Developing Strategic Information Systems

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INFORMATION SYSTEMS AS STRATEGIC TOOLS

Strategic information systems are systems that serve the information needs of upper management. They can be computer based or manual, and formal or informal. It is generally accepted that executive management performs functions different from those of middle or lower levels of management, for example, in crafting long-range strategies and in providing corporate-wide leadership, in making decisions and in resolving problems, and in serving as the primary communications link with the external environment. The information needs of executive management are different from those of other management levels. Consequently, strategic information systems (SISs) have characteristics different from those of management control or operational-level systems. These differences are evident in the data used by the system and in the functions performed.

SISs tend to use data on activities external to the firm. The data is highly aggregated with a current or future time frame. Other information systems generally use data about internal activities that is detailed and that pertains to past events. SISs are flexible systems that are designed to change easily. They often contain models that can be manipulated interactively by an analyst, and they provide analytic procedures that can be called upon as needed until the analyst and the client are satisfied with the result. Other information systems tend to be more rigid in their operation, with predetermined procedures and outputs. These systems are concerned primarily with the transformation of data from one form to another in ways that have already been decided upon by the system designer. Finally, SISs differ from other systems in their scale. SISs often operate on relatively small data bases, and they have one or, at most, a few users. In contrast, the firm's operational systems are often massive, with extremely large files (e.g., 5 million policy holders) and thousands of users.

While there has been some reference to decision-making systems in the literature, most strategic information systems provide assistance in some aspect of the decision process rather than actually recommending or making a decision. Most systems are limited to delivering information on a wide range of subjects necessary for planning, to assisting in the exploration and evaluation of alternative courses of action, and to provide structure for the planning process. This situation is due largely to a lack of knowledge about what executives actually do and how they do it. In all likelihood, because of the ever-changing nature of top management work and its fragmentation, verbal nature, and political essence, most of these activities are probably not amenable to heavy computer support.

Information systems and computer or communications technology can contribute to strategic activities in four ways. First, this technology has the potential of refining the planning process by the use of improved data sources and analytic methods in forecasting and evaluation. Second, a firm's internal information systems are the source of targets used to measure current operational performance. Knowledge about current performance is needed to establish a base from which strategic moves can be made. The ability to implement a new strategic information system successfully rests on an objective assessment of the strengths and weaknesses of the firm's data processing capabilities.

Third, information systems may be used to reduce the cost of current products or to improve the delivery of services, thereby obtaining a competitive advantage. Finally, information system technology may present opportunities for opening new markets through the development of novel products or services.

The importance of SISs to a firm largely depends on the nature of the firm's business and on its industry structure and its size. Firms engaged in dynamic industries with high rates of technological change frequently need more information about their environment than firms in more stagnant industries. Dynamic industries are characterized by emerging scientific knowledge, unstable markets, and a variety of customer needs that make the dominant competitive issue the ability to innovate.[1] Information about these factors contributes to innovation by expanding the number of options considered by decision makers and by improving decision quality. In a similar way, companies that must respond to the moves made by a price or product leader need information about what that leader is doing, as well as general economic forecasts, in order to devise a counter-strategy.

In more static industries, with mature technology, stable markets, and stable competitive dynamics, knowledge about the environment is less important. A competitor's moves can be more easily anticipated; thus, factors influencing the timing of major moves are more likely to be internal to the firm rather than external. However, even firms in static industries must be aware of general economic conditions in order to adjust plant capacity and production schedules to demand and to technological change that might lead to competitive or market unstability.

Large organizations need strategic information systems more than small ones because their planning process involves gathering data from a wide variety of external and internal sources and communicating this information to a relatively large number of players. Strategic information systems provide one strategy for accomplishing this coordination.

It should not be presumed that the use of some form of computer or communication technology in some strategic activity will, in and of itself, ensure an improvement in that activity. As with all organizational change, the use of technology must be well-conceived and properly implemented and managed. Under these conditions, technology has the potential that is discussed in this chapter.

DATA FOR STRATEGIC PLANNING

The quality of strategic decision making is often determined by the data upon which these analyses are based. There are two broad categories of data used in strategic information systems: internal data about one's own firm and products; and external data describing the industry, competitors, and the general economy.

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[1] For a more detailed discussion of environmental uncertainty see P.R. Lawrence and J.W. Lorsch, *Organization and Environment* (Homewood, Ill.: Richard D. Irwin, Inc., 1969).

Internal Data

One important source of data is the company's own operational information systems. (See Figure 21-1 on pages 21-6 and 21-7.) These include: (1) production, consisting of scheduling, work in process, job costing, and labor distribution; (2) logistics, involving inventory control and forecasting, purchasing, receiving, and distribution; (3) sales and order filling; (4) general accounting, including accounts receivable, accounts payable, cash receipts, check writing and reconciliation, and invoicing; (5) payroll; and (6) personnel. These systems provide inputs to management control systems consisting of: (1) budgeting, (2) general ledger, (3) fixed assets and depreciation, (4) financial statements, (5) project control, (6) sales analysis, and (7) profit analysis.

Gaps in these systems may result in a lack of information about the current status of a particular activity. This, in turn, may cause a decision to be made to adopt a particular strategy based on a presumption that later proves incorrect. If this presumption is central to the selection of the strategy, it may result in an incorrect selection, with unfortunate consequences. Furthermore, the significance of much internal information for strategic purposes may not be apparent without additional data from sources external to the firm.

External Data

Because of the broad nature of questions that are considered at executive levels of an organization and the long time horizons involved, most data pertains to factors external to the organization, such as data on sales of competitors' products, product demand, the costs and availability of raw materials, and the economy. Historical and forecast data is needed as well as current data. The purpose of analyzing this data is to recognize strategic opportunities that may exist in a market, as well as to detect threats to the firm's established lines of business. Market data of this type is often collected and distributed by private firms (for a fee), by an industry association, or, sometimes, by the government (e.g., the Bureau of Labor Statistics). It is not unusual for a firm to commission a market research study involving surveys of respondents or laboratory experiments to determine demand for or acceptance of a product. The firms that provide this data and related services are called data bank publishers.

Characteristics of External Data. While executives are familiar with buying data in printed form (e.g., consolidated airline schedules and catalogues), a whole new industry has emerged to serve the data needs of business and government. The products provided by this industry are varied; they involve the following factors:

- *Product content:* Products can be as small as a single piece of data, such as the credit rating for an individual, or as large as the complete profitability analysis of a new product.
- *Product format:* Products may be printed, such as a directory or guide, or they may be provided on demand at a computer terminal at the customer's site, using a public or private network.

- *Standardization:* Products can be standard in sense that the programming required to search the data bank has already been accomplished, or, they can be customized, requiring a new program to be written or a new analysis performed.

Printed directories are attractive when (1) the data do not change frequently, (2) access to the data is needed at only a few locations, and (3) only a few data elements need be considered. Computer terminal access is called for (1) when the data is volatile and a computer is used to update the data bank frequently (distribution is required only when a data element is used), (2) when the data is needed at many locations, since it can be distributed over a computer network, and (3) when there is a great deal of data.

Categories of External Data. There are several hundred organizations–private companies, government agencies, or not-for-profit groups–that function as data bank publishers, providing data, analyses, or related services. The market is divided into the following broad categories:[2]

- Business and Finance
  - a. Econometric statistics and modeling
  - b. Stock, bond, and commodity prices
  - c. Corporate statistics and news
- Marketing
  - a. Consumer credit
  - b. Business credit
  - c. Marketing and demographic statistics
    - –Surveys
    - –Forecasts
- Bibliographic
  - a. General news abstracts
  - b. Scientific and technical abstracts
  - c. Legal
  - d. Library

Business and finance subject areas involve the planning tools for economic analysis and strategic planning, security and commodity price and volume data, and general corporate news for buy/sell decisions and for portfolio evaluation. Marketing areas consist of individual and business credit ratings, customer location, and estimated demand for different types of products. Surveys provide information on current patterns and forecasts that indicate future trends. Bibliographic uses include abstracted articles from newspapers and magazines; summaries of technical writings; statutes, decisions, administrative rulings, trademarks, and patents; and filing and cataloging of library material.

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[2] For a more detailed description see Darrow and Belilove, "The Growth of Data Bank Sharing," *Harvard Business Review* (Nov.-Dec. 1978).

