INFORMATION TECHNOLOGY AND ORGANIZATION CHANGE: STRATEGIES FOR MANAGERS

(DRAFT)

(December 31, 1985)

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PREFACE

This paper is a revised and expanded version of the Fourth Annual William A. Patterson Transportation Lecture presented by the author on May 1, 1985 at Northwestern University.

Our purpose is to present a summary of research in progress. We look forward to critical reactions from colleagues in industry and academia. We would also appreciate suggestions of situations which may provide case studies for testing and refining these ideas.

ACKNOWLEDGEMENTS

The author has benefitted greatly from discussions and collaborative work with a number of colleagues. I would like to thank the following for their contributions, direct or indirect, to this research: Raphael Amit, Benjamin Mittman, Robert Duncan and Phillip Kotler, Northwestern University; John Robinson, The Harper Group; Harvey Romoff, CP Ships; Eliot Levinson, M.I.T.; Jane Fedorowicz and Liam Fahey, Boston University; and Peter Keen, London School of Business. I would also like to thank Robert P. Neuschel for his encouragement of this work on information systems as an issue of major importance for the transportation industry.

The author bears full responsibility for any errors or omissions in this work.

This research was supported by the William A. Patterson Fund. I want to express my deep appreciation to Professor Frank Spencer, United Airlines, and the other contributors to the fund which established the Patterson Professorship. This research would not have been possible without this support.

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STRATEGIES FOR MANAGERS

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EXECUTIVE SUMMARY

OBJECTIVES

Information technology is clearly becoming a major tool of competive strategy. This is true in most industries, and especially in transportation and logistics.

To manage the development and implementation of information technology-based strategy is a difficult task. Managers need a conceptual framework to guide this process. This paper proposes such a framework, suggests several practical techniques for strategy development and implementation [based on the framework], and concludes with recommendations for management actions.

BASIC PREMISE

In our view, strategic analysis of information technology options must be based on this basic premise:

TECHNOLOGY CHANGE SHOULD BE PLANNED AND MANAGED

AS PEOPLE CHANGE

To achieve a sustainable competitive advantage, it is not sufficient to plan information technology changes in isolation. Parallel, coordinated people change is essential if technology changes are to be effective. People are the basic resource of an organization. For every strategy being considered, there are certain people in the organization whose performance is critical to the success of that strategy. These critical individuals and groups not only must accept and be comfortable with the new technology, but

also must modify their basic patterns of work to take advantage of the new technology if the technology change is to succeed in changing strategic advantage.

THE FUNDAMENTAL OBJECTIVE OF CHANGES IN INFORMATION TECHNOLOGY IS TO BRING ABOUT CHANGES IN THE WAYS IN WHICH PEOPLE WORK.

CONCEPTUAL FRAMEWORK

The central ideas of the conceptual framework are expressed in Figure S-1, Linking Strategy to People and in Figure S-2, Integrated Action Program.

The first step in managing information technology effectively is to have a clear strategic vision of what the organization's business is to be. This strategy may be based heavily on the use of information technology, or information technology may play only a supporting role.

For any strategy, there will be certain processes the performance of which is critical to the successful execution of the strategy. These critical processes must be identified. Then, for these processes, the functions to be performed and the information flows to support the performance of those functions must be identified.

For each critical process, there will be several tasks whose performance is critical to the successful working of that process. These critical tasks must be identified.

Tasks can be characterized usefully in terms of the individual and group processes by which people work on the problems posed by the task. These "problem-working processes" are supported by, and influenced by, the human system around the tasks and by the information system.

The major aspects of the human system include organizational culture, organizational structure, social structure, reward systems, and human resource

