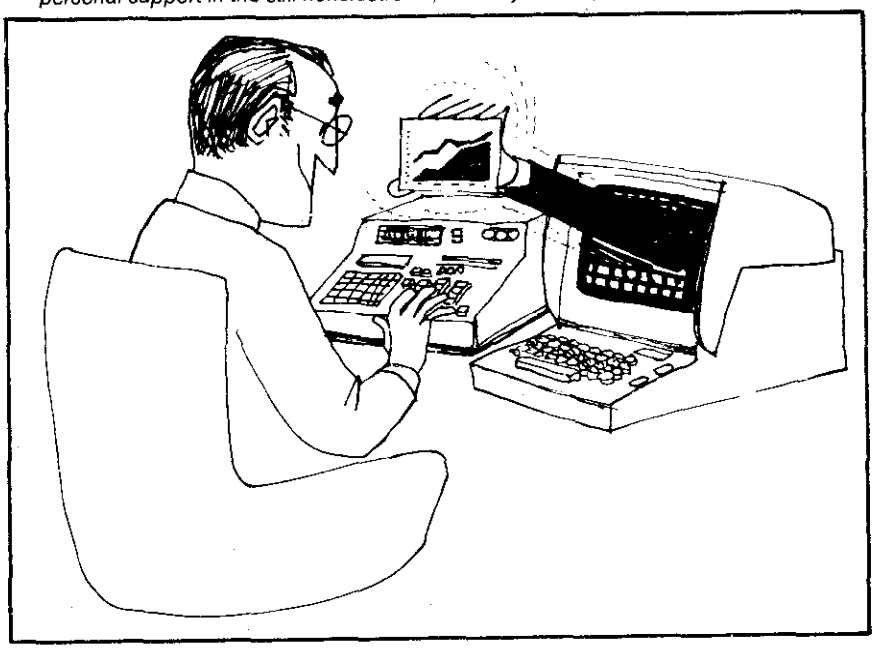
As industry develops new ways to utilize computer technology more effectively, companies are assigning computer terminals to individual managers for direct, personal support in the still nonelectronic, but very human, task of decision making.



Decision Support Systems:
Personal Computing Services for Managers

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Exception reports, models that produce optimal plans or answer what-if questions, and terminals that provide immediate access to current data on operations are among the services that computers provide for management in many organizations. However valuable these services may be, they really do not help a manager solve the unstructured problems typical of the real world of decision making.

Managers seldom rely on computers in making decisions such as

choosing among alternative manpower allocation schemes with qualitative rather than quantitative differences or selecting products that best meet corporate objectives and comply with governmental regulations. In fact, many managers complain that their computer services provide too much information or deliver information in the wrong form (not summarized or buried in the middle of a printout); therefore, they say, the computer really does not help much in decision making.

Even when the information is potentially valuable, the procedures for using today's computers often are so demeaning, complex, or time-consuming that most managers need staff support to make use of the information. Staff support in turn introduces additional costs, time delays, and communication problems that limit the utility of computer systems in supporting managers. In addition, managers normally expect to understand and direct their decision-making support, and understanding and directing today's computer services require too much time and effort for most of them.

A new tool for managers

Recently a number of companies have begun to use computers in new ways to provide direct, personal support for managers. Known as decision support systems (DSS), these new approaches to providing computer services to managers help them retrieve, manipulate, and display information needed for making decisions.

Gould Inc., for example, has combined a large visual display and video terminals with a computer information system. Designed to help managers make comparisons and analyze problems, it instantly prepares tables and charts in response to simple commands. IBM, working with the First National Bank of Chicago, has developed a similar system, which produces graphs and charts in color on a television screen.

Because professional judgments and insights are critical in decision making, a DSS must be designed to support a manager's skills at all stages of decision making—from problem identification to choosing the relevant data to work with, picking the approach to be used in making the decision, and evaluating the alternative courses of action. A DSS must produce information in a form managers understand, when such information is needed, and under their direct control.

Four main components can be incorporated into a DSS to achieve this base of support–

- The first is the ability to present information in ways that are familiar to managers and permit quick analysis of the data being presented. The graphs and charts used in both the Gould system and the Trend Analysis 370 system at First National of Chicago are examples of this feature. Good representations not only stimulate managerial insights and facilitate analysis but also can be used to generate new requests to the computer.

For example, by selecting points on a graph or locations on a map, a manager can request more detailed information. By subdividing a list or reconnecting groups on an organization chart, a manager can indicate a change to be made in the computer's data base.

• Once such representations have been chosen, the second main component comes into play—a set of easy-to-use operations that can be invoked to prepare and transform the representations. Simple commands to select data to be graphed, call up sales figures in a tabular format, or run a model to generate and display possible production schedules are examples of operations. Existing decision support systems use single, meaningful key words or phrases, such as SALES or RUN SCHEDULER, or selections from "menus" of operations as techniques for simplifying the selection of operations. The idea is to use representations and operations that will generate results useful to the manager.

• To save these results and to retain how the results were obtained, a DSS should provide a third component—memory. The memory should act like scratchpaper in developing intermediate results and like a file drawer in retaining results that are useful.