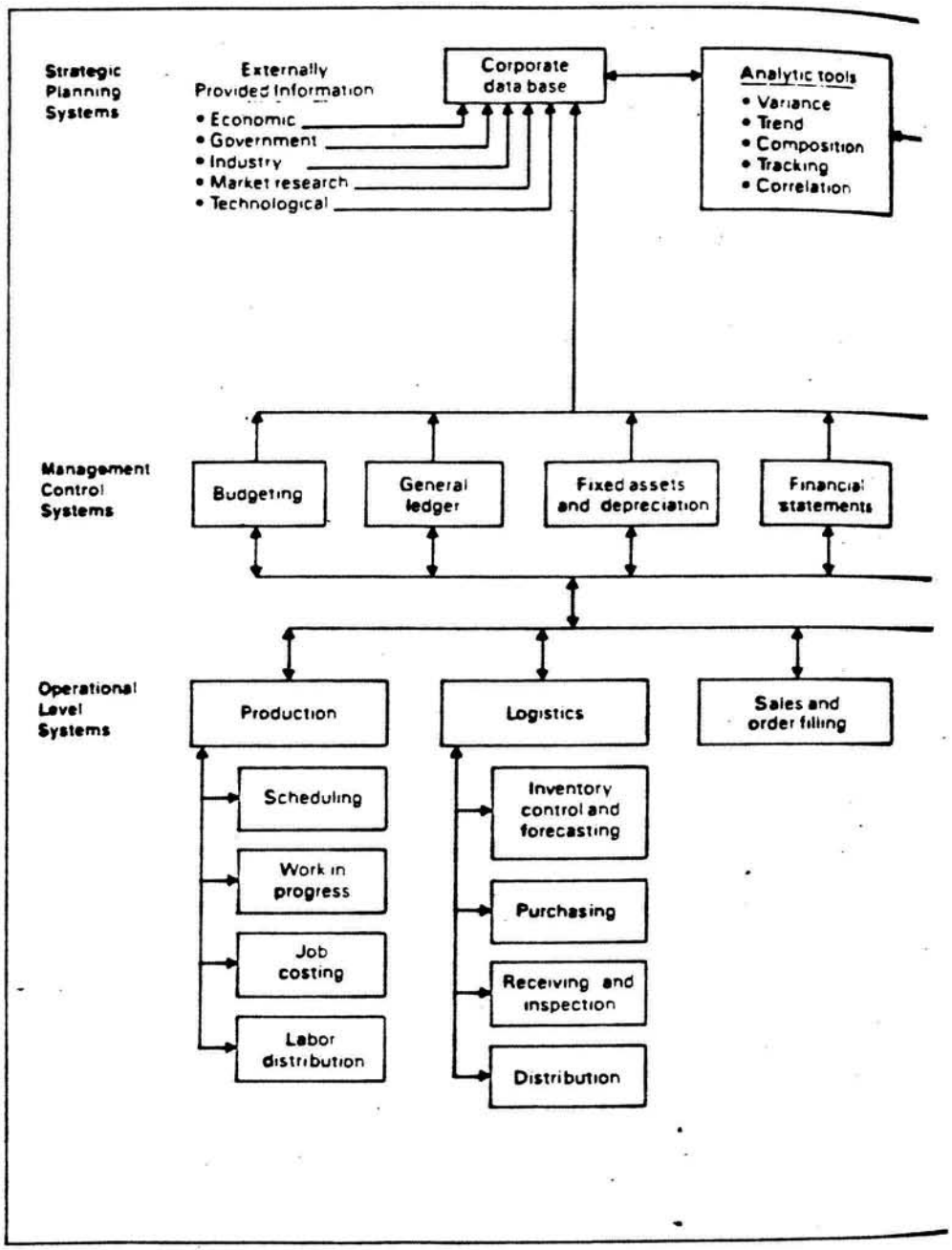
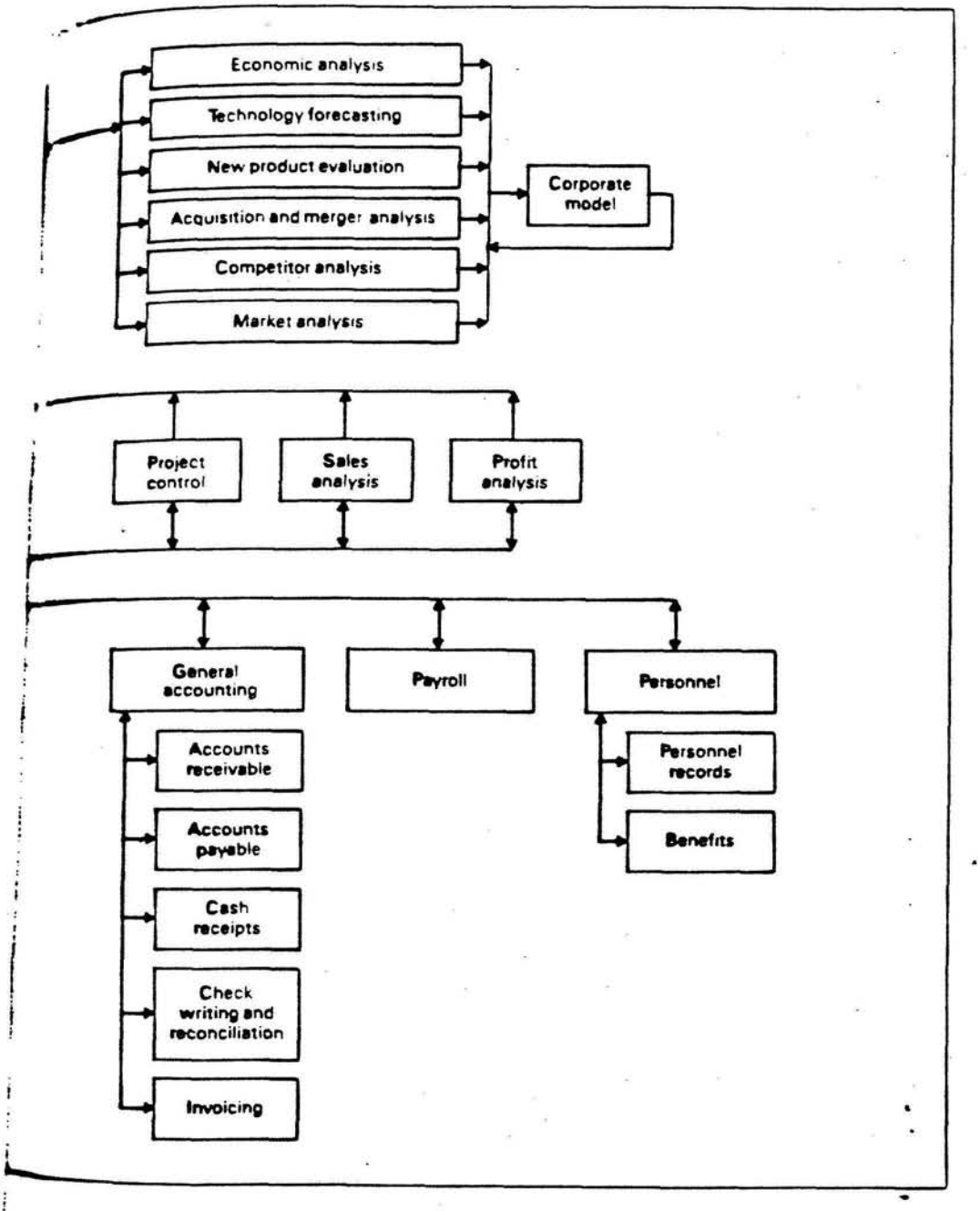


FIG. 21-1 The Information System Structure of a Typical Manufacturing Company



External Data Production. Data bank products are divided roughly into the following phases of production:

- *Collection:* the gathering of raw data from records of public corporations, banks, utilities, industry associations, government agencies, newspapers, magazines, technical journals, reports, and the judicial system;
- *Organization:* data bank creation and development of the computer software needed to access the data and to manipulate it;
- *Dissemination:* distribution of the data bank and associated analytic programs to customers; and
- *Liaison:* professional help to clients in using data banks and associated information tools.

Collection involves capturing the raw data from sources and translating it to printed, microfilm, or machine-readable form.[3] An example of machine-readable unedited raw data is the Federal Reserve Board's monetary statistics, which are provided on magnetic tape. Organization consists of coding the data, verifying its correctness, correcting errors, revising the data when changes are made, aggregating the data into meaningful categories, abstracting, indexing, and cross-indexing. For example, Abstracted Business Information is a weekly mailing of abstracts on 100 specialized topics. Some publishers also provide exception reporting, for example, informing a client when the credit rating of a particular company changes.

Computer networks permit on-line access to data banks, such as the New York Times Information Bank or the National Library of Medicine MEDLINE system of medical literature abstracts. Customers use searching, analytical, and editing software to obtain the desired information. Knowledge of the contents and structure of the data bank as well as the specifics of the software are usually required, or charges become prohibitive. The distinction between services at the organization level and at the dissemination level is that at the organization level, the customer deals through a central service group, while at the dissemination level, the tools are available directly to the customer through a distribution network.

Liaison services provide experts to perform special studies, usually involving small amounts of data from many sources.

Data bank publishers may provide services in one or all phases of production, but they usually limit their activities to one or a few data categories.