LINKING STRATEGY TO PEOPLE

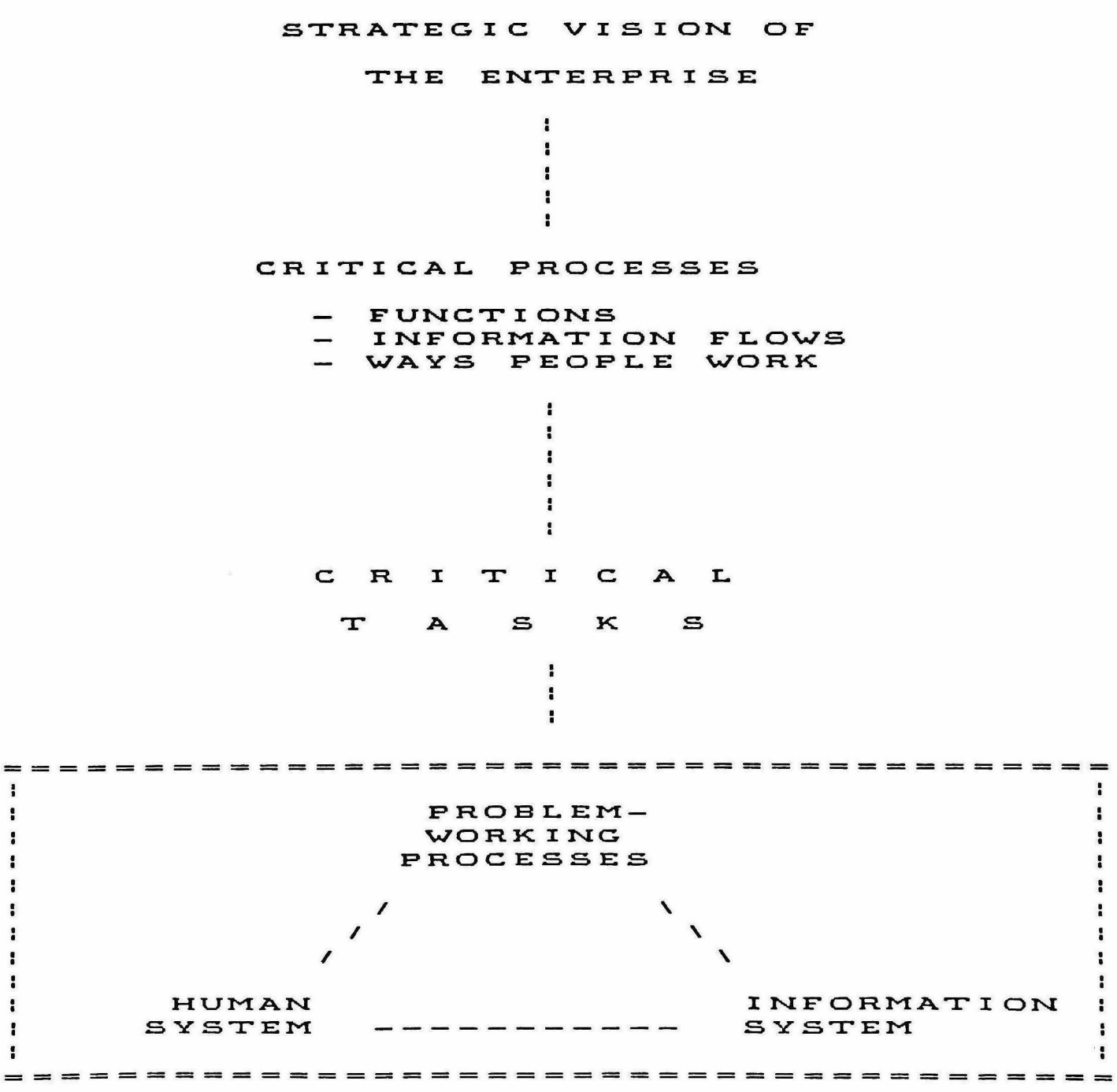


FIGURE S-1

INTEGRATED ACTION PROGRAM

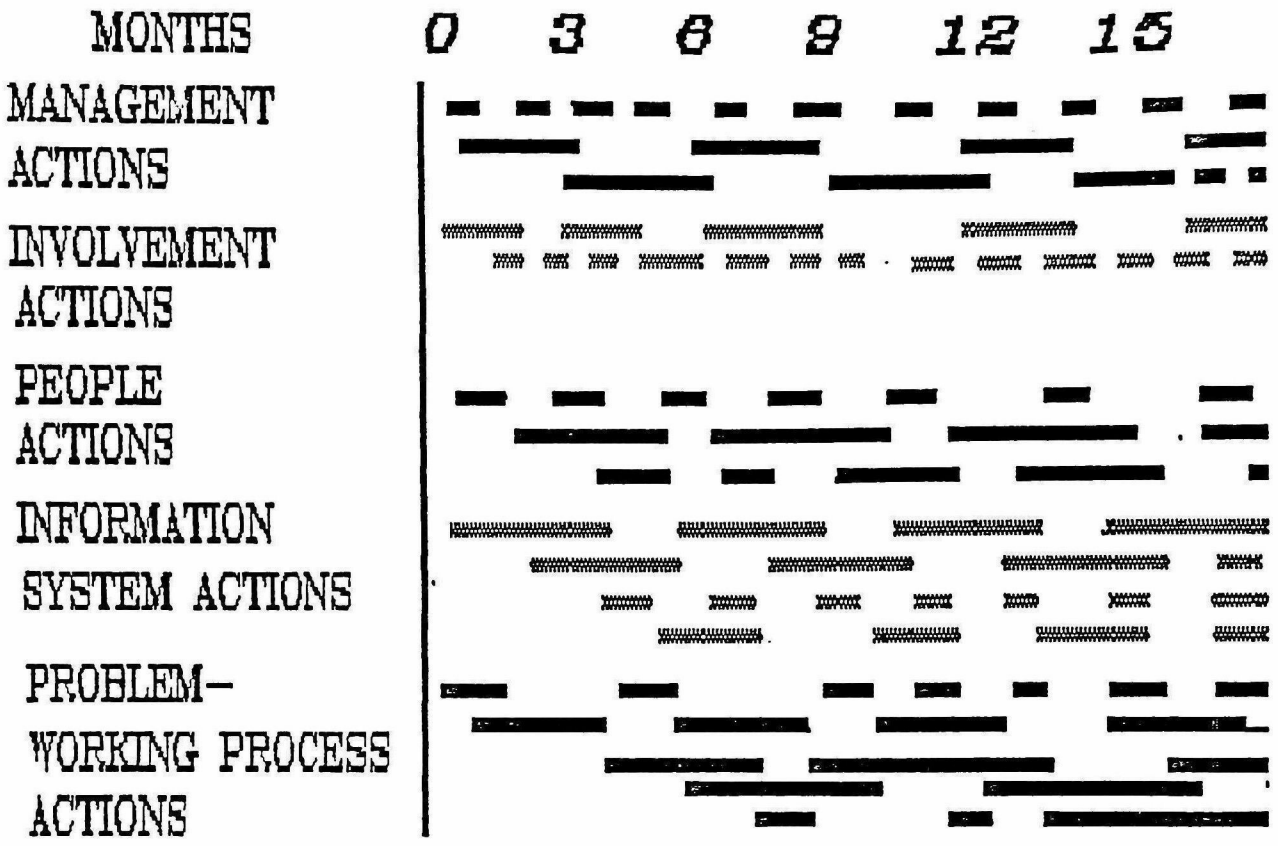


FIGURE S-2

development systems. The ability to bring about desired changes in problem-working processes may be retarded or helped by some of these aspects of the human system.

The major aspects of the information system include hardware (computers and communications), software, databases, and service delivery mechanisms - ways in which users get assistance in acquiring new capabilities.

The electronic work station is the interface between the individual or task group's problem-working processes and the resources reached through the information system. The workstation's linkage functions link the user to resources both within and outside the organization (e.g., customers, suppliers, etc.). The workstation's problem-working functions support the individual's activities of working on problems. Technology planning and implementation should be visualized in terms of potential changes in the linkage and problem-working functions provided by the workstations. These changes can be expressed through the concept of a Strategic Information Map.

Planned change must focus on changes in problem-working processes, but must also include both the human system and the information system. The information technology change is only part of the forces influencing the problem-working processes, and therefore task performance; the human system offers incentives and constraints on the processes as well.

For an information technology-based strategy to be effective, it is essential that the strategic concept and strategy implementation plan be integrated so that changes in all these major elements are consistent and coordinated:

- the strategic vision,
- the critical processes,
- the critical tasks, and

- the problem-working processes, information system, and human system supporting those tasks.

SOME USEFUL TECHNIQUES

The conceptual framework serves as a basis for development of a number of specific techniques.

The Information Technology Strategic Assessment is a systematic approach to assessing the strengths and weaknesses of the organization's present or proposed strategies.

The Strategic Information Map is a useful tool for visualizing the information system - existing or proposed - from a perspective of user service. Included in this analysis is identification of the information flows both internal to the organization - vertical, lateral, or inter-group flows - and external to the organization - customers, suppliers, competitors, others, and also the problem-working processes support by planned workstations.

Specific Information Linkage Criteria are proposed for assessing the quality and effectiveness of information flows internal and external to the organization. Workstation Design Criteria are also proposed for assessing the quality of the workstation functions provided, in terms of individual motivations and effectiveness and the quality of working life.

The Integrated Action Program is a management tool to structure the strategy implementation process into a series of tasks in a coordinated work program.

An overall Strategic Planning Methodology is laid out which integrates these techniques in a manner consistent with the conceptual framework.

ACTIONS FOR MANAGERS

The theoretical concepts also lead to specific action suggestions for managers:

1. Senior managers should consider carefully whether they themselves should take charge of managing information- technology based change.
2. Managers should manage technology change as people change, with a strategic vision.
3. Managers should integrate people change and technology change, using techniques such as:
   a. developing an Integrated Action Program, incorporating coordinated actions of five major types: management actions, involvement tasks, people system tasks (such as revising job descriptions), information system tasks, and problem-working process tasks;
   b. conducting an Information Technology Strategic Assessment, an in-depth examination of the organization's present strategies and capabilities;
   c. using the Strategic Planning Methodology proposed;
   d. developing a Microcomputer Action Program as part of the Integrated Action Program.
4. Managers should focus change on the individuals in the organization by:
   a. using a user-dominated strategy to develop information support to individuals and task groups;
   b. humanizing the technological environment by adopting explicit design criteria to guide the development of electronic work stations and supporting software;

c. taking steps to focus people's attention on their own problem-working processes through stimulating discussion, analysis, and development of improvement suggestions.

