and the entries might be flying hours, maintenance costs, or such. Or the matrix might be airline versus city pairs, and the entries might be passengers carried, or revenue, etc.

The AAIMS people say that the matrix capability makes the system easier to use than was the case with just time series data.

American Airlines is offering AAIMS to other companies, in conjunction with the Airline Transport Association and a commercial time sharing service. The current database is oriented to the airline industry, so the current users are related to that industry. But with other databases, the system could be just as useful for other industries.

For a further discussion of AAIMS, see Reference 1c.

***Analysis routines***. As these two cases have illustrated, the analysis of data can be most helpful for supporting management decisions. The analysis routines are often quite general purpose in nature—that is, they can be used equally well by a wide variety of organizations.

These analysis routines include (1) arithmetic operations on data, such as adding or subtracting two time series on a period-by-period basis, (2) calculations on data, such as fitting trend lines, computing ratios, calculating variances, determining correlations, and so on, and (3) eventually even more powerful mathematical methods, such as matrix functions.

There are other types of general purpose analysis routines to consider. Some are accounting routines, for computing pro-forma financial statements in the case of a proposed merger of two organizations, or the separation of one organization into components. Others have to do with examining all records in a specified data file and classifying the records into categories, according to specified criteria. For example, customers may be classified both geographically and by volume of purchases, and then by type of product purchased, for planning a marketing program.

As we see it, here is an area where hardware and software suppliers can offer both products and services of a general purpose nature, for supporting management decisions.

***Decision models***. To the extent that decisions are structured, decision models can be built that either prescribe the 'best' solutions or describe the likely results of alternative decisions. Operations research and management science have dealt largely with the prescriptive type of model, although there has been a lot of work with simulation (descriptive) models.

We do not see decision models being offered to any great extent by hardware or software suppliers as a part of the new computer environment of the early 1980s. The reason for this belief is that the models are too situation-specific. They almost always have to be developed in-house, with heavy participation by the managers who will use them, for them to be accepted. So we think the hardware and software suppliers will see this area as particularly risky.

As far as computer support for management decisions is concerned, then, we see query systems, graphics (particularly color graphics), and analysis routines as being provided by hardware and software suppliers in the not-distant future. These will be offered to encourage user organizations to convert to the new computer environment.

Now let us look at how a manager's informational activities might be supported.

## Informational activities

The informational aspects of the manager's job have to do with receiving information, filtering it, storing it, and disseminating it. As we have discussed in recent issues, the manager is the 'nerve center' of his or her organizational unit. Into this nerve center flows a variety of types of information, from both internal and external sources. The information flows by way of the telephone, mail, scheduled and unscheduled meetings, and tours. We have quoted Mintzberg (Reference 3) to indicate the relative amounts of use of each of these media by the average manager.

A key point made by Mintzberg is that the manager prefers the verbal media, in order to obtain information that is as current as possible. Further, the manager prefers short, pithy messages because of the many demands on his/

her time. The end result is that telephone calls and informal face-to-face conversations (unscheduled meetings) provide the bulk of the information exchange.

However, scheduled meetings are also very important. They are perhaps not too efficient a means of information exchange but they constitute the largest single demand on a manager's time (an average of 59%!).

The reading and answering of written communications (which Mintzberg lumps together as 'mail') is considered a burden by most managers, he says. The main reason seems to be that written communications are not as current as verbal communications. Also, the manager receives a lot of written material that is largely irrelevant to his/her interests. And creating written communications is more difficult than creating verbal messages; it is slower and words must be more carefully chosen.

'Tours of inspection,' made by a manager through his/her organization, are a fairly effective way to gain information about internal activities. But this method is seldom used, says Mintzberg. It is the type of thing that many managers feel they 'ought to do' but never seem to find time to actually do.

With this brief background on the manager's informational activities, let us now look at how computer technology might assist the manager in performing these activities better. There is, in fact, quite a bit that computer technology can do here, and we have discussed user experiences with many of the methods in past reports. So we expect the hardware and software suppliers to see this as an area of great sales opportunity and to begin offering packages of informational services for managers.

***Reduce interruptions.*** Because the manager is so anxious to get current information, says Mintzberg, almost total reliance is placed upon verbal methods for obtaining that information. So a large volume of telephone calls and unscheduled meetings occur during the working day; the two account for 43% of the manager's activities. And, in general, they are quite short in duration; they account for only 16% of the manager's time.

Perhaps the chief negative aspect of telephone calls and unscheduled meetings is that they constitute *interruptions*. Interruptions are the price that the manager must pay to receive the desired information, as long as today's methods are used.

But computer message systems provide a practical solution for exchanging information rapidly but with a great reduction in interruptions. When person A wants to communicate some information to person B, A simply enters (or has entered) the desired message, via a terminal, and asks that it be sent to B's 'mail box.' With very little additional effort, A can also have the message sent to C, D, and so on.

Periodically during the day—and at home in the evening, if desired, or on weekends, or when on a trip—B uses a terminal to access his/her mail box and asks to see a list of messages. The list is displayed, showing the sender, time, and a short title of the contents. B can then ask to see the complete messages in whatever sequence desired. In addition, many message systems provide B with a way to send a reply easily and/or forward the message (and the reply) to others.