Cost of External Data Services. Various financial arrangements can be made to obtain access to the information contained in a data bank. These include: (1) outright purchase, (2) rental, (3) subscription, (4) one-time usage fee, (5) cost on a per-datum basis, and (6) surcharges on a time-sharing bill. The choice of method depends on (1) the amount of data needed, and (2) the fre-

[3] Machine-readable form is data on a medium that can be directly read by a computer peripheral device, e.g., magnetic tape that can be read by a tape drive, and encoded in the proper format so that it can be interpreted by a computer program.

quency with which the request will be made. Purchase and rental are suggested when the amount of data is large and the usage frequency is high; one-time and per-datum charges are good approaches when small amounts of data are needed infrequently, or when a company is engaged in an initial exploration.

Rough estimates of what a customer might expect to pay for typical products are:

- Single datum or small set of related data: $0.01–0.50;
- Report requiring no new computer programming: $5.00–250;
- Report requiring new computer programming: $100–2,500 and up; and
- Complete data bank with one year's updates: $200–10,000.

The "make or buy" decision applies to using data bank services. A firm has a choice between gathering the data itself and constructing its own data bank or purchasing the data from a publisher. Creating a data bank is suggested when (1) the data is proprietary and valuable; (2) the organization expects to make such extensive use of the data bank that the cost of using an outside publisher would be prohibitive; (3) the internal staff has the necessary expertise to organize the data bank and develop the computer software; (4) the data base is small enough to be tractable; and (5) the contents of the data base may be marketable to others. Buying is recommended when (1) the data bank is available from a publisher; (2) the data bank will be large and the data will be difficult to collect; (3) the data requires frequent expert updating; (4) the data is needed only on a periodic basis; and (5) there is no undue risk in relying on outside services.

Issues

Internal Organization. A firm just starting out purchasing services from a data bank should designate a person, or a unit, to have primary responsibility for liaison with publishers. This is a specialty area that requires knowledge of the data and analytic procedures that are available and their costs, capabilities, and limitations. Publishers have no incentive (except their honesty) to point out deficiencies in their data or analytic procedures. Over time, a group within the firm should learn about the various publishers in sufficient detail to advise other members of the firm.

Initially, data bank usage should be controlled centrally. The major problem to be faced is coordination of products among potential users and encouraging them rather than restricting or controlling usage. Frequently, internal users do not know how much information is available; a centralized service unit can help disseminate information about the data bank market. If necessary, transfer charges can be used to allocate the services of this unit and the data bank charges to those other units using its services.

The central unit should keep track of publishers from which the firm is currently buying services, since there frequently are discounts for multiple use by a firm. It is also desirable periodically to inventory the strategic information

needs of the key units within the company. This permits identifying potential data bank suppliers before their services are needed internally.

As the use of data bank products grows, consideration should be given to decentralizing control to divisions, or other subunits, in order not to constrain usage.

Quality of Data. The contribution of strategic information systems to corporate planning depends greatly on the quality of data used as input to analysis and model building: Data should be timely, accurate, and complete. The historical nature of certain analyses and the long time horizon of strategic planning require that data be gathered on an ongoing basis.

Because of the likelihood of obtaining data bank products from more than one supplier, it is important to consider the relation of the products to each other. Particularly difficult is the different time periods covered by specific products, especially fiscal years and lags of certain statistics. There is also a need to ensure compatibility in terms of format and meaning.

Internal Information Sources. Because of the cost savings associated with operational-level systems as a result of improved efficiency, most information system investments have been at the operational level. As a result, most machine-readable information available in a firm pertains to operational-level activities. In contrast, at the corporate level, the need is to consolidate information reported by various parts of the organization into a consistent picture of the firm. This consistency is not achieved without considerable effort.

Several factors can assist in this consolidation:

- Corporate-wide data definitions ensure that a term has the same meaning throughout the company. For instance, "goods in inventory" may mean the goods are in the warehouse in one division, while in another division it may mean that goods have finished final inspection, but have yet to be shipped to the warehouse. If a corporate analyst is trying to determine the value of goods available to be sold, it is important for "goods in inventory" to have the same meaning in each division.
- A corporate chart of accounts should be established that is followed by each division and that has enough subcodes to permit splitting transactions among programs. Units tend to expend by program, while the corporate level is interested in reporting by category. The internal accounting systems should support mapping between these different views.
- Standard reporting categories permit aggregating of data reported by divisions. Both reporting categories and time periods should be common for all units.

Absence of a major internal system can create data gaps that, in turn, may reduce the completeness of analysis. The degree of compatibility among a firm's internal systems, in terms of data meanings and timing, becomes a major issue in developing and operating a strategic information system. In general, the less compatibility among a firm's internal systems, the more difficult it will be to develop its strategic information system.

SYSTEMS FOR ANALYSIS AND PRESENTATION OF STRATEGIC INFORMATION

Strategic information systems are composed of two parts. One provides access to a data base containing needed data, both internal and external. The other part of the system provides the capability to perform analyses and build models. Categories of analyses include:

- Variance analysis, to detect and explain deviation from a standard;
- Trend analysis, to track changes over time in sales, markets, and material prices;
- Composition analysis, to detect changes in composition of costs, competition, and markets;
- Competitor analysis, to discover and track behavior of competitors; and
- Correlation analysis, to discover meaningful relations between sales, costs, advertising, profits, and other important factors.

Building models requires the ability to perform computations and to display data in a variety of ways. It is generally agreed that model building frequently reveals insights about the dynamics of business function that are almost impossible to obtain in any other manner. As David C. Hickson, a vice president of Bankers Trust, observed:

> "Our model building was a most revealing task. Star shells of insight burst around us and we have been busy doing things as a result of what we saw revealed. I wish to emphasize that these insights came out of the building of models rather than the operation of them."[4]

Thus, it can be said that strategic information systems contribute to the planning process both by making available a great deal of necessary information and through insights gained in building and running models.

While many analytic techniques are used in strategic planning, there are two approaches that represent the kinds of computer support available today. In both cases, the essential element is the ability to answer "what if" questions in order to understand the implications of different courses of action. The first, spreadsheet analysis, provides the analyst with facilities for creating a spreadsheet in which a line on the sheet can be related to another line by means of a simple formula. Thus, one can write: "PROFIT = GROSS SALES − COST OF GOODS SOLD". New columns can be created by changing the value of a variable, for example, increasing gross sales by 10 percent, and the changes will be reflected in the other entries in the spreadsheet.

The second approach makes use of a more extensive system to build financial models of a company. In this system, features are available for data entry and editing, data retrieval, and various analytic procedures. The system is more difficult to learn and use than the previous system, but it is more powerful.

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[4] Daniel C. Hickson, "A Banker's Appreciation of System Considerations," Annual Meeting, American Society of Engineering Education, UCLA (June 1968).

Spreadsheet Analysis

A spreadsheet program permits the screen to be viewed as a window on a large spreadsheet consisting of columns and rows. By defining the relationship among various rows and columns as algebraic expressions, entries are created in the spreadsheet.

As an example, a spreadsheet could be built with the first column (A) containing period names: first quarter, second quarter, and so on. The second column (B) might contain actual sales data, while the third column (C) might have actual data on returns of goods. Then, the fourth column (D) could be defined as returns as a percentage of sales by entering the expression C1/B1*100 while the cursor is positioned at Column D, Row 1. This expression means that the entry at Column D, Row 1 is the result of dividing the contents of Column C (sales), Row 1, by the contents of Column B (returns), Row 1, and multiplying by 100 to obtain the percent figure.

The program provides a simple language for defining the relationship among various rows and columns in a table. When a number is changed, all of the related information on the spreadsheet is automatically recalculated. Thus, it is possible to see easily the effects of various changes and to answer "what if" questions.

Financial Modeling

General-purpose modeling programs consist of a modeling language that permits (1) identifying the elements of the model by name, (2) describing computations in a simple algebraic format, (3) describing portions of the model as systems of simultaneous equations, (4) calling of external functions, and (5) interactive debugging. These systems contain routines for many commonly used functions, including (1) depreciation, (2) rate of return, (3) loan payment and amortization, (4) compounding, (5) investment yield, (6) percentage distribution, (7) regression analysis and forecasting, and (8) sum, average, maximum, and minimum.

Flexibility in the selection and formatting of output documents is provided by report writing and graphic features. Customized report features include (1) ordering of information in reports independent of the ordering within the model, (2) formatting of text within reports, (3) interchange of rows and columns, and (4) full editing, including variable column widths, precision, brackets, prefixes, suffixes, and zero suppression. Graphic display features include (1) line or bar graphs, (2) standard or user-defined plotting symbols (plotting of any item against time or against other items), (3) automatic scaling, (4) controllable plot size, and (5) interchange of axes.

To aid in data management, these programs often have the following features: (1) data input, with error checking and prompting, (2) inquiries, to permit the examination of values without processing reports, (3) temporary changes, and (4) consolidation of multiple sets of data.

Interactive analysis features allow the analyst to test assumptions and evaluate alternatives. They include:

- Sensitivity analysis, to show the effects of incremental or percentage change to any model elements;
- "What if" analysis, to show new computed values as a result of different sets of assumptions;
- Impact analysis, a ranked listing of all model elements that will, if changed, have an impact on any element selected for study; and
- Target value analysis, which computes the values needed for any specified input items to achieve a target value for a model element.