5. Managers should implement technology-based change in a phased, controlled manner.

6. Senior managers should provide effective staff support to line managers to help them manage people-based technology change in their organizations. This requires careful planning for the integration of support provided by both the information systems and human resource staffs. It may be desirable to consider significant rearrangements of information systems and human resources staffs, possibly uniting them in one support group.

CONTENTS - SUMMARY

CONTENTS - DETAILED

Page

Page

LIST OF FIGURES

Page

EXECUTIVE SUMMARY

CHAPTER II

CHAPTER III

Page

CHAPTER IV

CHAPTER V

CHAPTER I

INTRODUCTION

A. Objectives

Rapid change in information technology is a key fact of modern life. Computers and communication systems have evolved rapidly in recent years and there is no indication that the pace of change will decrease.

Change in information technology offers significant opportunities, and significant challenge, for managers in all types of organizations, and especially in transportation and distribution organizations. To deal with this challenge, managers need to be able to think systematically about information technology and its potentials for their own organizations.

Our objective in this paper is to present a systematic way of looking at information technology and its implications for strategic management which we believe is especially useful to managers in transportation and distribution organizations.

The concepts and techniques presented here are the subject of on-going research. We hope their presentation here will serve to stimulate dialogue, testing and refinement, and further research on information technology and strategic management.

B. Information technology choices - a first look

We will first clarify what we mean by "information technology choices." The major components of information technology are:

- hardware -- computers, communications networks;
- software;

- databases;
- service delivery mechanisms -- the ways in which users can access computers and communications, and especially the ways in which support is provided to assist users in obtaining new capabilities.

(We will examine these components in more detail in Chapter III.)

There are many specific choices available for each of these components, so the range of options open to a particular organization is very large. In companies of all sizes, managers are wrestling with questions such as these:

1. How much emphasis should we place on microcomputers, as opposed to mainframes and minicomputers? Why should we support microcomputers at all?
2. How much emphasis should we place on networking our computers together -- local area networks within a building or building complex, or connected geographically across countries and continents?
3. Should we be planning to link our computers to our customers? To our suppliers? Or even to our competitors?
4. What should be our relative priorities for further development of our traditional transaction processing systems, of management information systems, or of the new "decision support systems"?
5. How much priority should we give to development of integrated voice and data communications networks?
6. How much should we push for office automation? For electronic workstations for senior managers? For technical staff? For clerical staff? What benefits would we expect?
7. What choices should we make for the major architecture features of the system elements we plan to implement in the next year? In the next five years? Next ten years?

Most importantly, more important than the answers to any single question: what process should we follow to think systematically about these many difficult technology choices?

Our objective in this paper is to present a conceptual framework, and suggest some specific techniques, which can provide a systematic basis for analysing such questions.

C. Importance of information technology

Clearly, these are not one-time decisions. Rather, managers in transportation companies can expect to face a series of such technology choice questions in future years. The process of change in information technology will be a continuing process. Managers have to manage this technology change process on an on-going basis.

In making these decisions, managers will be taking actions that will significantly influence the ways their companies operate. Can a senior manager in a transportation company afford to delegate these decisions to the technical experts -- the Director of Information Systems, for example?

In our view, no senior manager today can afford to ignore information technology and its potential implications for his organization. There are several reasons for this:

1. Information technology can, in many situations, be a major component of a company's competitive strategy.
2. Even if not a primary tool of a company's own strategy, a manager must anticipate and examine possible threats from uses of information technology by competitors.

3. Information technology may be a useful supporting element in a company's implementation of its strategy.
4. Even when not a major factor in a company's strategy, change in information technology is inevitable and will have a strong influence on the nature of work in almost every organization of any size. Office automation; changes in access to data by customers, competitors, or suppliers; and the use of personal computers will have significant impacts on the workplace.

These four issues are especially important to transportation and distribution organizations. Such organizations are characterized by geographic dispersion, rapid changes in operations in the field, and decentralized control of dispersed field operations. For these reasons, transportation and distribution organizations already rely heavily on communications and computers to provide current information for operational and management decisions. Information technology is already a major tool in most transportation and distributions companies.

D. PREMISE: TECHNOLOGY CHANGE IS PEOPLE CHANGE

A substantial amount of research has been done to develop general theories and methods for strategic planning and strategic management. In addition in the specific area of information technology and its role in strategy, there is a small but rapidly growing literature (Note 1-1). In assessing the methods and techniques which have been developed so far for their applicability to transportation and distribution companies, we find that there is a major omission: all of the literature on information technology and strategy treats only the technology dimension, with little or no attention to the human dimension.

It seems clear to us that information technology cannot be discussed in the context of strategy without equal attention to the human dimension. Consider these two transportation examples:

a. A major transportation company recognized early that deregulation required major changes in marketing and sales techniques. Prior to deregulation, when prices were regulated and service characteristics largely fixed, an inquiry from a prospective customer would be handled primarily by looking up the applicable tariff in a rate book and quoting that price to the shipper. In a deregulated environment, the carrier was free to set prices and also service characteristics.

   A new senior marketing officer was brought in from outside the company's traditional transportation operations. His top priority was to change the way the company's marketing people worked in a very fundamental way: He wanted them to shift from simply looking up tariffs in a rate book, to developing a price for that particular customer based upon an analysis of the costs associated with that particular shipper's requirements. Further, he wanted then to develop alternative service options with alternative prices. This required a significant change in people's attitudes, as well as new techniques. To bring about these changes quickly, he procured a number of microcomputers and had some pricing programs written. With these tools to help them, the marketing personnel were able to rapidly transition to the desired mode of operations. (Eventually, the pricing programs were made operational on the company's mainframe computers, and the microcomputers were shifted to other uses.)

b. The chief executive of another transportation company has several concerns. As he assesses where his company stands today, he feels that it has a competitive edge because of the ways in which it is using information technology. However, he is also concerned that since almost all of his managers have come up through the operating ranks, they are relatively conservative, not really comfortable with the information systems, and not involved in the development of innovative applications of information technology to the company's business. Yet, he feels that continual innovation, by managers as well as systems staff, is essential if the company is to retain its competitive advantages.

   The CEO is considering and has partially implemented a strategy to deal with these issues. He has initiated an extensive management training program to develop basic management skills, and is encouraging the information systems department to stimulate the development of microcomputer applications throughout the company. He is considering mounting additional educational and dissemination activities in a coordinated program: hands-on training for managers in basic microcomputer uses, discussion in management meetings and training sessions of current and potential uses of microcomputers and other information technologies, and a program to seek out and reward productive innovations in use of information technology. This recognition program would be especially targeted to identifying microcomputer applications

developed in field offices which were particularly useful, and especially those applications which might be further developed by central information systems staff for dissemination throughout the organization.

In both these examples, managers were using information technology changes as part of an overall strategy to change the ways people work in their companies to achieve broader strategic objectives.

