ADMINISTRATIVE MANAGEMENT INFORMATION SYSTEMS

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I have arranged my discussion of administrative management information systems to fit problem-solving processes of (a) gathering the facts, (b) defining the problem, (c) developing alternatives, and (d) making recommendations.

GATHERING THE FACTS

The purpose of an information system is to provide information needed by the user for the conduct of his business. The administrative management information system is an information system that provides the manager with information that he needs to make decisions concerning the internal operations of his organization. Administrative activities are those activities required to operate an organization. Administrative personnel consists of a chief executive officer and all other personnel who supervises one or more employees. The management process consists of four basic steps: (a) planning, (b) organizing, (c) directing, and (d) controlling.

This paper deals with those activities that relate to an organization's internal performance and production capabilities. These activities are (a) personnel and payroll, (b) budgeting and accounting, and (c) data processing and other centralized or standard services such as purchasing. All of these activities can be automated, but before automation is considered, management must make sure that its present administrative information system is reasonably clean and effective.

The term information system is of recent origin, although the news media have long collected information for popular dissemination. Business and government have processed quantitative data for inventory and production control, billing, and accounts receivable, and innumerable other applications. Only recently, however, has it been possible to pull together both quantitative and nonnumeric data into a single integrated system serving many applications at one time. This is the result of two trends: increasing use of computers and increasing need for computerization of documentary data. These trends result from the limitations of precomputer data processing.

Data processing by hand or by electric accounting machine can solve small independent problems involving only numeric data. The problems must be small because the processor has a small memory. Any data common to two problems can only be stored in the processor's memory at the expense of active storage for each problem. The problems must be numeric because the processor functions are limited to arithmetic operations. These problems are essentially all transaction-oriented; that is, the same set of operations is used on each transaction in the input stream.

Given this capability, uses were developed that made execllent economic sense. Work such as preparation of payrolls, cost accounting, and invoicing can be done one transaction at a time with practically no reference to a backup file. Thus, the data processing industry thrived by selling unit record equipment to the chief financial officer.

The unit record itself strongly influenced the type of data processing done on accounting machines and early computers. The unit record, typically an 80-column card, contains fixed-length fields in predetermined card columns. Space can be conserved by using code numbers rather than written information. Consequently, the computer era opened in an environment in which all information was represented as numeric codes in fixed positions within a fixed length unit record. For several years, computer applications were just bigger and better accounting machine applications. Then, as

computer storage costs decreased, designers began to use storage as a bridge between applications within a functional area. Within the personnel area, for instance, all employee data were gathered into a single file that was used for payroll, home address listings, organization directories, and vacation records. Historical data, conversion tables, cross-reference tables, and results of completed programs were stored for later use by other programs. The data were still mostly numeric and the fields were of fixed length, but the integrated systems began to include records of varying length. Processing was still transaction-oriented in that each transaction usually affected only one record in the file.

Although this trend modified the character of data processing, the information explosion was generating a requirement for nonnumeric processing of library books and catalogs, legislation, and foreign languages. The key feature of nonnumeric processing was the dominance of alphabetic data—ordinary words and phrases. A simple library system would provide a list of documents that would stisfy the request of a user.

The users of nonnumeric systems had requirements for very long alphanumeric records. Some of the records were formatted as were unit records, but the fields were not all of predetermined length. As a means for coping with this, the formatted file concept was developed. It had the ability to handle records of variable length by referring to a data definition that described the permissible record contents, context, and internal structure.

The early practitioners of nonnumeric processing were the only ones to describe their work as information systems. They soon recognized, however, that the information system was, in fact, a more general case of integrated data processing. This recognition relaxed the constraints on both data structure and language that had been taken for granted. It also gave promise of applying computers to areas of business planning, operation, and management that had been ignored because they were not easily quantifiable. As a result, computers and information systems are now understood well enough to be utilized in the management process effectively. We must now search out administrative activities that can benefit from use of these tools.

Within the scope of fact gathering, we must define nontechnical limitations within which administration activities can be automated. We must understand the organizational or governmental agency. We must understand that most highway agencies operate within, or potentially within, a department of transportation, which in turn operates within a state government that may have a statewide department of administration. The fact is that most state agencies operate within a hierarchy of administrative services. We must find out who performs these services so that we can get needed information for the decision-making process.

