Organizational response and information technology*

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INTRODUCTION

In one instance after another, organizations have remolded themselves, not in direct response to great ideas, but in response to the development of intervening technology that stimulates implementation of those ideas. The remolding, however, does not immediately correspond with the advent of the new technology. An organizational response process is initiated with the advent of the new technology, and then evolves over time. The purpose of this paper is to render theoretical frameworks that are useful for understanding the organizational response process and then to apply the frameworks to add perspective to contemporary organizational developments in respect to information technology.

RELEVANT THEORY

There are two theoretical frameworks that are particularly relevant to the impact of information technology on organization. The first is an organizational change framework developed by Harold J. Leavitt. The second is an organizational learning framework developed by Richard L. Nolan.

Organizational change framework

Leavitt’s organizational change framework views the organization as a complex system consisting of four main variables: task variables, structural variables, technological variables, and human variables. As shown in Figure 1, the variables are interrelated. A change in one results in compensatory change in the others. Usually, efforts concentrate on structure, people, or technology variables in order to effect an improvement in the task variable, but other variables also react to the change.

For example, a structural change such as decentralization may have been made with the primary intention of affecting the way in which production tasks are carried out. However, the change will most likely have an impact on the technology, such as a shift toward distributive data processing from centralized data processing. The impact on the technology variable could be consciously intended, or could be unforeseen and often a costly outcome of an intention to change only one variable.

Recognizing that a change in one variable affects the others, the remainder of this paper will concentrate on the effects of developments in information technology and the resultant impact on structure variables or, more specifically, organizational response. Information technology is defined as any technology that affects the way in which people in organizations carry out decision-making and administrative activities. The essential concept is that new information technology enables implementation of ideas about more efficient organizational structures. This flow from new information technology can be better understood by applying a second framework.

Organizational learning about information technology framework

Nolan’s organizational learning framework views the assimilation of information technology as an organizational learning process involving four growth process variables: application portfolio variables, DP (data processing) organization variables, DP planning and management control system variables, and user awareness variables. The applications portfolio consists of all the automated systems of the company. It changes over time in a fairly predictable pattern. The other three growth process variables are acted on in order to develop an effective applications portfolio.

In Nolan’s original work he identified four stages of maturity in the evolution of assimilating computer technology. The four stages are initiation, contagion, control, and maturity. The assimilation of data base technology requires four similar evolutionary stages. Typically, the data base initiation stage has coincided with the control stage of computer technology assimilation. The overlapping of the two four-stage evolutionary patterns produces the six stage evolution of the data resource functions illustrated in Figure 2.

STRUCTURE VARIABLES:
Systems of communication, authority and work flow

TASK VARIABLES:
Operations to produce goods and services

TECHNOLOGY VARIABLES:
Direct problem-solving inventions

PEOPLE VARIABLES:
Actors participating in the organization

It should be noted that while data base technology is typically introduced during Stage III of computer technology assimilation, the degree of computer technology assimilation is only one of several factors affecting the timing of its introduction. Other factors affecting the timing are: (1) availability and maturity of the technology itself, (2) external knowledge of the technology, (3) business needs of the organization, (4) economic climate of the organization, and (5) competitive pressures for data-oriented customer services. Companies that are currently in Stage I or early Stage II of computer technology assimilation may well initiate data base technology in an earlier stage of maturity than has been typically observed in the past.

Nevertheless, the pattern of the data processing budget curve is a manifestation of the organizational learning. Stages I and II are predominately influenced by the assimilation of computer technology; Stages V and VI are predominately influenced by the assimilation of data base and data communication technologies. Stages III and IV are influenced by both types of technologies.

There are two key concepts that affect the rate and the way a company progresses through the six stages: (1) status of internal and external bodies of knowledge, and (2) balance between control and slack.

1. Status of Internal and External Bodies of Knowledge—At any point in time, there exists an external or professional body of knowledge and an internal, or company, body of knowledge on how to effectively manage information technology. The external body of knowledge is largely codified knowledge. It exists in books, seminars and courses. The internal body of knowledge is within the company and exists in documents and policies, as well as in the minds and behavior of the company's management. The internal body of knowledge is largely knowledge that is obtained through experience with information technology. It is also obtained through books, seminars and courses. But the critical point is that experiential knowledge within the company is the major factor in progression through the stages. Figure 3 illustrates the bodies of knowledge concept. The impact of external knowledge on the internal body of knowledge helps explain why companies that automated their first systems in 1970 move through the stages differently than companies.

that automated their first systems in 1960. The relative permissiveness of an individual company to experiential learning is also important in understanding how a company moves through the stages.