In our view, this is the fundamental principle on which strategic analysis of information technology options must be based:

TECHNOLOGY CHANGE SHOULD BE PLANNED AND MANAGED AS PEOPLE CHANGE

To achieve a sustainable, competitive advantage it is not sufficient to plan information technology changes in isolation. Parallel, coordinated people change is essential if technology changes are to be effective. The people who are the basic resource of the organization must not only accept and be comfortable with new technology, but also must incorporate the technology into their basic patterns of work if the technology change is to succeed in changing strategic advantage.

In this paper, we take this principle as our basic hypothesis, and explore its implications.

E. Overview of this paper

In Chapter II, we examine the work of a railroad locomotive dispatcher. We conclude that there are three critical dimensions of people change that must be considered: Changes in the ways of individuals do their work, changes in the ways groups of individuals accomplish specific tasks, and changes in the ways the formal and informal structure of the organization of influence people's abilities and willingness to change ways of work.

In Chapter III, we examine several aspects of information technology. Our basic objective is to suggest a methodology, including criteria and analysis techniques, which can guide the design of the delivery of information technology support to users.

We first examine the microcomputer phenonomenon. The microcomputer impact on organizations demonstrates several elements: In addition to being a useful tool it can be a catalyst to individual initiative and can stimulate people's imagination and creativity. Thus, the microcomputer illustrates the potential for using information technology to achieve broader organization change objectives.

We then look at how the field of information technology has been evolving, especially with respect to the evolution of the relation between users and system developers. We see that the focus of support to users has begun to shift to a view that users can develop many of their own applications themselves, and that information systems staff can be useful in the role of supporting users' own developments, as well as the traditional role of implementing systems according to specifications jointly worked out between users and developers. This new view is supported in some companies by a decentralized support strategy, in which some elements of information technology expertise are decentralized to functional units.

These two discussions cumulate into a view of information technology as being delivered to users in a wide variety of ways, with users able to develop their own support tools when desired, with or without expert assistance from specialised information systems staff.

Next, we turn to the problem of designing support for the user. This question is addressed at two levels.

A first level of query is in terms of the functions which can be performed, at the "electronic work station," the user's point of access to the information resources. We see two aspects to this. First, what external linkages can be established from the workstation? To whom and for what purposes? Second, what types of support is provided for individual problem-working activities? We examine several ways of analysing this question. A key issue is the extent to which the information systems supports computer-assisted problem-working, rather than simply data access and basic numerical and graphic manipulation of quantitative data.

This leads to the second level of inquiry: what objectives ought to be achieved? In answer, we identify a set of candidate design criteria for assessing the capabilities provided. A key element of these criteria is the capability of the user to shape his or her own IT support, alone or with assistance from specialized staff, and the implications of this capability for user satisfaction with the nature of work.

Chapter IV presents the basic elements of a methodology for designing and managing a people-based information technology strategy.

Chapter V summarizes the concepts developed in the paper in terms of action recommendations for managers. Chapter VI presents suggestions for educators and researchers. Chapter VII presents conclusions.

CHAPTER II.

THE HUMAN DIMENSIONS OF INFORMATION TECHNOLOGY: AN EXAMPLE

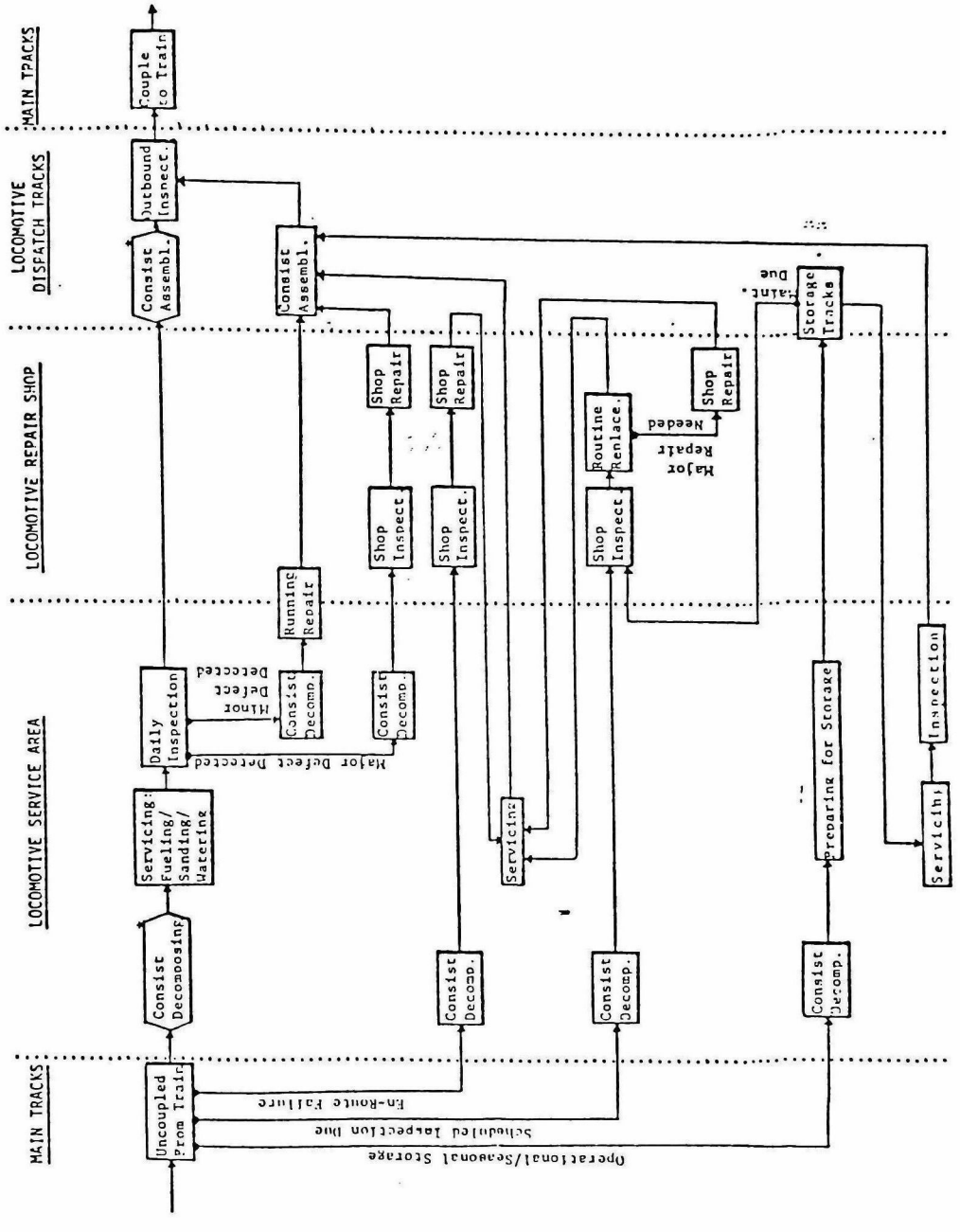
To begin our examination of the ways in which technology change must be managed as people change, we will examine the task of managing the use of locomotives in a railroad. This example is based on a study of ways of improving the effectiveness with which railroads used locomotives (called "motive power" or simply "power"). (Note 2.1). The study began by examining the "power dispatchers" - the individuals who make detailed operating decisions about the uses of locomotives. The processes which power dispatchers appeared to follow were studied by observations of dispatchers at work and by interviewing dispatchers and other personnel. Several railroads were examined in this study.