• And to make the representations, operations, and memories useful, the manager must be able to control them. This means letting the manager select or change the colors of a graph, the format of a table, or the place where subtotals appear in a report. Control of operations means letting the manager pick the order in which operations are performed and making it easy to select these operations. Control of memories means letting him decide what is to be saved, when it will be saved, and what names will be used to label the information that is saved. Because most managers are not accustomed to sitting down at a computer terminal, support for control may at first require an intermediary, or "chauffeur," to operate the DSS under the manager's direction.

Another important criterion of the usefulness of decision support systems is ability to be interactive, that is, quick response to commands and easy availability where decisions are made, such as in boardrooms and individual offices. (Gould, for example, uses a large video display in its boardroom and several smaller video terminals in the offices of senior managers.) Responsiveness and availability, combined with representations, operations, memories, and control, give a DSS the scratchpad and information-source capabilities that support the human skills used in decision making.

Technical requirements for a DSS

The development of decision support systems in organizations has been stimulated more by an increasing sophistication in data processing

capabilities and improved computer technology than by a better understanding of decision making. Organizations that are developing systems have experience using computers for record keeping and transaction processing and have staff capable of utilizing recent developments in computer technology. A firm just beginning to rely on computers for record keeping and transaction processing is not likely to have the technology required for a DSS.

Decision support systems require three basic technologies: a computerized data base and data base management system, computer time-sharing support of interactive systems, and video terminals.

- A computerized data base provides the primary source of quantitative information. If a data base is not available, then DSS development will include a substantial data entry cost. The experience of the IBM Research Division in DSS development indicates that data entry costs can exceed the combined costs of DSS development and use.

The data base management system provides the technology for linking the DSS to the data base and for incorporating any other data a manager needs. Again, without an existing data base management system, another substantial cost will be added to DSS development to provide data base management capabilities. (For the DSS developed by IBM Research, about one-third of the implementation cost went to provide data base management.)

- Several facts point to interactive, time-sharing computers as a requirement for DSS development. Decision making is not necessarily a routine or scheduled activity, and computing done by a DSS may not require a large computer. Nonetheless, the DSS will need access to the data base and data base management system—which probably will require a large computer. Also, the DSS should be available when the managers need it and be able to respond in time to help make decisions.

Several decision support systems—American Airlines's AAIMS, for example—use an interactive, time-sharing computer with the programming language APL. Interactive, time-sharing services such as those provided by APL systems are reported to reduce DSS development costs by over 50 percent while increasing the flexibility and convenience of using a DSS.

- Video displays—such as those used by Gould, the Trend Analysis 370 system, and several banks using a DSS marketed by Index Systems, Inc. and used in portfolio management—provide a mechanism for presenting information in a variety of forms (charts, graphs) and are easier to use than other technologies (typewriters, keypunches) that are available for communicating with computers. Decision support systems that have been developed without video displays incur costs (often hidden) for transforming the information produced into a graphic form and for the staff that transforms the manager's requests into a form that can be communicated through the typewriter or

DSS vs. Other Computing Services

Decision support systems incorporate features found in management information systems and in computer simulation and optimization models. Nonetheless, a DSS has a number of distinguishing characteristics that make it different from other computing services for managers. For example:

1. Decision support systems emphasize direct support for managers to enhance the professional judgments required in making decisions. The use of interactive systems and video displays in successful decision support systems are examples of this point. In DSS design, the emphasis is on helping the manager make decisions rather than on actually making decisions for the manager. DSS design also stresses presentation of information in a form that is useful rather than on presenting all the information that might be useful.

2. A DSS should be flexible enough to respond to the changing information needs and decision-making processes that are typical of a manager's job. A DSS should not require that a manager specify exactly what data will be required or what sequences of operations will be useful before the DSS is developed. It should allow the manager to select the relevant information and operations while using the system.

3. Decision support systems are intended to support all phases of decision making, including identifying that a problem exists, generating useful information, selecting a course of action, and explaining that course of action to others. Management information systems typically are used to generate useful information, and a computer-based model may help select a course of action. But such support is of limited value if it cannot be incorporated into the other activities involved in making decisions. In a DSS the representations, memories, and control are intended to help the manager use the information provided by the system's operations; in other systems the operations are available, but there is not much support for using the information they provide.

keypunch device. In DSS with video displays, these costs are eliminated or substantially reduced. And convenience benefits increase because color video equipment makes it easier for a manager to analyze data and permits display of information in ways that are familiar to managers.

Like the familiar cathode ray tube, video displays, moreover, are decreasing in price. A 10-in. (diagonal) video display that can produce black and white charts and tables costs about $5,000. A 19-in. (diagonal) color video display that can produce almost any form of graphic output costs about $100,000. A sophisticated video display system, including a large (7 ft. × 7 ft.) screen may cost over $300,000.

Each of these vital technologies—data base systems, interactive

time-sharing systems, and video displays—is widely available. An organization already using them can expect the cost of developing a DSS to run about $250,000, an estimate based on five man-years (at $50,000 per year) for DSS design and implementation. But if developing a DSS includes installing one or more of these technologies, the costs will climb quickly to a million dollars or more.