Computer message systems *have* been successful in providing fast communications without the interruptions of telephone calls and drop-in, unscheduled meetings. We discussed user experiences with them in our April 1977, September and October 1978, and May 1979 reports.

Two other points should be noted. In our May issue, we discussed how the Continental Illinois National Bank is using automatic telephone answering devices for providing much the same service to managers, using regular telephone technology. And the University of Pennsylvania's DAISY terminal can provide a window which displays the fact that one or more messages are waiting in the manager's mail box.

We have seen no studies on this point, but we believe the manager productivity will increase if interruptions are reduced, but without reducing the flow of information to the manager. In fact, computer message system users report an *increase* in their flow of information—and without a consequent increase of effort on their parts.

Note that telephone calls and unscheduled meetings would not be eliminated by the use of computer message systems; they would only be reduced.

*Reduce scheduled meetings.* Scheduled meetings represent only about 19% of the manager's activities, according to Mintzberg, but they consume almost 60% of his/her working hours. So a reduction in the number and/or duration of such meetings could be beneficial.

There are many reasons for holding scheduled meetings—status reviews, discussion of problems, appointments with visitors, committee meetings (both ad hoc and standing committees), listening to the presentation of reports and proposals, and so on.

Computer technology offers several methods for reducing the number and/or duration of these meetings. For one thing, a computer message system can be used prior to a meeting, to check on the status of preparation for the meeting. If adequate preparation has not been made, or if some key person will be missing, the meeting might better be delayed.

Computer message systems can also be used for 'tele-conferencing,' as we discussed in our April 1977 report. Instead of the manager having to physically attend the meeting, he/she can 'attend' via a terminal. In fact, the whole meeting might be held much like a telephone conference call, where the attendees are at their own terminals. But unlike the telephone method, a record of the conference can be produced as a by-product.

Tele-conferencing is also making use of closed circuit television and facsimile methods.

There are a number of advantages, of course, in scheduled meeeings that tele-conferencing cannot replace. There are the group interactions that occur. Then, too, facial and voice expressions often convey important information that might not be sensed with tele-conferencing. Attendance at scheduled meetings makes the manager unavailable for interruptions. And some of these meetings require travel, which some managers look upon as a fringe benefit.

Even so, we think computer technology can help here.

*Aid the manager's memory.* Since the manager receives most of the information verbally, he/she has to remember much of it. Yes, notes can be taken or dictated, but they capture only part of the information. After receiving the information, the manager must filter it and then disseminate selected portions.

All of these steps are relatively slow and error-prone. So what can computer technology do to help?

*Manager's personal computer files.* As a manager begins to use a computer message system, for sending and receiving messages, and has his/her correspondence prepared on word processing equipment, it becomes practical to think of the manager's personal files. These would include messages sent and received, outgoing correspondence, tickler files, daily schedules, work assignments, and so on. The computer would be used for storing this information, rather than on paper media. And now the manager can access his/her files from home, while on a trip, and so on—if a terminal is available and subject to security access controls, of course.

*Powerful query system.* Having this variety of information in the files is one step; the next step is to provide a powerful means for retrieving it. Earlier in this report, we discussed query systems with 'friendly' user interfaces; such a user interface would be very desirable here. But in addition, we see value in the multiple index approach to storing the manager's files. This would allow the manager to access information in much the same way that the human memory seems to work—that is, get some sort of 'hook' on the information and then pull it out of memory. The manager would be able to retrieve information based on the author, on the approximate date, on the subject, on the name of someone mentioned in the message, and so on.

Initially, managers and/or their secretaries probably will have to manually specify the index terms under which an item is to be indexed. Eventually, this function may be made automatic.

*Improve dissemination.* One-third to one-half of a manager's time is spent with subordinates, according to Mintzberg, mostly receiving and disseminating information. But the manager's memory is fallible, the verbal methods used to receive and send information are slow, and the manager considers written communications as burdensome. So only a portion of the information that the manager should really disseminate to subordinates is actually disseminated. Also, nearby subordinates have advantages over those who are geographically remote. The latter must use written methods to a great extent, and they tend to feel isolated.

Computer message systems and personal files on the computer can aid dissemination. The manager can easily forward copies of messages received to appropriate subordinates. And the geographic location of the subordinates is almost irrelevant; remote subordinates no longer feel so isolated.

Further, as the manager browses through his/her personal files, he/she may see something that should be disseminated. With a computer message system, it is almost a case of "no sooner said than done."

*Aid desk work.* About one-quarter of a manager's time is spent at his/her desk, doing 'paperwork,' but managers tend to dislike paper media for communications, says Mintzberg. Information received via letters and memos has been delayed, and is not as current as the manager desires. Sending information by writing is slower than talking, and the manager must be more careful in his/her choice of words.

Computer technology can help in the preparation of written communications, whether the information is to be sent on paper media or by a computer message system. Word processing systems help in the creation of messages, reports, and so on; additions, deletions, and changes are relatively easy to make. If desired, the messages and documents can be forwarded to colleagues for review, via the computer message system, with no large delay involved. The manager can retrieve information from his/her personal files, to aid in the preparation of the communications. In fact, the manager might access outside bibliographic services for getting information to go into a document or message.

In short, there are many tools for building an EIS that are already commercially available. Others are well along in development, almost ready for commercial use.

As we said in our May issue, computer support for managers is not something for the future. It is already arriving.

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