Assume the following hypothetical set of jurisdictional facts: There are statewide payroll and accounting systems but no statewide or agency automated personnel system. Each agency is responsible for preparing its own budget and its supporting facts. There are separate statewide and agency computer services. In this example, if we want automated personnel or budget information, we must develop the systems ourselves. If this is desired, we would use our own computer to support these automated-information applications. We would have to cooperate with, and solicit from, a higher level organization to get the information our agency needs for other administrative decision-making. In general, any agency that has the data-gathering responsibility for a small number of information categories (regardless of the number of data elements in the categories) is likely to find it easier to instrument an information system than will the agency responsible for many interacting information categories.

An information system uses a centralized data base for all its tasks. The data in the data base must be valid and current. The procedure for ensuring this and for guaranteeing that only one current copy of each file exists must be carefully planned and executed. This is a difficult and time-consuming task that should not be duplicated. It is a good rule to let the high-level organization be responsible for maintaining the data base. What is needed are information reports that give everybody a common base from which to make decisions.

The task of gathering the facts for designing an information system for an organization can be approached in one of three ways:

1. Identify, define, and lay out the classical administrative and management functions that should apply based on "textbook" knowledge;
2. Study the functions performed in the organization and automate them; or
3. Study the information flow of the organization and build a system that brings the basic information together and makes it accessible to all functional groups.

In general, the third approach is the most fruitful. The first method is weak because it ignores the "personality" of the organization; it is impossible to mold the organization to fit the textbook, and it is generally impractical to fit the generalizations of the textbook to the specifics of the business. The second method is practical but weak because it tends simply to speed up the way the business has operated. If the business is not well suited to data processing automation, the technique will fail. This approach can usually be justified if the work load outstrips the capability of manual methods. However, the system is generally unsuccessful if it merely increases the fixed cost of data processing without actually improving the process. The third method, on the other hand, takes advantage of the fact that the business organization is the creation of the information that flows through it.

What information is needed to perform the management function? First, we must identify the information flow. It is here that value-judgment decisions must be made by administrative staffs. This step is best shown by listing a few questions that management may ask. These lists identify how management will use the information for analysis prior to making a value judgment. For example, the following series of questions may be important.

1. How many dollars of bonding revenues are planned for expenditure in the next year?
2. How many dollars of the last bond issue have we spent?
3. How many dollars must be offered for the next bond issuance?

By using answers to such questions, the systems analysts can design reports that identify the necessary data elements, select the source of data, and define the necessary information flow. The design includes a set of specifications for the information system that describes exactly how the system will be built to meet the objectives established for it by management. The specification is a document that includes a flow chart of the information paths in the organization, a picture of the data bases on which the system depends, and a description of the data-processing functions to be included in the system. After thorough review and approval by management, the specification will also include detailed designs for each separate module of the information system, complete operating procedures for the personnel who will use the system, a test plan to verify that the system works as planned, and resource plans that show the cost, manpower, schedule, and milestones for the project.

The project should be phased from milestone to milestone in order to permit management to maintain control of the process and to measure progress against the plan. A milestone is more than just a date on the calendar; it is a date on which a specific scope of work is to be accomplished and on which a management decision is required. The purpose of the milestone is to force management to look at the plan and decide whether to proceed without modification or to adjust the plan to fit the situation.

Management must be involved in every stage of the plan. This is absolutely essential to the success of the information system because it is a system to serve management, and no one but management itself can represent management's requirements. Technical personnel should be trusted to design a system properly to meet management requirements, but they should never be trusted (or empowered) to establish capability needs. Suffice it to say that an information system should satisfy the needs of the people who set the requirements for it.

DEFINING THE PROBLEM

Problems concerning the availability of existing data, the source of new data, and the timeliness of data must be searched out and clearly defined. Quite frequently a problem does not exist. Consultation with an analyst should be the first step in determining the existence of a problem. If data are not available in agency files, but are available in the statewide files, a problem does not exist. It may involve work and cooperation to get those data in the appropriate format and language, but it is not a problem that justifies gathering the data in a duplicate manner.