A. The work of the power dispatcher

The primary role of locomotives is to pull trains of freight cars over the railroad from one location to another. The processing of locomotives in yards is a central element in power utilization (as it is with car utilization). Figure 2-1 shows the basic events that happen to locomotives as they are processed through a yard on a railroad:

1. When a train pulls into the yard, the locomotives are inspected to see if there are any maintenance needs.
2. The locomotives are detached from the cars. The cars are moved through the yard by a yard engine to wait on tracks for departure to their next destination. If locomotives require repair or scheduled

FIGURE 2-1: PROCESSING OF LOCOMOTIVES IN A TERMINAL AREA



* Whether to decompose an inbound consist or to re-assemble an outbound consist will depend on the requirement of engines' next assigned tasks.

maintenance, they are moved to appropriate locations. All other locomotives are moved to a holding area to wait to be assigned to an out-bound train.

3. When required repairs on locomotives are completed, they are moved to the holding area.
4. When an out-bound train is to be assembled, appropriate locomotives are selected from the holding area and moved to the train.

There are numerous uncertainties in this process. In addition to the uncertainties about the arrival time of a locomotive at a yard, the occurrence of unscheduled repairs and the many factors influencing the time required to accomplish maintenance (whether scheduled or unscheduled) create additional uncertainties. Therefore, the numbers, types, and locations of power units available to be assigned to particular trains is always uncertain.

The problem faced by the dispatcher is to assign the necessary number of locomotives to each planned out-bound train. He also tries to improve the distribution of available locomotives by repositioning units when necessary. He tries to assign locomotives to trains to meet several goals:

a. train departure requirements - providing enough locomotives at the right place at the right time to enable a scheduled, or unscheduled, train to depart when desired;
b. meeting minimum power requirements - having the required total horsepower available to haul each train, which requires estimating the number of cars for each train in advance, or alternatively, holding some cars for a later train if sufficient power can't be supplied;

c. observing required standards for maintenance and other servicing of power units;

d. achieving desired goals for utilization of the units;

e. and others.

This problem is complex not only because of the multiple goals, but also because of the uncertainties indicated above. The power dispatcher is continually having to adjust his plans for using particular locomotives to reflect the randomly-changing availabilities of particular units. Further, requirements for power to be assigned to trains depend not only on the scheduled trains, but also the numbers of cars in a yard requiring movement to particular destinations, and corresponding operating decisions that are made about train lengths and about running unscheduled trains.

B. Individual problem-working process

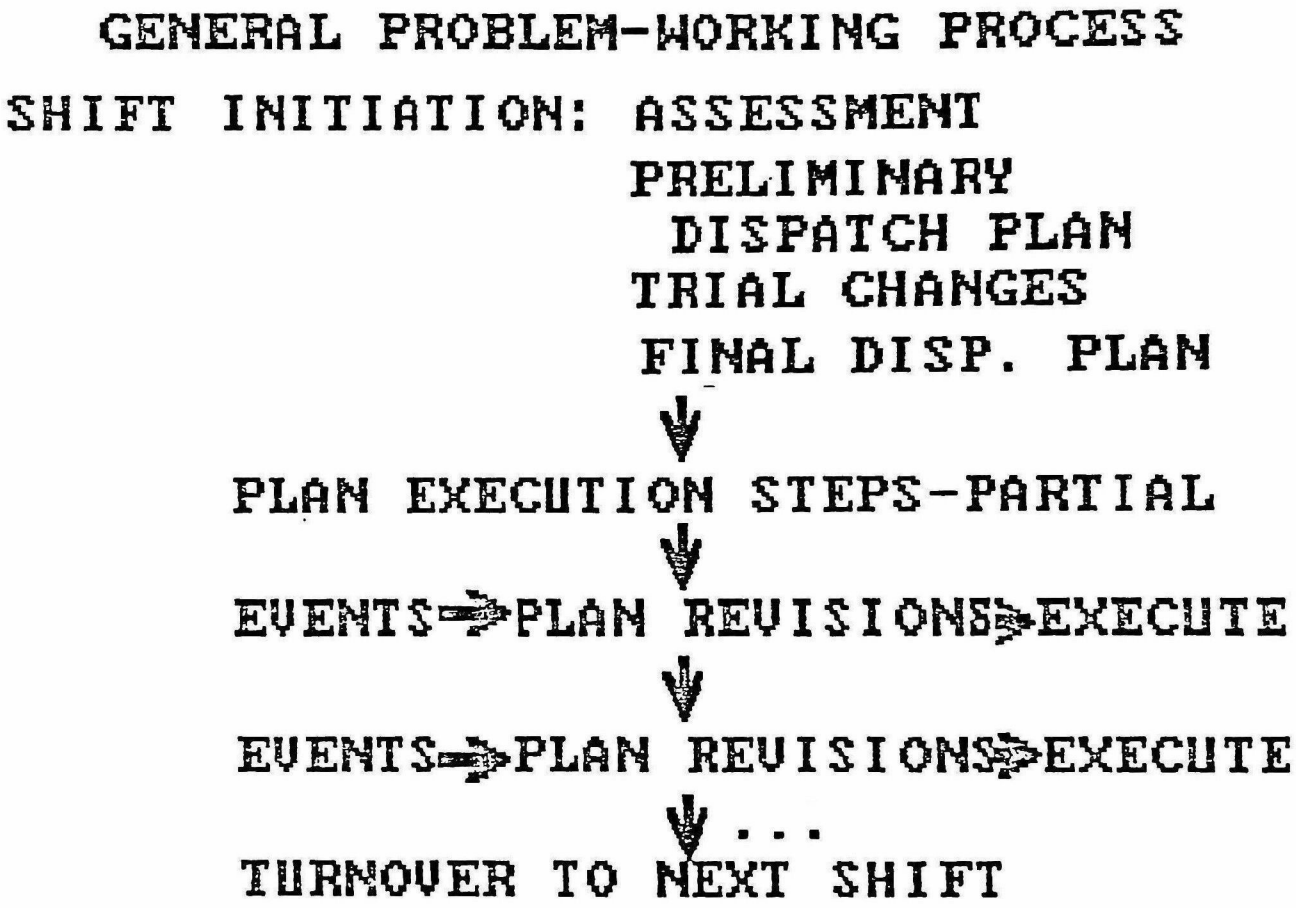
To analyse this problem, one focus of the research was to study the actual processes used by dispatchers. Through interviews and observations of a sample of power dispatchers, data on the processes followed by dispatchers were obtained.

Figure 2-2 shows the general structure of a typical dispatcher's processes of working on the power management problem. At the beginning of his shift, the dispatcher develops an initial dispatch plan which will guide his work during the shift. This involves

1. reviewing available data and assessing the present situation - locations where there are too few or too many locomotives, the numbers and status of units in the various repair shops, and their expected times of availability for use, and other data;

FIGURE 2-2

TYPICAL DISPATCHER PROBLEM-WORKING PROCESS-OVERVIEW



2. development of a preliminary plan for his work shift, specifying how he plans to deploy the available locomotives to meet the expected train requirements;
3. adjustments of the preliminary plan to redeploy locomotives to obtain better plans;
4. finalization of a plan for the shift.