Risk analysis may also be performed by specifying the ranges of possible values, that is, the probability distributions for key variables. The system then randomly selects values for these variables and executes the model logic, to provide a composite profile of computed results. To analyze time series data, these systems often provide (1) regression, (2) exponential smoothing, and (3) moving average computations. An example of a financial modeling system is EMPIRE,[5] which is available for many types of computer systems.

Integrated Planning Systems

Integrated planning systems have been described at length in planning literature.[6] Forecasting data obtained from data bank publishers are contained in a data base system running on the company's main computers. A set of analytic tools, including mathematical programming routines and econometric and risk analysis models, are used iteratively, over a corporate network, by members of the planning staff to evaluate the implications of following alternate courses of action over a multiyear planning horizon.

In large corporations, some mechanization of the planning and control function is necessary just to process the large quantity of data. The design of effective plans over multiyear horizons implies the ability to maintain historic plans as well as historic realities. Key to the notion of integrated planning systems are standardized reporting formats that specify the content and form of information flowing from lower to higher levels in a company. Each higher level consolidates and evaluates the performance and plans of lower-level units. Plans are revised in light of conflicts and interdependencies in strategies proposed by the units as well as rapid changes in the environment. The implied model is that of a feedback control system with an overall response time measured in years.

The requirements for integrated planning systems are:

- A flow of information to create strategies;
- Analytic tools for evaluating alternate strategies;
- Information describing changes in the external environment; and
- Measurement of actual performance.

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[5] EMPIRE is a financial modeling package developed by ADR Inc., Princeton, N.J.

[6] For a more complete description, see Hamilton and Moses, "A Computer-Based Corporate Planning System," *Management Science* (Oct. 1974).

The process is one of translating strategies to plans, plans to projects, and projects to actual performance. Then, the process is reappraised and repeated. The key to this effort is the ability to view the corporation as a whole, no matter how diversified the individual components (it is this that differentiates corporate-level planning from top-level divisional or business planning). This implies being able to consolidate information from the components to determine corporate profitability both at the present and at forecasted future points in time. Then, alternate strategies are generated and evaluated in the context of top management's goals, which may be as diffuse as maintaining a certain level of corporate profitability independent of cyclic or economic fluctuations. This requires the ability to perform "what if" analyses and impact analyses. The selected strategy is then reflected in division plans and projects, thus disaggregating the previously consolidated information. All of this must be done iteratively and consistently.

The evaluation of alternate strategies requires considering the following factors:

- *Management viewpoint and values:* the predominant perspective and style of the leaders of the company; the corporate culture;
- *The company's strengths and weaknesses:* what the company does best, and where it has the greatest problems;
- *Business and industry criteria:* those factors that determine success in a particular business, as well as factors that are important due to industry structure;
- *Competitive actions:* the courses of action being followed by the firm's competitors; and
- *Environmental conditions:* the opportunities, risks, and pressures associated with changes in the environment.

Management's viewpoint may not be consistent or homogeneous, but it is the context in which key corporate decisions are made. Objective recognition of a company's strengths is necessary to prevent establishing unattainable goals. Competitors' actions are tracked in order to recognize their probable strategies, facilitating the design of counter-strategies. Awareness of changes in environmental factors permits positioning the company to take advantage of these changes.

The key problem at the corporate level is not one of obtaining enough information: It is distinguishing *relevant* information from the overwhelming amount of data available. Top management cannot afford to wait until all relevant information is known; it frequently must act on partial information and analysis.

Issues

Use of Formal Systems. One popular image has the chief executive officer (CEO) operating his or her own terminal and making key corporate decisions based on the programs he or she runs. This notion has several flaws:

- Most important decisions require analysis of data from many different, incompatible sources. It requires considerable skill to run the analyses and to interpret their results. It is not just the running of a program that is involved. There is an analytic process that takes many years to master. Most top-level executives have neither the patience nor skill for this type of work.
- Descriptions of the work that executives do indicates that it is fragmented by interruptions and paced by external events rather than being thoughtfully analytic. Thus, the mode in which executives function and the mode necessary to be a good analyst are incompatible.
- Executive decision making involves negotiating and bargaining with other power centers within the company, a process requiring face-to-face meetings and two-way communication. Evaluation of competing strategies is more the result of the interaction of key players than it is the reasoned weighing of alternatives; thus, it is not amenable to being made completely by computer processing. The decision outcome is influenced by the decision-making process.

The arguments above do not mean that systems with good display features cannot be used to *present* information. In many cases, backup data or operating data can be presented much more conveniently by a computer system than by stacks of printed data. However, there will still be a staff performing the analyses and packaging the material for presentation.

Decision-Making Systems. The issue of decision-making versus decision-aiding systems frequently comes up in discussions with top executives. Since most decisions at top management levels are nonrepetitive (i.e., the decisions tend to be unique), where the factors involved in the decision and their relative importance change from decision to decision, they do not lend themselves to programming. In order to do so would require the system to have general knowledge about the decision. Because it is difficult to ensure that the system contains all of the necessary knowledge for the decision (the system cannot know what it does not know), general decision-making systems, for business, are a long way in the future.

There are also political reasons for not relying on decision-making systems. If a decision is made by a system, then the outcome may be predicted by someone who has access to the system. No top-level executive feels comfortable with the notion that others may be able to predict his or her moves.

As problems become more narrowly defined and more routine, and are performed by more people in the organization, it becomes worthwhile to do the necessary analysis and to build the knowledge base needed to program the decision.

For the present, top management decision making will rely on skilled analysts supported by a variety of analytic tools and data, many of them based on computer programs. These clusters of data, analytic tools, and procedures are frequently referred to as decision support systems, especially when a subset of these tools has been configured to apply to a particular decision-making situation.

Benefits of Modeling. As mentioned above, the main benefit of computer modeling and simulation often is not the solution of a specific problem, but, rather, the insight gained from a more precise description of the decision-making situation and an identification of critical parameters.

DETERMINING SIS REQUIREMENTS

A number of experienced executives have observed they seldom have the information they need to manage their companies. As a rule, the higher a manager is in a company, the greater the flow of information with which he or she must contend and the less clear are his or her real information needs. Various techniques for defining information needs are described later in this chapter.

Three factors determine how a firm should go about determining its strategic information system requirements. First, the business that the firm is in and the structure of the industry imply certain information categories that are critical to success. For example, companies in dynamic fields with frequent technological innovation need information about new technological developments and trends. For these firms, strategic information systems are important devices in tracking technology, in forecasting environment change, in monitoring competitors' actions, and in coordinating the firm's activities. SISs should reduce the time necessary to recognize a threat or opportunity and decrease the response time required to respond. While companies in more static industries may be less willing to invest in strategic information systems because they are not as vulnerable to environmental change, they still must monitor competitive actions, introduce new products, and control the company's activities.

Second, firms with little experience in developing information systems may have difficulty in integrating internal strategic systems. Because of the range of skills required to build SISs, a firm should be well advanced in applying computer technology before developing strategic systems. It is generally accepted that firms go through states of data processing growth.[7] Stage 1, initiation, usually involves cost-reducing accounting and other operational applications. In this stage, a firm is coping with understanding the technology and gaining experience in how to apply it.

In Stage 2, expansion, data processing seems to take off, with applications often seeming to have been selected at random. There is a steady rise in expenditures for hardware, software, and personnel. This stage frequently ends in crisis, when top management becomes aware of explosive data processing growth without corresponding bottom-line benefits.

In Stage 3, formalization, top management attempts to rationalize and coordinate the firm's data processing activities. This stage is characterized by the withdrawal from innovative applications development, the initiation of formalized management reporting systems for computer operations, and the

[7] See Gibson and Nolan, "Managing the Four Stages of EDP Growth," *Harvard Business Review* (Jan.–Feb. 1974).

establishment of elaborate quality control methods. Frequently, applications with real potential for increasing revenues and profits and for facilitating management decision making have not been developed by this time.

Stage 4, maturity, involves developing applications that touch directly on critical business operations. The relationship between top management and the highest-level data processing officer is sound enough, at this stage, to permit him or her to be accepted as a member of the key decision-making group. It is at this stage that strategic information systems most easily can be developed. Attempting to build strategic systems before attaining mature data processing growth may impose unnecessary problems.

The stage model of data processing growth is useful for identifying general problems and issues related to a firm's experience with data processing. However, it implies a step-by-step progression through stages. This need not be the case. Firms can successfully bypass one or more stages of growth, or a small firm can develop a strategic information system, as long as the necessary prerequisites are met and key issues are resolved.

The third factor a firm should consider in selecting an information system requirements strategy is the condition of its operational systems. If its operational systems are well-developed and high-performing, and if they cover the core technology (i.e., the key production technology) of the company, then most of the requirements for a strategic information system will deal with obtaining external data, integrating this with internal data sources, and performing the necessary analytic procedures. However, if operational systems are underdeveloped, or if they do not provide the necessary internal information for strategic planning, then these systems must be developed. One way to assess the status of internal systems is to perform a systems audit (discussed below).