A manual function should never be automated without a long period of dual operation. When in doubt, discontinue use of automation. Do not stop the manual system until the "nonexperts" in the organization think that automation is better. Some problems can be identified by answering the following general questions:

1. Does the agency need improved personnel information reporting?
2. Does the agency need an improved payroll system?
3. Does the agency need improved budgetary information reporting? Does the budgetary information match the accounting method? Is there a need for manpower planning reports separate from personnel reports?
4. Does the agency need improved accounting information reports? Must the agency develop a supplemental accounting system to get the financial data needed (a) to manage construction contracts or (b) to manage highway maintenance programs? Must the agency develop a supplemental accounting system to satisfy the accounting specifications of the Federal Highway Administration? How many accounting methods must the agency maintain?
5. Does the agency need improved purchasing information reports? Does the agency need a supplemental physical property inventory system? Does the agency's accounting system provide adequate purchasing information?
6. Does the agency need improved financial management reports for business activities operating within one agency? Is the computer installation provided with adequate financial and product management reporting? Is the vehicle fleet installation provided with adequate financial and service management reporting? Are all business activities provided with financial and product management reporting?

DEVELOPING ALTERNATIVES

When the problems have been defined by comparing existing data and information with the actual needs of the manager, the next step is to define alternatives. Compatible procedures and systems are necessary. As a base for developing alternatives, I use three levels of data processing system design: (a) the simple system, (b) the integrated system, and (c) the management information system.

The simple data processing system consists of a large number of independent transaction-oriented tasks that summarize inputs to produce reports. The user in this case is supposed to be the chief executive of the organization, and he may actually receive the reports himself. After seeing the volume of data contained in the reports, however, he usually sends them down the line until they reach clerks who are assigned to analyze them and prepare a summary of the significant aspects. The analysis passes back up the line until it reaches the chief executive in the form of a briefing by his staff managers referring to handwritten notes. Several points are clear:

1. The system serves the clerk not the executive;
2. The system does not generate the information needed by management;
3. The system permits data interpretation at such a low level that distortion is possible; and
4. The information that finally reaches top management has been filtered by several people according to their concept of management needs and not according to a rigorous statement of management's needs.

This type of data system is valuable and very satisfactory when it is meant to support the clerical worker as in a billing operation. When the system is meant to support management decisions, it will be both frustrating and inadequate.

The simple data processing system is limited to the manipulation of single elements of data. Its output is in the form of status reports on each element. The simple system looks at each part; it does not recognize the whole.

Integrated data processing attempts to show how various elements are related to each other. It structures its contents so that facts can be extracted according to many different criteria. The ability to answer series of questions, as discussed earlier, is typical of an information retrieval system based on the availiability of a structured data base into which a considerable amount of data about each administrative activity has been integrated. An integrated data system provides for a single transaction to update several files and thus be available for personnel, payroll, budgeting, and accounting information.

The major problem of building an integrated data system is its cost. The high cost of the system is due to the need for a thorough understanding of all the interrelationships that exist in the organization. Most operations get along adequately without this information, and it is very time-consuming to obtain it. The cost is also affected by the need for new procedures to ensure that all the data needed to update the files are properly acquired and submitted. It is no longer possible for one department to establish and operate its own data processing job; this task now involves the joint effort of virtually all segments of an organization.

Are the benefits to be accrued from an integrated system worth the effort needed to establish it? The answer to that question depends on the nature of the organization involved. In general, the larger the business and the more aggressive is its growth plan (or the more critical its performance objectives in the case of government agencies), the more valuable is the integrated data system. This is also the case with decentralized organizations with multiple geographical facilities.

In those organizations where an integrated system exists, the potential savings due to the improved knowledge of business affairs and the improved ability to bring together diverse facts needed to answer questions are thought to pay for the system many times over. However, this cannot be substantiated because of the dearth of actual data on the financial benefits of such systems. The trend, however, is in the direction of increased use of integrated systems, particularly among those organizations that have been using computers for a number of years. The reason is that these organizations anticipate a number of use-integrated systems for advanced planning and decision-making. This means they are looking forward to having a management information system in 5 to 10 years.

The management information system is the culmination of the lower levels of information handling capability. It possesses all the capabilities of the simple data processing system, the integrated system, and the information retrieval system. In addition, it is characterized by additional programs that permit the user to perform a wide variety of "scientific" management algorithms. The ability to apply these algorithms at opportune times has great value to management.

An integrated system for a highway department could combine, for example, data on soils with data on road inventory and construction unit price, which could be used to help define project priorities. These projects could be manipulated by management algorithms to create a program of projects. This program would enter the budgeting system and through the use of algorithms and combinations of personnel, payroll, and accounting data generate an operating budget, with alternatives.