Once finalized, the plan serves as a basis for executing the decisions - assigning specific locomotives to particular trains scheduled to depart at particular times. Then, the dispatcher begins executing the plan. Inevitably, as time goes on, various operational contingencies rise - e.g., breakdowns on the road, inspections identifying needed but unanticipated repairs, delays in completion of maintenance, greater or lesser numbers of cars to be moved than were planned for, etc. These result in the need for the dispatcher to revise his plan throughout his shift as he executes it.

Figure 2-3 and 2-4 show the processes in which dispatchers developed and revised plans in greater detail. Figure 2-4 shows in detail the processes used to accomplish one step in Figure 2-3, the search for additional locomotives. Different dispatchers perform this search in different ways. Some search broadly, while others search deeply.

While these figures do not capture all of the richness of detail of the actual processes, they do suggest the complexity of the processes used by actual dispatchers.

C. Improving problem-working processes

Several conclusions emerge from this examination:

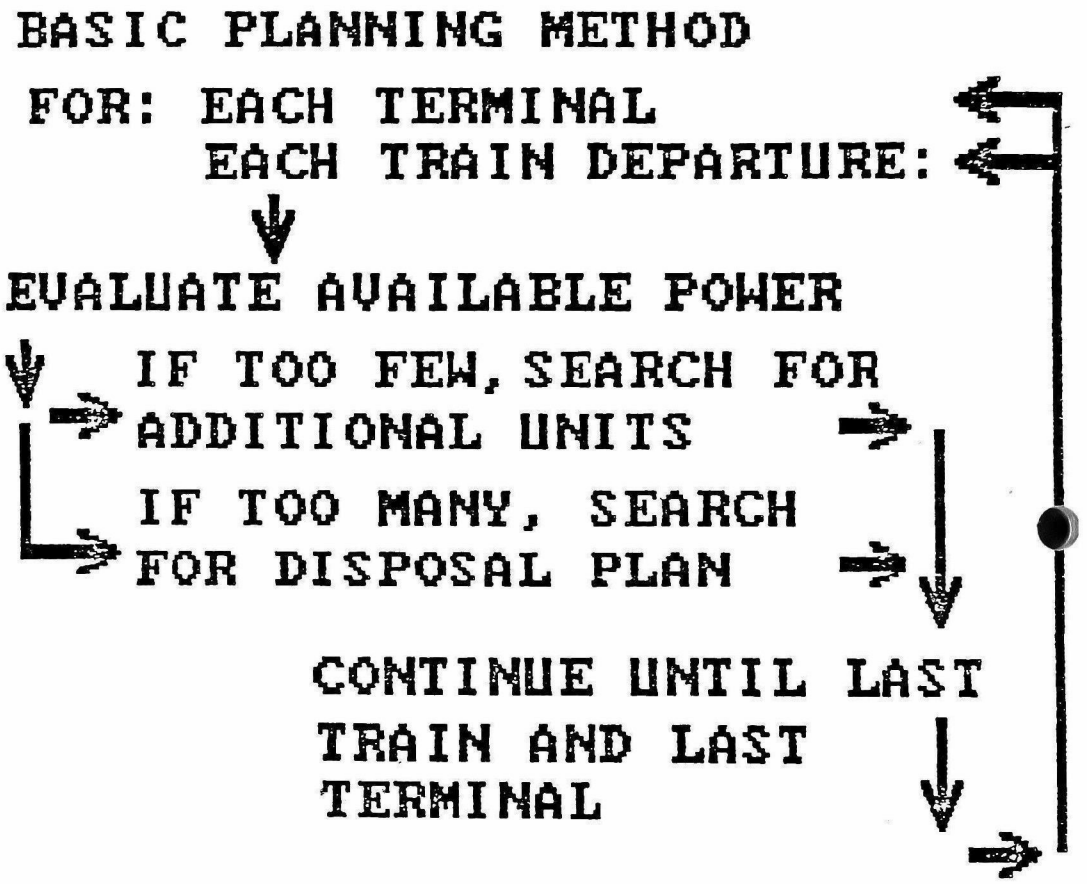

BASIC PLANNING METHOD
FOR: EACH TERMINAL
EACH TRAIN DEPARTURE:
EVALUATE AVAILABLE POWER
IF TOO FEW, SEARCH FOR ADDITIONAL UNITS
IF TOO MANY, SEARCH FOR DISPOSAL PLAN
CONTINUE UNTIL LAST TRAIN AND LAST TERMINAL