Management control systems require the establishment of standards against which various activities can be measured. The question many executives face is deciding at what level or value a standard should be set. Strategic information systems can be of assistance in establishing these performance standards by showing the relation between desired performance and the standards for measurement. For example, a CEO may desire a certain level of profitability from a division. However, profit figures may not be available on a division basis. The CEO may decide, therefore, to control the division on monthly sales and cost data through the use of a model that relates the division's sales and costs to estimated division profit.

Although there are many methods for determining system requirements, two—systems planning and success factors—represent examples of different approaches to requirements analysis that lend themselves to strategic information systems planning.

Systems Planning

Systems planning is a structured analysis approach to establishing an information systems plan in order to satisfy short-term and long-term information needs.

Underlying this approach is the notion that an information systems plan for a company should be integrated with its business plan, and that it should be developed from the point of view of top management and with the active participation of top management. Systems planning is composed of two phases:

- An identification phase attempts to understand the business. This involves identifying the information systems that are needed to support the business and grouping them into clusters of related systems. This process permits management to set implementation priorities and become more aware of relationships among systems.
- A definition phase validates information gathered in the first phase and defines the systems that are most needed (i.e., those with the highest priorities). This phase includes defining major actions, resources, and schedules required to build these systems.

Frequently, gaps in operational-level systems develop because of a lack of past user demand for mechanization in certain areas or because of an inability to justify a particular activity based on its cost. Also, operational-level systems often have a scope that parallels organizational boundaries (however, sometimes even operational-level systems cross functional boundaries, such as in the case of inventory control). The vertical orientation of these systems may restrict data sharing, which is needed for strategic information systems. Systems planning is a top-down analysis approach that starts with business objectives and problems, relates these to processes and organization, and then identifies the application systems, data files, and data classes needed to perform the business processes.

Systems planning usually involves a group of executives from different levels of the company, and from different functional areas, as well as staff support from an outside consultant. A top executive sponsors the study, and a manager with a broad perspective who commands the respect of management is appointed team leader. The team then agrees on its objectives and begins gathering data. This includes information on (1) organization structure, (2) financial and product reviews, (3) market analysis, (4) current plans, (5) environmental analysis, (6) profile of information systems, and (7) results of previous related studies.

The major business processes (i.e., the essential decisions and activities required to manage the resources and operations of the business) are identified and represented in a table. The team then interviews key executives to gain knowledge of management's views, values, priorities, and information needs. The team asks questions about (1) objectives and responsibilities, (2) methods of measurement, (3) major problems, (4) satisfaction with current information, and (5) information requirements. The team then reviews the current data processing support, and it identifies gaps between the information systems that are currently in place and those that are needed. All of this material is assembled in tables and matrices, analyzed, and then presented to top management in the form of a recommended action plan, with backup material. An example of the

systems planning approach is Business Systems Planning (BSP) developed by the IBM Corporation.[8]

It takes many months to perform a systems planning study because of the large amount of data that must be gathered and because of the methods used to present the data. Critics of this approach point out that it is expensive and time-consuming, and that it deals primarily with current needs rather than with future needs. And, by trying to produce a complete systems plan, much more information is gathered than is really needed. Analyzing the data produced by the study is somewhat of an art. Furthermore, critics observe that the documentation produced by a systems planning study is seldom read by top-level management within the firm (because they already know most of it), and that it does not address the information needs of top management.

On the other hand, supporters of systems planning report that the process produces a corporate-wide information systems plan that permits identifying gaps in coverage and facilitates establishing development priorities.

Success Factors

In contrast to systems planning, the success factor approach to determining information requirements focuses directly on the information needs of top management. Short interviews are held with top-level executives to identify their goals and the success factors that underlie these goals. Success factors are three to six key elements, related to both the industry and the job, that must be handled exceedingly well in order for a company to be successful. For example, in the automobile industry, styling, an efficient dealer organization, and tight control of manufacturing costs are critical to profitability. Success factors are then refined, and an initial cut at identifying measures is made. Knowledge of these success factors, methods of measuring them, and the systems that need to be present in order to deliver this information help to identify a firm's strategic information systems.

Follow-up interviews are used to sharpen the factors and to define measures and reports in depth. There are four sources of success factors:

- Industry structure, which determines those particular factors that must be effectively dealt with if the firm is to be successful;
- Competitive strategy and industry position, which identify those factors related to a firm's history and current strategy that are important for success (e.g., an industry leader's approach to marketing products is a success factor to other firms in the industry);
- Environmental factors, such as the gross national product and inflation rate, that influence the behavior of consumers in certain industries; and
- Temporal factors, involving internal organizational considerations, which may influence the success of a company over a particular period of time.

[8] For additional information, see "Business Systems Planning Guide," IBM Corporation, GE20-0527-1 (Aug. 1975).

A number of benefits are attributed to this approach to information systems planning. First, the process helps a manager determine those factors on which attention should focus. Then, identification of success factors defines the type and amount of information that must be gathered, limiting the collection of costly, unnecessary information. Third, this approach moves an organization away from the trap of building systems around data that is available or easy to collect. Rather, it focuses on data that is needed, but that otherwise might not be collected. An example of the success factor approach is critical success factors developed by Rockart.[9]

Critics of the success-factor approach observe that much more detailed information is needed to design a firm's information systems than is gathered by a handful of interviews with top managers. Then, success factors are directed at the management control function rather than specifically at the process of strategic planning. One also must wonder if a manager's reflections about factors that are critical for success are stable information needs or if they are transient demands of the moment.

STRATEGIES FOR BUILDING INFORMATION SYSTEMS

Once a firm's strategic information systems have been identified and their requirements have been determined, the resources necessary to build these systems have to be allocated. The approach selected for building a particular SIS requires an assessment of (1) the quality of the firm's existing information systems, (2) the skill level of the firm's information systems staff, and (3) the firm's capacity to commit to building additional systems. Information systems involve two very different activities: operating a computer facility and developing information systems.

Information Systems Activities

Operations. Operating a computer facility involves running a computer system on a day-to-day basis. It is similar to running a production line in that the work is routine and the skill level required is not particularly high until a failure is encountered, although a fair amount of training is needed.

Development. Developing information systems consists of performing studies of system requirements, designing systems, programming and testing them, providing operating procedures and user training, and then supporting them once the systems become operational (e.g., making changes to enhance systems and keep them current). The development staff is highly skilled, somewhat similar to research and development engineers. They frequently have strong ties to their profession, and weaker ties to their company. Because of the

[9] John F. Rockart, "Chief Executives Define Their Own Data Needs," *Harvard Business Review* (Mar.-Apr., 1969).

great demand for people with knowledge about designing and building information systems, there is a large amount of staff turnover.

There are good reasons for making a distinction between operations and development. First, the people that staff each function tend to have different values and culture. Operations tends to have blue-collar workers, while development tends to have white-collar workers. Second, the two functions involve different management jobs. Managing operations is like running a production line or a power plant, where the product being produced is clearly defined and performance standards exist, while managing development is more akin to running a group of professionals. The product is different in each situation, and performance standards are very nebulous. Then, a firm may have a well-run operations unit and a relatively poor performance in systems development (or vice versa). This would affect a firm's strategy for developing SISs.

Performance Measurement and Control

Unless top-level executives are able to control the quality of information services provided in the firm, they are unlikely to take the risk of relying on these services in making a major strategic thrust. Two factors—performance measures and incentives—are particularly critical to successful management of the firm's information systems activities.[10]

Performance Measures. Operational performance measures usually include both the percentage of availability of a computer facility and the number of interruptions of a system over a time period. The specific measures used are far less important than the fact that top management is sufficiently concerned about the performance of the computer facility to have measures reported on a regular basis.

It is considerably more difficult to measure development performance than it is to monitor a computer facility. Frequently, schedule and cost are the only performance measures used (i.e., how close a job was to the original implementation schedule and the ratio of actual to estimated development cost). While these are objective, and they do represent important factors, it is not easy to adjust for the difficulty of projects, and they tend to obscure other issues. For example, an application system may be delivered on schedule and within cost, but users may not be satisfied with it and they may not use it. Should the system be considered successful?[11]

The following factors are suggested for monitoring development of information systems:

- Percentage of actual to budgeted cost of system development;

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[10] A more complete discussion of the issues and techniques involved in managing the data processing function is beyond the scope of this chapter. For additional information, see Lucas and Turner, "A Corporate Strategy for the Control of Information Processing," 23 *Sloan Management Review* 3 (Spring 1982).

[11] For a detailed discussion of the implementation of information systems, see Lucas, *Implementation: The Key to Successful Information Systems* (N.Y.: Columbia University Press, 1981).

- Percentage of actual to scheduled delivery, measured according to when the system is accepted by the user;
- Evaluation of whether the anticipated benefits of a system are achieved (this requires identifying the rationale for a system—usually found in the requirements study—and seeing whether it is actually met);
- Determining whether a system is actually used;
- Measuring perceived user satisfaction with a system; and
- Determining the number of problems reported after a system is delivered to the users and the average time to repair these problems.