The main difference between an integrated system and a management information system is that the information system not only permits analysis of historical data but also permits the simulation and prediction of the results of alternative courses of action. An integrated system may provide reports on relationships that management did not realize were significant. In any case, the information system should be responsible to management's changing needs for information. It should direct output data to the right level of the organization and not bother upper management with data that are not relevant to its needs. It should keep track of trends in the data it is processing so that it can give warning when the existing algorithms are becoming obsolete and should be reanalyzed and, perhaps, replaced.

Because managers want different data at different times, the information system should be easy to change with respect to the data it contains and the programs it can execute. In some cases, the convenience of access to the data is all-important; accordingly, the information system should permit direct inquiry from terminals in the manager's offices. The information system should be able to do all these things efficiently and economically while still producing all the reports and documents needed at lower levels for the routine conduct of the business. The difficulty of accomplishing these things is the main reason why true management information systems are hard to find in practice.

An integrated system with integrated manual procedures is a logical and desirable first step because it shows the normal flow of information among the administrative activities. The budget system feeds data to the personnel system and sets up the accounting methods; the personnel system feeds the payroll system; the payroll system feeds the accounting system; and the accounting system receives all management data and returns its information to other systems, especially the business systems.

This information flow must be compared and designed according to the agency responsible for providing the data, maintaining the data, and generating the information. If new data are needed, these responsibilities are established separately for each requirement. When the information flow is designed, the defined problems should be ranked in priority order. When ranking is complete, the problem should be grouped into areas of output information for which new and separate systems could be developed. Then, based on an economic evaluation as well as on a technical analysis, a single system could be selected that, if developed, could produce a benefit in terms of improved management.

The implementation plan should include handling input, file organization, communication with the system (retrieval), on-line considerations, graphics, and classes of users.

RECOMMENDATIONS

The question has been raised whether it is feasible to build an administrative management information system. Certainly, the capabilities exist for information systems that do all sorts of functions such as information retrieval, manipulation, report preparation, and display. Is it possible to build such an information system? Perhaps it is not.

What more is needed to make existing information capability qualify as an administive management information system? The information system needs foreknowledge of what decisions will have to be made. Without that it is impossible to know whether the output of the information system is going to produce the information the manager needs to make the decisions. The manager's job is to make decisions under conditions of uncertainty. Whenever a situation occurs often enough that a procedure can be developed to handle it, it becomes routine and no longer requires management decisions. Thus, the manager is always dealing with problems that are new. He must acquire all the information that appears to be relevant to the situation, fill in the gaps by drawing on his experience and his intuition, and use his judgment to make what appears to be the right decision. The odds that he will make the right decision all the time are poor; however, if he makes the wrong decision, he usually has an opportunity to correct it. Over a period of time, he can gradually determine the right solution and add it to his experience file.

Because this cycle is typical of all managers, managers do not know what information they need to do their jobs. They may think that the same data can be used to solve many problems, and they may be right. Invariably, though, they will also need data that they never had occasion to use before. The information, which is a measure of the uncertainty in the environment, cannot be foreseen and cannot be provided by the information system. Enlightened managers will realize this and insist that their information specialists maintain a high degree of flexibility to respond to management's requirements.

The proper way to develop an information system that helps the manager is to build it in increments. The first step is to integrate the data that have been used in the past and test them to see how well they work as a management aid. During the evaluation,

those things that do not work well will show the designers what to change in the basic system. The next phase can incorporate improvements and delete items that are irrelevant.

Each phase comes closer to satisfying the current needs of management, partly by making the interaction between the manager and the system more comfortable and partly by making the information output more relevant. This system is effective also because it establishes a feedback loop between the decision-makers and the information system. Each makes incremental changes in its behavior so that the two together improve the decision-making process. The design of an information system that can grow under these circumstances is difficult, but it can be done.

The principal information that the chief executive needs is information that helps him to prepare and support his organization budget. This requires a type of integrated budgeting and accounting information system. This can be expanded, over time, to include personnel and payroll, and it can be linked to the goal and objectives process of planning and its socioeconomic data base and analyses.

As long as the chief executive bases his decisions on emotion as much as on fact, he will never find the output of a data processor adequate to his decision-making needs. Is a management information system feasible? In these terms, the answer is no because the system never provides more than a portion of the information the manager needs and, in fact, never provides enough information to make the decision. If it did, the machine could make the decisions.

In summary, what I have really been demonstrating is that, no matter how sophisticated data processing skills become, men, not machines, will be making the decisions.