FIGURE 2-3

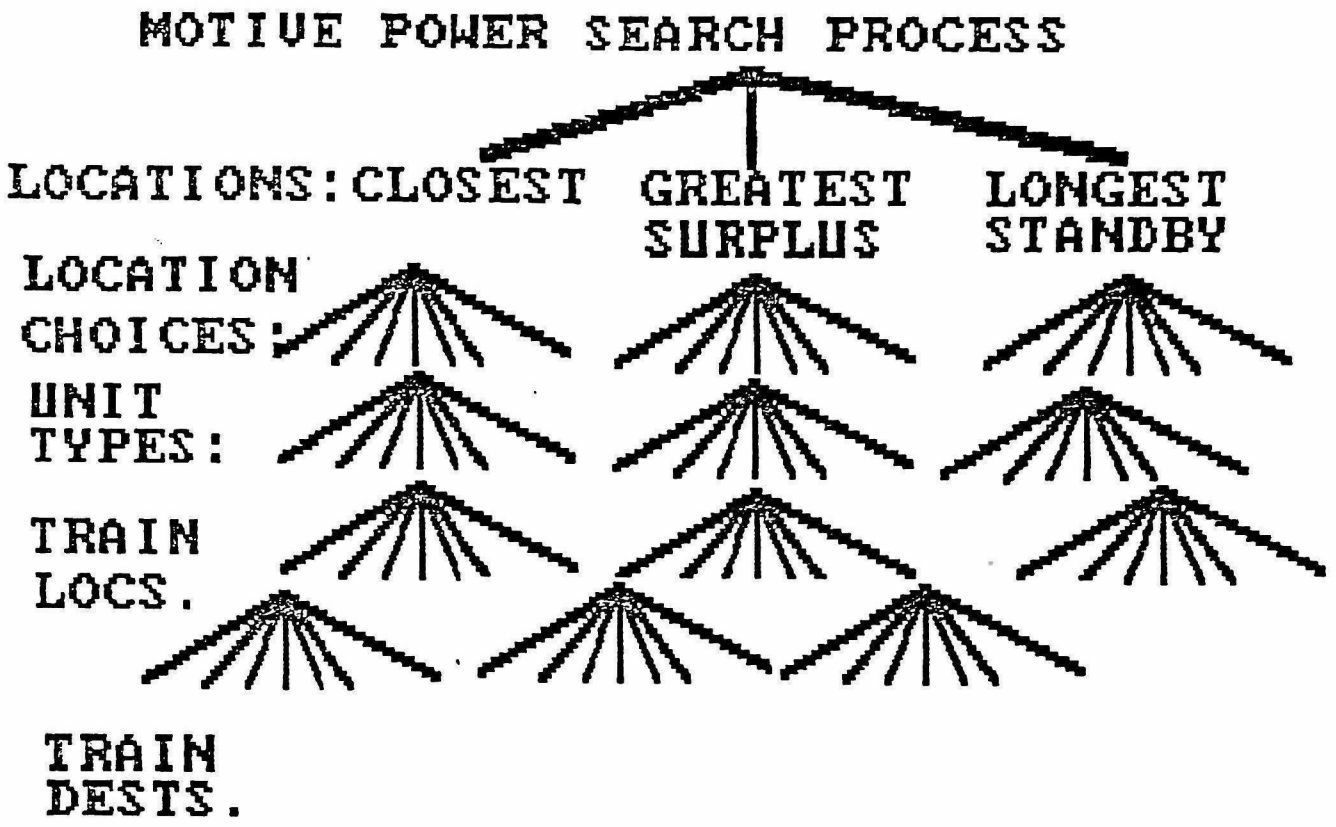

MOTIVE POWER SEARCH PROCESS
LOCATIONS: CLOSEST
GREATEST SURPLUS
LONGEST STANDBY
LOCATION CHOICES:
UNIT TYPES:
TRAIN LOCS.
TRAIN DESTS.

FIGURE 2-4

1. The task of dispatching power is complex, involving many choices and many criteria, in a dynamic, pressured, and uncertain context.
2. The power dispatchers typically have worked at their jobs long enough to have developed good methods for working successfully on this complex problem. In addition, they have acquired substantial experience with, and insight into, the issues with which they are dealing. Their methods are "good enough" that they produce results with which the individuals and the organization survive.

The basic objective of this research was to improve the utilization of power, through the provision of computer tools. There are two basic approaches to achieve this objective:

1. optimization approaches - develop large-scale computer models which endeavor to find dispatch plans which "optimize" some objective such as the utilization of power;
2. heuristic support approaches - develop computer tools which enhance power dispatchers' abilities to work more effectively on this problem.

In the first, "optimization," approach, often advocated by operations researchers and other computer specialists, the objective is to minimize the need for human input and if possible to replace the human with a computer model. The premises of this approach are that it is feasible to develop a computer model which incorporates all the relevant factors at a level of completeness and detail sufficient to produce results sufficiently detailed and valid to be used under all possible operating conditions.

We doubt that it is feasible to follow this approach successfully in a problem as complex as that of power management, or on many other similar tasks in transportation and distribution organizations.

In the second, "heuristic support," approach, the objective is to find ways of providing computer tools which the dispatcher himself finds useful as he works on the power management problem. That is, the premises of this approach are that the experience and insights of the dispatcher are valuable, and cannot be captured completely in a computer model. Instead of trying to build a single large computer program or model which tries to find "the best" dispatching plan, one should try to understand the ways in which humans work on this complex problem and endeavor to develop techniques which make this human "problem-working" process more effective.

This requires several things:

1. understanding how the dispatcher operates now;
2. development of ways of improving the dispatcher's performance, while still leaving him in control of the process;
3. incrementing improved capabilities in steps, in which the user tests and reacts to new capabilities, and at each step can accept them, reject them, or suggest improvements (see Note 2-2).

Thus, we see several principles emerge from this example:

I. It is essential to understand the processes by which people work on problems now, in order to design methods to improve those processes.

II. In most situations, the objective of improving human problem-working processes is more desirable and more effective than the objective of replacing people by computers.

III. Improving human problem-working processes requires active acceptance of the objective by the individuals now working on the problem, and active participation in the process of developing new tools by those individuals as users and "testers" of possible tools. This requires that those individuals developing new tools gain the confidence and support of users prior to, and throughout, the process of implementing each successive improvement in the tools.

IV. There may be organizational factors which influence the individual dispatcher's capability and willingness to try new approaches. For example, promotion and other reward criteria may penalize failures and not reward risk-taking, thereby causing individuals to be reluctant to try new methods. It may be necessary to change these organizational forces.

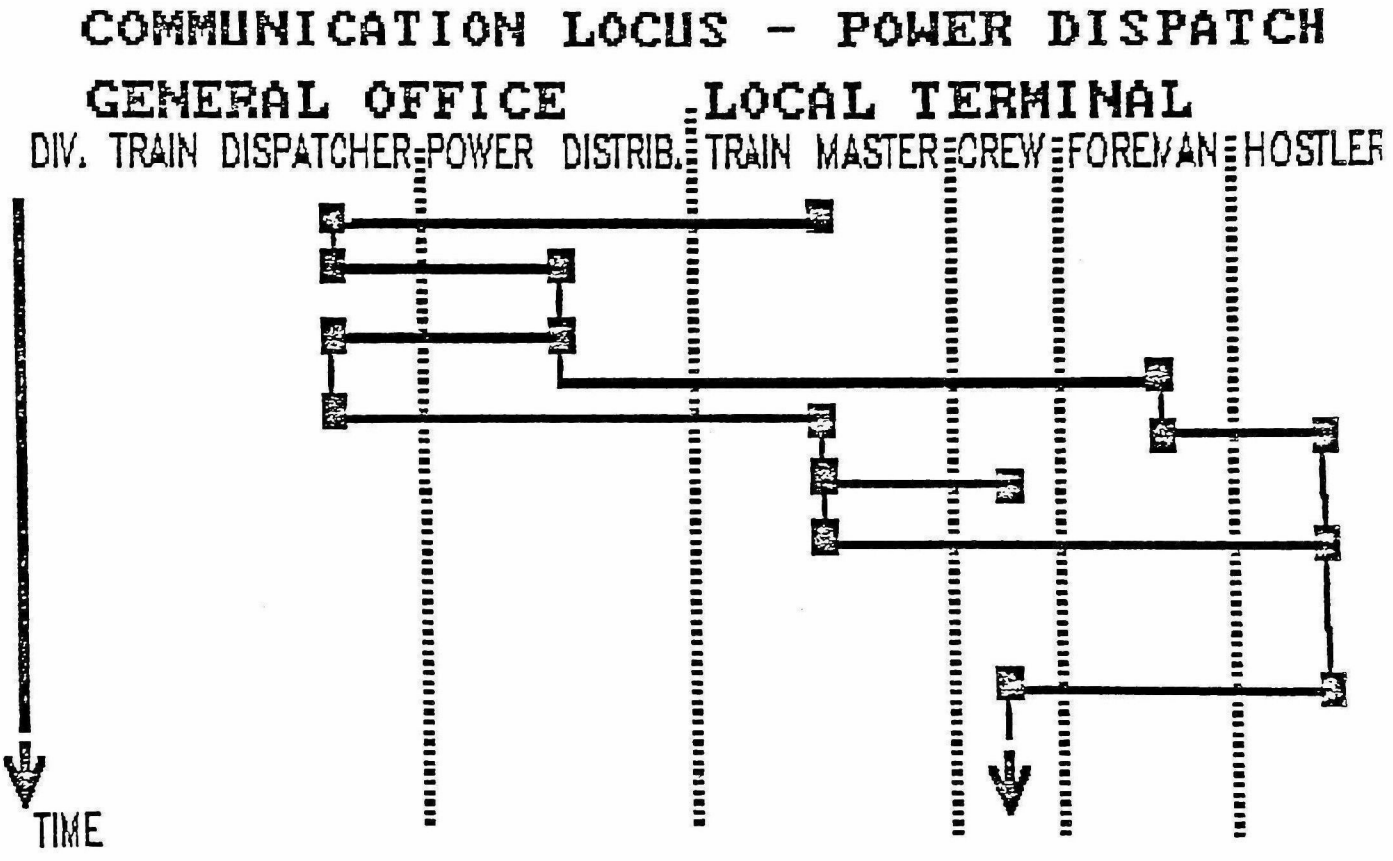
D. The individual in the task group

When we were studying the processes used by individual dispatchers, it quickly became clear that we had to study the activities of a number of other individuals with whom the dispatcher interacted.