How managers use decision support systems

The expense of a DSS is justified only if it can be well used as a management tool. Systems in use today support a variety of decision-making activities. Some perform jobs such as data gathering and formating, tasks that ordinarily consume many hours of staff time, and their value in terms of cost displacement is directly measurable. Some, as indicated previously, are used as a workbench or scratchpad for developing decisions and thus are useful to managers in creating and comparing alternatives, and their value can be expressed in terms of increased management activity. A DSS also may lead to improved decisions through better analysis or investigation of more alternatives, but the contribution of the system to such improvements can be difficult to measure. Thus, the best measure may be the amount that a manager is willing to pay to use a DSS.

Another managerial activity where a DSS is supportive is the explanation or "selling" of a decision. The DSS can show why or how an alternative was chosen, provide a visual representation (such as a portfolio list) of the decision, and help other managers test or modify a decision. The value of the DSS in such activities will be increases in management productivity, plus intangible improvements that are best measured by the willingness to pay.

Two examples illustrate different uses of DSS as a management tool. As part of a four-year joint effort, IBM and First National Bank of Chicago analyzed some of the bank's managerial activities. They found that as much as 90 percent of the time spent in making decisions involved gathering and setting up information for the manager. The bank executives felt that information for analysis was hard to obtain, that information from different sources often was conflicting, and that not enough time was available for analysis.

The joint effort produced an information system that helps the bank's managers analyze asset and liability positions, decide on loan portfolios and interest rates, and check indicators of bank performance with respect to competitors. A variety of other uses also are anticipated. Through a video display, information can be called up in seconds in tabular form or on colored graphs or charts; a variety of other uses is anticipated. Although the bank and IBM have not released the cost/benefit data on this DSS, both companies are convinced of its value. Bank personnel give examples of cases where use of the DSS reduced the cost of providing information to decision makers by over $100,000.

Another DSS developed by IBM and used for the past five years by a number of organizations helps managers analyze and display data that can be related to a geographic location. Customer data, market surveys, and land characteristics are examples of the type of geographically related data that can be reached via this system. Called the Geo-Data Analysis and Display System (GADS), it has been used to make decisions such as allocating police manpower, setting school attendance boundaries, making territory assignments for repairmen, evaluating urban zoning, and planning equipment for fire stations.

Managers use a video display to select relevant data from the computer's data base, draw maps and graphs, compile lists, and manipulate the maps, graphs, and lists to help arrive at a decision. For example, a customer-service manager can use the DSS to display a map showing the location and equipment inventory of customers, to subdivide the map into territories for each service engineer, to draw a graph of the distribution of workload by territory, and to project the future workload by territory.

The system often is used by groups of managers to develop decisions together. It also is used by staff personnel to prepare information for managers. In six recent applications, users paid between $3,000 and $10,000 to cover the operating costs of GADS, and managers estimated that, for these applications, the cost of obtaining the same services from a consultant or from staff support would total $20,000 or more.

A key factor that makes both these systems useful tools is that they can be used directly by managers. Whether or not the manager directly operates the terminal or uses a staff chauffeur depends on the individual's style. What is important is that the DSS can provide information when it is needed in a form that the manager can understand and at an acceptable cost.

The future of DSS

Until recently decision support systems have been of interest primarily to academic and industrial research and development groups. Organizations using DSS tend to be large, with substantial experience and investment in computers. But as computer technology for DSS becomes cheaper and more available, a broader-based interest in DSS can be expected.

The rapidly decreasing costs of computer storage and improvements in data entry and data management systems make it increasingly likely that much or all of the information a manager needs to reach a decision will be stored in a computer, making decision support systems a necessary aid for managers. Without a DSS a manager will need other support to access information stored in the computer and to manipulate and transform it into understandable form.

Personnel costs already exceed 50 percent of most data processing budgets. Also, hidden personnel costs—such as programmers employed as management staff analysts, a manager's time spent trying to communicate his

information needs to the data processing department, or personnel used for making slides or charts from data on a computer printout—may exceed the direct labor costs of data processing.

Indications are that a DSS can reduce personnel costs of providing information for managers; in the future this reduction alone should be enough to justify DSS along with improved management productivity and perhaps even improved decisions that may result from increased use of decision support systems. More experience and better methods for measuring the impact of support systems on decision making are needed, however, before claims of such improvements can be fully justified.

Further developments in computer technology will not be enough to ensure the success of DSS. Technology still must be assembled into systems that are compatible with managerial styles and provide support that managers feel is valuable; decision support systems will have to fit into an environment where the relevant data and decision-making processes cannot be specified in advance; and they must be available even when not used on a routine basis. A DSS also should be able to support decisions where compromise or time constraints may be more important factors in reaching a decision than optimal solutions or standard operating procedures.

Achieving these goals will require new ways of using computer technology, uses that are different from how technology has been used previously in management information systems or computer-based models. But because only managers know what representations, operations, memories, and methods of control fit their styles of decision making, management involvement will be more important than computer technology in developing useful decision support systems.

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