Incentives. The other important determinant of staff behavior is incentives. Discounting extrinsic rewards such as salary or job title, the act of simply including key members of the information systems staff in symbolic activities, such as strategy sessions, can improve their performance. Of course, consistently meeting performance objectives, such as developing systems on schedule, within cost, and with anticipated bottom-line consequences, should be rewarded by salary increases and promotion. What is important is that the measures and criteria applied and the incentives be coordinated and consistent.

Strategies for Developing SISs

There are two broad strategies for developing strategic information systems. The first is to develop a system internally. This approach involves determining the requirements for, designing, and programming various forecasting, econometric, and analytic systems needed for planning and evaluation as well as for the consolidated internal information system. Considering the diversity of these systems and the multiple sources of data, this course should not be attempted unless the company has a proven track record in building systems as well as an experienced staff.

The second approach is to buy (or lease) packages and data banks from publishers. This course is followed by most companies. The challenge is then to integrate the packages so that data can be transferred between them and to reduce the amount of manual handling required to run the system. Leasing has the advantage of permitting use of the systems and data without full commitment. Until cost factors become prohibitive, this course is attractive.

The importance of an information systems plan is that it permits identification of gaps in internal systems and it helps establish a sequence for obtaining various packages and data banks on a priority basis. The plan also can become the framework in which compatibility issues are resolved.

Issues

Role of the Information Systems Department. Frequently, internal information systems departments are not familiar with the tools or process of policy analysis. This area is a specialty, involving economics, management science,

and information systems. A company beginning to do policy analysis may have to bring in help from the outside, which has the potential of creating a conflict with the information systems department.

Unrealistic Expectations. The assumption is frequently made that a heavy investment in strategic information systems will necessarily result in improved strategic decision making. Many factors other than a SIS influence decision-making quality, including the skill of the staff performing the analysis, the scope of the analysis as defined by executive management, the staffing process, judgments about probable outcomes, and the role of politics. SISs may contribute to improved decision-making performance when they fill a clearly defined need, such as a particular analytic procedure (e.g., being able to answer what-if questions or considerably improving the data upon which decisions are based), but they should not be viewed as a cure-all for some other factors involved in strategic decision making.

USING INFORMATION SYSTEMS TO IMPROVE CURRENT OPERATIONS

Thus far, the focus of this chapter has been on using strategic information systems to support strategic planning and decision making. This section considers the use of information system applications to improve the competitiveness of products and services, which is the ultimate purpose of strategic planning.

Information systems can contribute to profitability by providing opportunities to improve operational efficiencies. The need for systems of this type is usually perceived by an operational unit, based on changes in procedure. For example, it may be observed that capturing data about clients at only one point in the company will decrease redundant manual record-keeping. The primary objective of such systems is to reduce cost, frequently by substituting machine procedures for human data processing. Since, in general, the cost of data processing machines is decreasing, while the cost of labor is increasing, this substitution can result in a lower total cost.

New systems, however, involve changes to peoples' jobs, changes to the structure of an organization, and changes to the distribution of power within a firm. As such, they involve risk, and they are frequently resisted. If system implementations are to be successful, they require active executive participation, careful preparation, and strong leadership.

Another way that computer and communications technology can contribute to current products is by extending or enhancing the features of a product to give it a competitive advantage. For example, many of the computer-generated displays and engine controls on recent automobiles (e.g., timing and mixture) fall into this category.

Methods for identifying high pay off applications and the barriers to implementing systems are described in more detail below.

Routine Applications

The first use of computers in business was for routine financial applications, such as payroll and accounting. The rationale for these applications was error reduction and variable (i.e., transaction-related) cost control. Workers performing routine clerical functions, such as posting debits and credits to a journal, were replaced by a computer program that did the posting. The number of errors introduced by the application program was far less then the number of mistakes made by humans. A secondary benefit of these applications was that they frequently either reduced per-unit processing costs or made them independent of transaction volume.

Systems of this type, called transaction processing systems, have similar structures. They accept a transaction (input), check it to be sure that the data it contains is valid (editing), post the transaction to a file of some sort (file maintenance), and produce reports from the file (report writing).

Business systems had to have two characteristics in order to be programmed:

- All conditions that might be encountered in the system had to be known in advance; and
- Rules for handling each condition had to be completely specified.

If the application was an accounting system, then all transaction types had to be defined in advance. And, the procedures for posting each type of transaction had to be completely defined. If an undefined transaction was encountered, it would be treated as an error.

These characteristics are typical of activities at the operational level of organizations. These systems are termed "programmed" systems and they are, for the most part, of a routine clerical nature.

The motivations for building programmed computer application systems provides clues for potential opportunities. They are intended to:

- Reduce errors in data;
- Reduce costs of production and services;
- Process data within set schedules and with acceptable dependability;
- Carry out large calculations that would otherwise not be possible;
- Provide compatability between different parts of a system;
- Facilitate planning and orderly growth; and
- Respond to a mandate to use a computer.

The last item requires some explanation. Sometimes, it is necessary to report or record certain information, for example, when that information is to be requested by the government. Under these conditions, a computerized system may be directed, rather than cost-justified. For example, starting in the middle 1970s, many firms installed computer-based personnel information systems, so that they could meet affirmative-action reporting requirements of the government.

More specifically, direct benefits of programmed systems include: (1) reduced inventory, (2) reduced back-office processing time, (3) better customer service, (4) more efficient use of funds, (5) availability of new funds, (6) improved data accuracy and speed, and (7) improved access to files. Indirect benefits include: (1) improved company image, (2) better tracking of work processes, (3) improved decision making, (4) better information flow in the firm, (5) improved planning, (6) increased organizational flexibility, and (7) organizational learning.

The extent to which these advantages will be realized depends on many factors, including readiness by management and operational staff to consider new ways of doing things, the presence of a trained and experienced staff, and the availability of good data.

Decision-Aiding Systems

Another type of system is the decision support system. These systems support semistructured and unstructured decision making and problem solving by providing access to data and modeling tools. They also may assist in structuring a problem solution and enhancing coordination among decision makers. Since use of these systems is presumed to be discretionary, the decision-making process and user-control aspects of decision support systems tend to be customized for individual users in order to take into account a user's preferred style of interacting with a system.

Decision support systems can improve current products and services by helping people perform their jobs better. For example, a major oil company observed that one of their most important decisions was bidding on leases. They applied statistical and game theory analysis techniques to assess the risk of losing a bid. The performance of bidders improved dramatically when they began to use the system to help them establish their bids.

Evaluating Alternate Implementation Projects

A firm has only limited resources, both financial and human. There are many competing uses for these resources. Consequently, a key management decision is how resources are to be parceled out among opportunities, especially new computer applications. Thus, a top executive may be faced with the problem of deciding which of a number of potential cost-reduction or service improvement opportunities should be pursued.

When evaluating alternate opportunities, one should:

- Identify all benefits and impacts of a candidate project;
- Estimate the magnitude of each benefit or impact on a scale that allows comparison across benefit/impact type; and
- Compare the total package of benefits offered across alternate projects in order to find those projects that represent the best use of the company's resources.

Although these steps are conceptually simple, they are difficult to apply in practice. For example, often, only a small number of benefits are identified for each project considered instead of the full range. Sometimes, no estimate is made of the magnitude of the benefit, usually because this is difficult to quantify. Comparisons across projects tend to be qualitative; when quantitative comparisons are made, they often neglect uncertainty.[12]

One method that is frequently used to compare project candidates is a weighting and scoring approach. The characteristics of projects are divided into a number of major classes, or factors, such as operational cost savings, project development cost, improved customer service, probability of success, and importance of the project to the company. A weight is then attached to each factor in relation to the relative importance of the factor. Each candidate project is then scored according to the degree it possesses the desired characteristics. The scaled weights and scores for each factor are then multiplied together and summed to get the weighted score for the project. Projects are then ranked high to low on the basis of their weighted score; they are selected for implementation in this order until the amount allocated to application system implementation is exceeded.

This method has the advantage of being simple to apply. It ensures that the candidates are evaluated on the same factors, and it makes subjective factors identifiable. However, it also has a number of disadvantages. First, the evaluation technique assumes that the factors are independent and that trade-offs can be made between them. For certain factors, this may not be true; for others, such as cost of operation and cost of implementation, the trade-off may be more complex than portrayed by the weighting scheme. Second, it is extremely difficult to identify all of the factors needed for evaluation. Third, it is often difficult to place values on many system benefits, especially intangible ones. Finally, there is a tendency to focus on system features, just because they are part of a system, even when these features may not be particularly useful for an application.

A complementary approach is to calculate the return on investment (ROI) of the projects, using a discounted cash-flow analysis. This permits identifying potentially high-return projects, but it tends to favor cost-saving projects because their benefits are easier to quantify. A strict ROI analysis may eliminate a large class of innovative systems that may have a high–but a priori uncalculable–benefit to the firm.