2. Balance Between Control and Slack—When organizational learning is viewed as a managed process, two environments are balanced—control and slack. In the control environment, all financial and performance management systems—including planning, budgeting, project management, personnel performance reviews and chargeout/cost accounting systems—are used to ensure that data processing activities are effective and efficient. In the slack environment, on the other hand, sophisticated controls are notably absent. Instead, incentives to use data processing in an experimental manner are present. The incentives come in the form of what Cyert and March call “organizational slack.” When management permits organizational slack in the data processing activities, they are committing more resources to data processing than are strictly necessary. The extra payment achieves another objective—nurturing innovation. When the objective is no longer present or when the benefits of overpayment are not apparent, slack is reduced. The balance between control and slack is important in analyzing the functions of each stage of organizational learning. Figure 4 shows this balance for the six stages.

In Stage I, a discretionary expenditure for data processing is made, and the objective is designated as the development of a particular application. The organization and staffing for data processing are focused on the narrow objective. Stage I is a period of primary learning about the technology and how to use it. It is also a “proving” period to demonstrate that the new technology has utility to the organization. Control is low because a high fixed-cost discretionary expenditure has been made, and there is little reason to monitor further low-level expenditures. Slack is low because the first applications are narrowly defined replacements for existing manual systems.

Once the first applications reach production status and demonstrate the utility of computer applications to the company, slack is increased to nurture widespread use of the computer, marking the transition into Stage II. Systems analysts and programmers are often recruited from user departments and trained. Formal control is kept low to promote extensive experimentation with applications in multiple functional areas. Having little experience with computer technology, management generally is unaware how fast applications proliferate. The data processing budget rises rapidly during this period because applications often are inefficient and because problems occur when attempts are made to integrate operationally-oriented applications with management’s control and planning requirements.

The product of inexperienced programmers and virtually
no standard for systems development is a portfolio of applications that are almost impossible to build upon. Thus, data processing expenses continue to rise while computer services fall off and stagnate.

When this happens, management initiates actions to increase formal control and reduce slack. The functions of Stage III are to develop appropriate management controls and to "professionalize" data processing personnel. Often management consolidates data processing activities and mandates either greatly reduced or zero budget growth. To appropriately restructure the applications portfolio, the data resource concept is embraced and data-base technology is usually introduced to implement the data resource concept.

This has a confounding impact on the data processing budget as illustrated in Figure 2. Despite tight control and minimal slack in regard to computer technology, a discretionary expenditure is made for a data base application to test the viability of the technology. This is illustrated in Figure 4. Once the data processing staff is rebuilt and the data base technology is proven, the high control becomes a drawback to further progress. Low organizational slack impedes the experimentation and innovation needed to restructure the applications portfolio under the data resource concept.

In Stage IV, slack again becomes high, but control over the data processing department remains high. This is accomplished by fundamental reorganization of the data processing activities. The responsibility for applications that can be associated directly with functional users are assigned to the users and programmers and analysts are organized into Account Teams to assist users. This relieves the data processing department of the no longer logical responsibility for operating and maintaining low-level functional systems. The responsibility for multifunctional applications is vested in a user-represented steering committee. As shown in Figure 4, slack concerning data base technology is high, resulting in a rapid conversion of the existing applications portfolio to a data base structure, as well as a proliferation of integrated

Figure 3—Development of DP bodies of knowledge and movement through stages
Applications. The architecture of these applications reflects user-orientation through the extensive use of on-line terminals in user departments.

The low control/high slack for data base technology in Stage IV leads to data processing budget growth at rates which lead to a second senior management intervention for control. Stage V is characterized by data administration and a sorting out of data processing department and user department responsibilities under the data resource concept. Slack is reduced and control is increased in order to implement the standards and policies required. The data base structure and specific technology employed are re-evaluated in light of current external and internal bodies of knowledge. Major restructuring of the data base is typically necessary in Stage V.

Once data resource management is accomplished in Stage V, slack can be increased in the specific areas of application development where it is required for innovation. The more stable and conventional data processing activities then can be subjected to a high level of control to ensure maximum efficiency. The result is a controlled data processing budget growth rate more consistent with the company's overall growth rate. These are the characteristics of Stage VI. They indicate organizational acceptance and a relative maturity in the Data Resource function.

Within the context of the two frameworks (i.e., organizational change and organizational learning about information technology), the organizational response to contemporary information technology developments can be probed.