One important part of evaluation is to assess the risk associated with each project. Possible risks include the following: (1) projects may fail to deliver anticipated benefits; (2) the cost of implementation may exceed planned levels; (3) the time for implementation may be much greater than planned; and (4) the performance of the system may be below estimate. Three factors contribute to risk:

- *Project size:* The larger the project is, the more communication is needed among project members and the more likely is a serious misunderstanding. In general, the larger the project, the greater the risk.

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[12] See McFarlan, "A Portfolio Approach to Information Systems," *Harvard Business Review* (Sept.–Oct. 1981).

- *Experience with the technology:* Because of the likelihood of unexpected technical problems, project risk increases as the project team's familiarity with the hardware and software decreases.
- *Project structure:* As procedures, functions, and outputs become less well-defined, project risk increases.

One method of measuring risk in each of these categories is to use a questionnaire, answered by the project manager and key users, several times over the life of the project. Top managers should ask themselves whether the benefits of a project are great enough to offset the risks.

Barriers to Implementation

In addition to the resources needed to accomplish a strategic information systems project, there are often other factors that management should consider. Building an information system usually involves changes to peoples' jobs. These changes can involve the tasks performed, the procedures followed, the interdependence among workers, and the clients served. Workers frequently are reluctant to change the way they do things. This reluctance stems from a fear of the unknown, habit, and an unwillingness, as people grow older, to learn new things. One way to cope with this reluctance is to make workers aware of the shortcomings in the way things are done. This "unfreezing" makes users more willing to change. After this, the changes involved in a new application system can more easily be made.

Often, new systems involve redistribution of power within an organization. Individuals (or groups) that lose power as a result of a system are likely to resist it, while those who gain in power are likely to promote the system. The uncertainty surrounding the implementation of a new system creates opportunities for political game-playing.

Another barrier to building information systems is lack of knowledge about how to apply computer technology to business problems. Frequently, people with the necessary skills are not readily available. And, building a system can be expensive (although the cost is decreasing), and many managers are reluctant to spend this money for uncertain returns. Experience to date has been problematic, increasing the fears of management.

Issues

Implications of Investing in Information Systems. What effects do information systems have on productivity, on the structure of organizations, and on the quality of working life of the people within them? At operational levels, the evidence is strong that computer-based application systems increase productivity. This is because the cost of computers has been dropping, while the cost of labor has been rising. However, the high cost of capital partially offsets this. Packaged application systems have reduced the cost of systems development, and there are now a reasonable number of trained people to apply the technology.

Along with this productivity improvement, there seems to be a decline in working life quality, especially in routine clerical jobs where workers have no choice but to use a system. The reason that job quality is poorer is because computers permit designing a mechanized job, where the system paces and controls a worker. Frequently, decisions about job design are made on the basis of this model rather than on one that takes advantage of a new job to give workers more control over their work tasks. Mechanical jobs come about because system designers are not experienced in job design and because management is not particularly interested in using technology to improve the quality of working life.[13]

There is no evidence of a consistent structural change in organizations related to using computer systems. The current low cost of equipment encourages decentralization of equipment, data, and staff using private or public networks. Computer-based mail and other message systems provide new techniques for communication and coordination. It is generally accepted that the internal structure of an information services function should match the structure of the larger organization. That is, the system should be decentralized if the organization is decentralized, and it should be centralized if the organization is centralized.

BUILDING NEW SERVICES AND PRODUCTS FROM INFORMATION SYSTEMS

A number of companies have extended their product line offerings or modified their products based on expertise in information systems that was developed internally to serve planning and decision-making needs. One exciting strategic opportunity is to use computer and communications technology to create new products and services. This is where the most freedom of action lies, where the most creativity is needed, and where the greatest returns exist.

There is an advantage in being first to market a new product or service; if a demand has been identified and the product has been well-executed, then a huge success may result. Other firms attempting to imitate this success may find legal barriers, start-up costs, and lead times so great that by the time they get their product to the market, it is already committed to the original product. However, there is also a risk in being first. The technology may have problems that delay product introduction or reduce product capability over that planned. Then, the market may not exist. Judgment on timing is critical to success.

Computer and communications technology expands the range of strategic alternatives available to a firm. In this sense, it is a subcategory of all technology that can be transformed into new products or services. At this level, the dominant relationship is between technology and strategy rather than between

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[13] See Turner, "Computers and Clerical Jobs: The Missed Opportunity for Work Redesign," presented at the ACM SIGCPR Conference, Georgetown University, Washington, D.C. (June 1981), available as Research Report 24, Graduate School of Business Administration, New York University, and Bjorn-Andersen and Hedberg, "Designing Information Systems in an Organizational Perspective," *TIMS Studies in the Management Sciences* (1977).

information systems and planning, as was the case with the direct contribution of strategic information systems to strategic planning. Technology forecasting thus becomes a central part of corporate planning, and the opportunities presented by computer and communications technology becomes advanced product planning.

For example, a company recently announced plans for a chain of retail stores that contain no merchandise; they provide only mail order catalogues and a computerized index to the catalogues. Customers come to the store or telephone it; the customer or a salesperson uses a terminal to search an index in order to locate the goods requested by the customer. A computer system then aids in generating merchandise orders. The customer gets the advantage of one-stop shopping, and the company obtains a discount for quantity orders and for providing machine-readable order data. In this situation, computer and communications technology permits treating merchandise from many different suppliers as if it came from one source, thereby creating a new service to market.

These opportunities are not just limited to the service sector. A number of years ago, McDonald Aircraft Corporation invested heavily in computer equipment and application systems to support the manufacturing of their line of military aircraft (as did many of the other major defense contractors). McDonald Automation, the outgrowth of this effort, is now one of the country's largest suppliers of computing services (as are Grumman Data Services and Boeing Data Services). The banks and insurance companies have also spun off data processing subsidiaries.

Methods for recognizing opportunities to create new products or services that incorporate computer technology are described below, along with the barriers to and implications of investing heavily in these systems.

Recognizing Opportunities

While recognizing opportunities requires both entrepreneurial skill and knowledge of computer and communications technology, several patterns have emerged that are useful.

Using Computer and Communications Technology to Differentiate Products From Those of Competitors. Home ovens have long used mechanical timing devices to control cooking time length, to compute the relationship of the weight of the item being cooked with oven temperature and cooking time (this is a feature of deluxe models), to show the time, and to do countdown timing. These units have an average failure period of about three years. It would not be difficult, from either a design or manufacturing standpoint, to build a solid-state microprocessor-based control unit that also controlled oven temperature. Such a unit would be easier to use, more reliable, and cheaper to produce. Yet, no U.S. manufacturer has introduced an oven with these features, probably because of the industry's commitment to existing products, (which is based on factors such as an established production line and a trained service staff). Yet, this represents an opportunity to improve and differentiate a product.

In contrast, consider the electronic control features in microwave ovens. Almost all manufacturers have products with microprocessor-controlled power, time, timer, and delayed-cooking start/stop. This is probably because microwave ovens are relatively new (thus meeting less resistance to change) and because the market is competitive. Electronic control features result in product differentiation.

Using Computer Technology to Create a Unique Product. For many years, games were static; that is, the human's interaction with the game was one way. Chance, in the form of a drawn card or thrown die, provided the system response. Incorporating microprocessors into games permitted creating a whole new family of dynamic games that provide more competitive and realistic responses.

Cable television has become a major industry. Cable provides more channels, programming that is not available on commercial television, and clear reception. However, most of the cable networks do not permit the viewer to send messages (except in several trial systems, and, even then, the messages are extremely limited in content, and they can be sent only to the transmitting station). The exciting possibility of cable television is not in the expanded number of television channels, the programming, or the improved reception, but in the potential changes in marketing and financial institutions when consumers are linked together by local networks that permit two-way, computer-based communication.

Firms that make a heavy commitment to information systems at the operational, management control, or strategic level have greater technological capability (through the skill of professionals and managers) to provide computer and communications technology-based products to new markets than those firms that have passing familiarity with the technology. A considerable investment is required before a firm becomes sufficiently experienced with a technology (e.g., with suppliers, applications, and implications) to base a new product or service on it.

Some Examples

Examples of ways in which computer and communications technology has allowed firms to gain a strategic advantage are presented below. The examples are diverse, and they are drawn from many different industries. The common thread running through these descriptions is that computer and communications technology was used to create a new product or service. The organizations involved had enough confidence in their ability to apply and manage this technology to rely upon it for major changes in company direction.

Real Estate Applications. Some 250 of the more than 1,800 realty boards in the country have installed computers. It is estimated that there are more than 37,000 terminals linking real estate offices to regional systems, which provide brokers with services ranging from listings of properties for sale to financial analysis.

Commercial firms have led the way in applications, but now the greatest growth is in analyzing customer finances in the residential market. ROI, amortization schedules, and evaluation of alternative forms of financing are provided as customer services. Programs also help match customer needs with available properties by enabling the realtor to find houses in a location that fit a customer's budget.

Library Innovations. Libraries are undergoing a dramatic change in their mode of operations. In the next decade, they are likely to be smaller, but they will be able to provide users with more services and access to more information.

The Southeastern Library Network links 260 libraries from Virginia to Louisiana. Some 2,400 libraries across the country are tied into another network that provides access to a data bank in Ohio with 7 million titles. Bell Telephone Laboratories has 22 libraries linked together in a private network sharing specialized research resources.

Many people believe these events are the first step in providing home service. In the future, it may be less expensive to have people access library data from home computer terminals than to provide services at the library itself.

A Hospital System. American Hospital Supply Corporation (AHS) is the number-one firm in the hospital supply business, with over $2 billion a year in sales. It is the only company offering automated order entry and inventory control systems to hospitals. Approximately 40 percent of the 7,000 hospitals in the country deal with AHS, using computer terminals for direct communication.

Incoming orders are forwarded over the network to the company's distribution center located nearest to the hospital. The hospital immediately receives an order confirmation with prices and delivery dates. AHS claims that they have been able to cut the price of products by 20 percent through efficient handling and reduced shipping costs. Hospitals can reduce inventory because AHS can ship 95 percent of the orders on the day they are received.

The firm believes that the system is responsible for increasing profitability. The average hospital orders 5.8 items per order from AHS, compared with an industry average of 1.7 items per order.

Market Research. Information Resources, Inc. developed a unique service to perform marketing studies. The firm invested $2 million to buy point-of-sale scanning equipment and provide it, free of charge, to markets in two selected towns, one in Indiana, the other in Massachusetts.

The firms enlisted 2,000 households in each town and provided them with identification cards that trigger the point-of-sale terminal to send a record of the customer's purchases to the company's computer in Chicago. The system is used to measure consumer reaction to special coupons, free samples, advertising, various kinds of displays, and pricing.

An early experiment involved determining the effectiveness of free samples in place of or accompanying television commercials. The household panelists

were divided into four groups of 1,000 each, and were given various combinations of advertising and free samples. Sales doubled in all groups having free samples, but the group exposed to advertising in addition to samples proved to be more loyal over time.

This new marketing analysis technique, with its increased accuracy, gives Information Resources an advantage over its competitors.

Discussion. The firms described above all used computer and communications technology to embark on new products or services. In the real estate market, early adopters are able to offer better service, at reduced cost, than their competitors can offer. Libraries, through the opportunities provided by networking and computer technology, are examining ways in which they can provide increased service at lower cost, by distributing information to individuals at home or at their office instead of at a central location.

American Hospital Supply has been able to improve customer service and lower product cost, thus tying customers more closely to them. Information Resources built a new market research business using this technology.

These firms view computer and communications technology as a means of creating new roles and new markets for themselves instead of just using it to improve operational or internal performance. In this case, technology provides opportunities for new products and services.

Forecasting Technological Trends

In order to integrate computer technology into strategic planning, it is necessary to forecast technology trends. Forecasting techniques can be grouped under three headings: (1) extrapolation of trends, (2) classification analysis, and (3) intuitive projections. Trend extrapolation depends on finding some suitable quality–frequently, a measure of performance–that describes the technology and projecting the value of this quality forward in time. The common experience is that the shape of this curve rises steeply initially and then levels off. A major improvement in the technology or a new device is then found that moves the performance up to a new curve. It is often possible to draw the envelope of the family of performance curves that shows the progress, over time, of the technology as a whole. Of course, it is not possible to predict whether a new device will be invented to extend the envelope.

Classification analysis involves studying a set of devices or processes having the same function. These items are then grouped into classes according to features they possess or parameters that can be identified. From this grouping, it is sometimes possible to recognize a missing member of the group, or, one may be able to anticipate performance from a precursor event or device.

Intuitive projections are derived by inviting experts or informed persons to speculate about technological possibilities, often by arranging some interaction among them. One might generate a list of potential or desirable technological breakthroughs, and follow through to the consequences. Another approach is to enact scenarios where participants take on various roles and improvise responses to situations. One approach that is quite popular is the Delphi

method, where participants are given a list of events of high significance and asked to indicate the date at which the events might happen. On a second iteration, participants are given the average prediction date (compiled from responses to the previous round) along with the interquartile range (containing 50 percent of the estimates), and they are asked if they wish to revise their predictions. After a few iterations, a consensus is often reached on the part of the participants about what is likely to happen.

While all of these techniques are useful for technological forecasting, drastic changes in the political, military, cultural, or economic environment may invalidate the underlying assumptions of an analysis, rendering it useless.

Methods of Incorporating Technology Into Strategic Activities

The executive is faced with the question of how to go about incorporating computers in new products and services. It is first necessary to recognize likely trends in computer technology. Then, two approaches can be used: technology push and needs pull.

With technology push, the capabilities of the technology suggest new products and services. For example, the existence of inexpensive microcomputers in a significant number of homes created a market for video games. Successful games are more lucrative to their distributors than movies, and they provide a much higher ROI. The key to this approach is to be able to forecast technological trends (especially in the consumer market) and to be able to interpret the implication of these trends.

In needs pull, a service or product need is identified that can be filled using computer technology. For example, a West Coast entrepreneur decided there would be a market for a service that scanned the newspaper for information on subjects selected by clients. He observed that late-evening air time could be purchased inexpensively. This time could be used to broadcast a reading of the newspaper, preceded by a coded header that contained information on the content of the article. He then had a microprocessor device designed that accepted a list of subject codes as input from the client. The device contains an FM radio pretuned to the station. The broadcast subject headers are scanned by the device to see whether the code matches one of the codes on the client's active list. If so, the device turns on a recorder. In the morning, the client hears only articles of interest, read aloud over the recorder.

Another approach is to analyze a firm's strategic objectives in order to identify opportunities for the use of computer and communications technology and to plan for its use. While this generally results in recognition of gaps in internal information systems and in identification of application systems for development, a by-product can be the recognition of a new service or marketable product. A firm's strategy set consists of the following:

- *Company mission:* what the company does, and what it does *not* do;
- *Company objectives:* descriptions of desired future company positions;
- *Strategies:* general directions in which the company expects to move in order to achieve objectives; and

- *Organizational attributes:* organizational strengths or important factors that should be taken into consideration in using information systems.

The company's strategy set can now be transformed into an information systems strategy set, made up of the following:

- *Application system objectives:* the purpose of each project in operational terms;
- *Constraints:* internal and external considerations that must be followed; and
- *Design principles:* operational guidelines for system design.

An interest group structure made up of (1) customers, (2) creditors, (3) employees, (4) management, (5) creditors, (6) stockholders, and (7) the public all exert pressure on the company. Each company mission can be identified with the principal interest group advocating the mission as well as with objectives and strategies associated with that mission.[14] This process permits identifying the source of each component of the company's information systems plan, and it links that plan to the company's mission. Computer and communications technology can also enhance the company's mission by providing a strategy for mission accomplishment.

While many companies do not formally or systematically attempt to recognize opportunities for applying computer and communications technology, analyzing a firm's strategic goals does provide a practical method.

Barriers to the Use of Computer and Communications Technology

One of the major barriers to using computer and communications technology in new products and services is that these new activities often compete with existing power centers for limited resources. For example, a major metropolitan police department installed a computer-based command and control system to dispatch patrol units to reported incidents. A new unit, the communications division, was created to develop and staff the new system. After the system became operational, the department became concerned that precinct commanders were not using the system to manage their patrols. It turned out that the commanders felt that the new division was now responsible for the patrols, since they had taken over the assignment function, even though the department management had not relieved them of their responsibility. They felt the communications division had encroached on their turf, and they responded by relinquishing the responsibility for their patrols.

Another barrier to the use of new technologies is a lack of familiarity on the part of top management with technology and the opportunities it presents. Experience with information systems at all levels of the company can help develop a cadre of experienced specialists and managers.

Finally, some companies are unwilling to accept the risk involved with a new and rapidly changing technology. Decisions that are perfectly reasonable

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[14] See King, "Strategic Planning for Management Information Systems," 2 *Management Information Systems Quarterly* 1 (March 1978).

today may be undercut by technological change. The only defense against this possibility is to allocate resources to technology forecasting.

Issues

Risk. With any new technology, there are a number of uncertainties. One is that the technology will not be available when promised. Another risk is that the technology will not meet its performance or cost objectives. Technological change tends to move unevenly; there is always a chance that once one is committed to a path, new developments will occur that cause the existing technology to become outmoded. For example, third-party computer leasing firms that committed heavily to the IBM 370 line found the value of this equipment greatly reduced after the announcement of the firm's 4300 line of computers that afforded enhanced price performance.

Applying Technology. It is often difficult to obtain the skilled staff needed to apply a new technology properly. Workers who are knowledgeable about a new technology tend to be in high demand and few in number. Therefore, it is important to acquire the necessary human resources before embarking on a technology-dependent strategy.