**ORGANIZATIONAL RESPONSE AND INFORMATION TECHNOLOGY DEVELOPMENTS**

Among the organizational developments in companies' data processing departments that I have observed over the past five years or so, three stand out: (1) balancing centralization with decentralization, (2) data administration, and
(3) distributed processing. Each of these is associated with an initiating information technology and stage. Once initiated in a company, the organizational development or response to an underlying technology evolves through the stages. While there is a “natural” initiating stage, the organizational development may be initiated in other stages as well. Often, earlier initiation precedes a company’s readiness for the organizational development and is dysfunctional to effective use and evolution of information technology. I call these stages “red flag” stages.

Organizational response #1: centralization versus decentralization

In the late 1950’s and early 1960’s, the initial high cost of computer processing and storage resulted in the centralized organization of most data processing departments. Then, as shown in Figure 5, the incredible cost/performance improvements in computer processing and storage and development of user-oriented programming languages gave rise to considerations for decentralizing parts of the data processing activity. Initial considerations were generally given to locating systems analysts in user departments followed by considerations to locate computers in the user departments as well.

The relative absence of planning and control of data processing activities in Stage II results in a recentralization of data processing in Stage III in order to implement the planning and control structures required to effectively manage the activity. Once the controls are implemented, the relative centralization/decentralization of the data processing activity tends to gravitate toward the overall centralization/decentralization philosophy of the company. This gravitation evolves through Stages IV, V and VI.

Stages I, II, and III are “red flag” stages because aggressive management action to effect centralization or decentralization which is contra to the natural forces of centralization in Stage I, decentralization in Stage II, and centralization in Stage III can have a disastrous impact on the data processing activity. The movement toward centralized MIS projects in the 1960’s when many organizations trying such projects were in Stage II is an example of a disastrous impact. Many of these companies ended up writing off their MIS projects as total losses. The organizational learning on how to develop applications in multiple departments and manage large development had simply not developed sufficiently.

Organizational response #2: data administration

Data Administration receives a lot of attention in Stage III when data base technology is introduced. However, the phenomenon is not understood well enough to write appropriate job descriptions and staff it. As shown in Figure 6, the activities of data administration are usually incorporated into a DP Controller position. During Stage IV the applications portfolio is restructured using data base technology, and a critical mass of data base applications results. Data base applications, along with data communications technology, enable a user orientation.

Consequently, the experiential base that evolves by late Stage IV creates the need and appropriate organizational understanding for establishing data administration in Stage V. As the application portfolio continues to evolve with higher-level integrated applications, the opportunity for gaining competitive advantage through effective management and use of data resources emerges. This will lead to the position of Data Planner in Stage VI.

Stages I through IV are “red flag” stages for data administration because of the lack of critical experiential knowledge. However, Stages III and IV represent important opportunistic stages for laying the groundwork for effective data administration.
Organizational Response #3: Distributed Processing

Distributed Processing is a direct result of technology developments in mini/micro computers, terminals, and data communications. As shown in Figure 7, distributed processing is usually initiated in Stage III. If initiated in Stages I or II, the technologies are usually overwhelming to the data processing department from both a technical standpoint and a management standpoint.

In Stage III the critical control structures are in place so as to enable a managed balancing of the relative centralization/decentralization of the data processing activity to correspond with the overall company philosophy.

The evolving complexity of distributed data processing within the context of an extensive applications portfolio that impacts every aspect of the business, leads to the need for the participation of a high-level data processing manager on the senior management team. In Stage VI, this is reflected in an organizational position such as a Vice President of Data Resources. Figure 8 illustrates the Stage VI organizational structure. Parts of the functions are distributed into the user departments dependent upon the company's overall organizational philosophy.

SUMMARY AND CONCLUSION

Organizations have been and are being remolded by developments in information technology. The advent of the computer has set off this remolding process, and the process has been quickening ever since.

The first remolding was initiated by breakthroughs in computer processing and storage technologies, and the innovation of higher level languages. The organizational response was search for the best balance between centralized and decentralized structures. The overall issue was never resolved because its resolution depended on the individual company's philosophy about centralization and decentralization.

Data base and data communications technologies set off another remolding process of organization structure. We are just beginning to witness the way that this remolding is shaping up. The six stages of the evolution of the data resource function is helpful to understanding current developments as well as future organizational developments.

Distributed processing has been set off by developments in mini-micro computer and terminal technologies. The main
effect of these technologies has been added complexity to the data resource function. In conclusion, three points are important:

(1) Developments in information technology create organizational responses.

(2) Organizational responses of a company are dependent upon its data processing stage of maturity. The stage is a result of the organizational assimilation of external and internal bodies of knowledge. The rate of knowledge assimilation is greatly influenced by the balance of organizational slack and control.

(3) The current information technology and relative stage status of most companies has created an extremely complex data processing management environment that defies simple solutions. Organizational theories and frameworks are necessary to sort out the phenomena so that effective management action can be executed.

REFERENCES