Each day, all the relevant operating personnel participate in an operating conference, conducted by telephone. Figure 2-5 shows the usual participants, and the sequence of interactions which typically take place each time it is necessary to assign locomotives to a specific train at a specific terminal. Figure 2-6 shows the organizational locations of each participant in the process shown in the preceding figure.

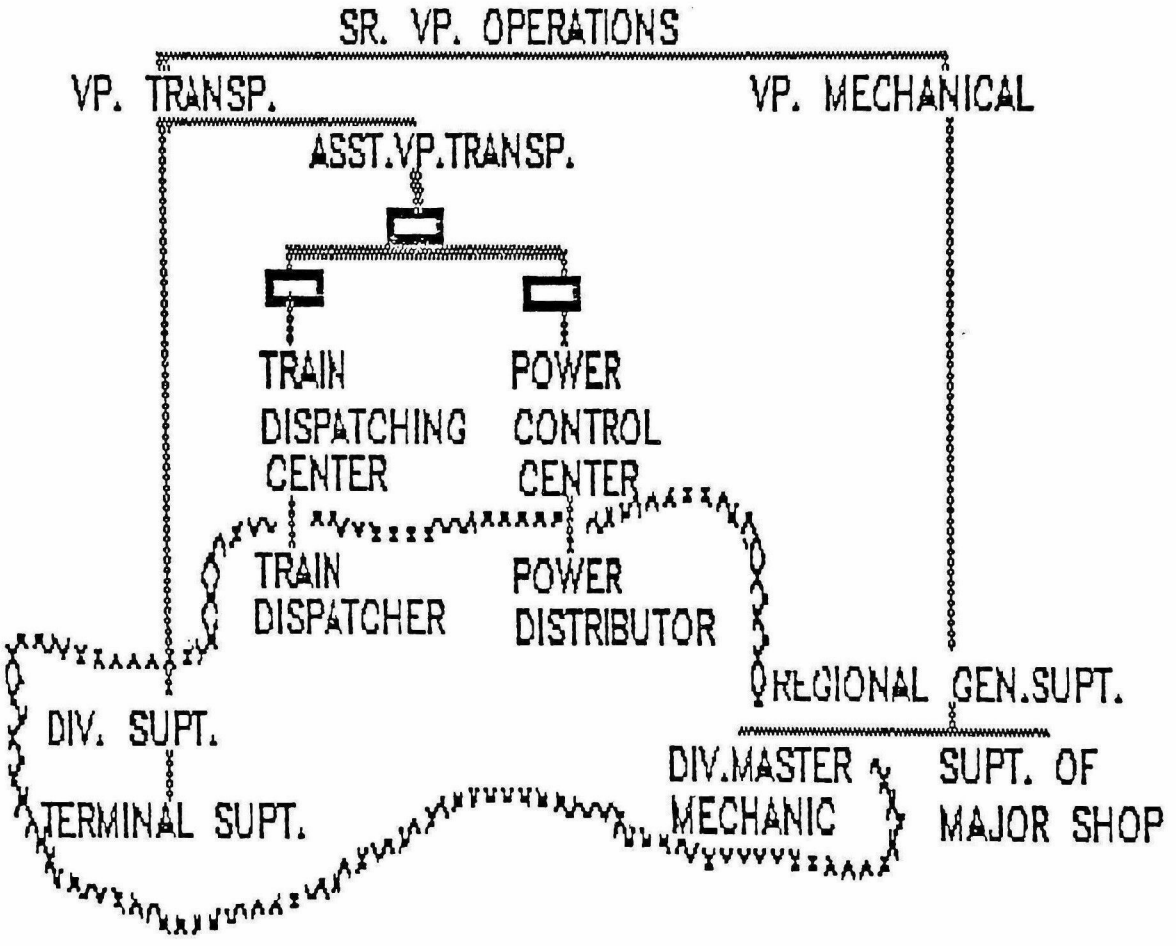
It is immediately apparent that the organizational dimensions of this process are complex. The individuals who participate in the process of managing locomotives are in different formal organizational units. Therefore,

F I G U R E 2-5



COMMUNICATION LOCUS - POWER DISPATCH TASK

FIGURE 2-6. ORGANIZATIONAL LOCATIONS OF PARTICIPANTS
POWER DISPATCH TASK



we can expect that they have different criteria for effective performance, different goals, different perspectives, and different skills, training, and experience. Further, we can expect that in the normal nature of organizations, each unit has different goals, styles, and processes, and that there is some mixture of conflict and mutual support affecting the relationships among various units.

In general, then, we can add these observations to the four earlier:

V. The task of dispatching power is a complex organizational process, involving participants in a number of organizational units.

VI. Typically, any change in the procedures used by one or more participants in the process will have some impacts on the ways participants in other units do their work, and some of these impacts may be perceived as negative by those other units.

VII. To gain acceptance of improved procedures by the individuals in different organizational units who participate in the dispatching process, we need to recognize the many, possibly different, pressures on each of the participants, and develop ways of accommodating those pressures.

E. Conclusion: a conceptual framework for analyzing tasks

This brief description of the issues in improving power dispatching allows us to suggest a few elements of a basic conceptual framework for analyzing tasks.

We will use the term task group to identify the set of individuals who participate in the performance of a particular task. We will use the term problem-working processes to describe the various activities in which individuals working on a complex problem engage. (This term is more inclusive

than the more common terms "decision-making processes" and "problem-solving processes.")

If we are trying to use information technology to improve the functioning of an organization to achieve some specific objectives:

I. We must understand the problem-working processes of those whose behavior we want to see changed, in order to identify ways in which those processes can be changed to achieve the objectives.

II. The problem-working processes must be understood at two levels:

   A. the individual level, and

   B. the task group level, in which a number of individuals interact in the process of working on the problem.

III. The organizational forces operating on individuals may significantly affect their readiness and capacity to accept changes in their problem-working processes. Therefore, these organizational forces on the individuals in the task group must be understood, again at two levels:

   A. forces on the individual, and

   B. forces affecting relationships among, and interactions between, individuals in the task group.

These conclusions lead us to the conceptual framework summarized graphically in Figure 2-7. This figure says that

1. Every task is accomplished through the interactions of three major elements:

   a. the problem-working processes of individuals and the interactions of the processes of the individuals in the task group:

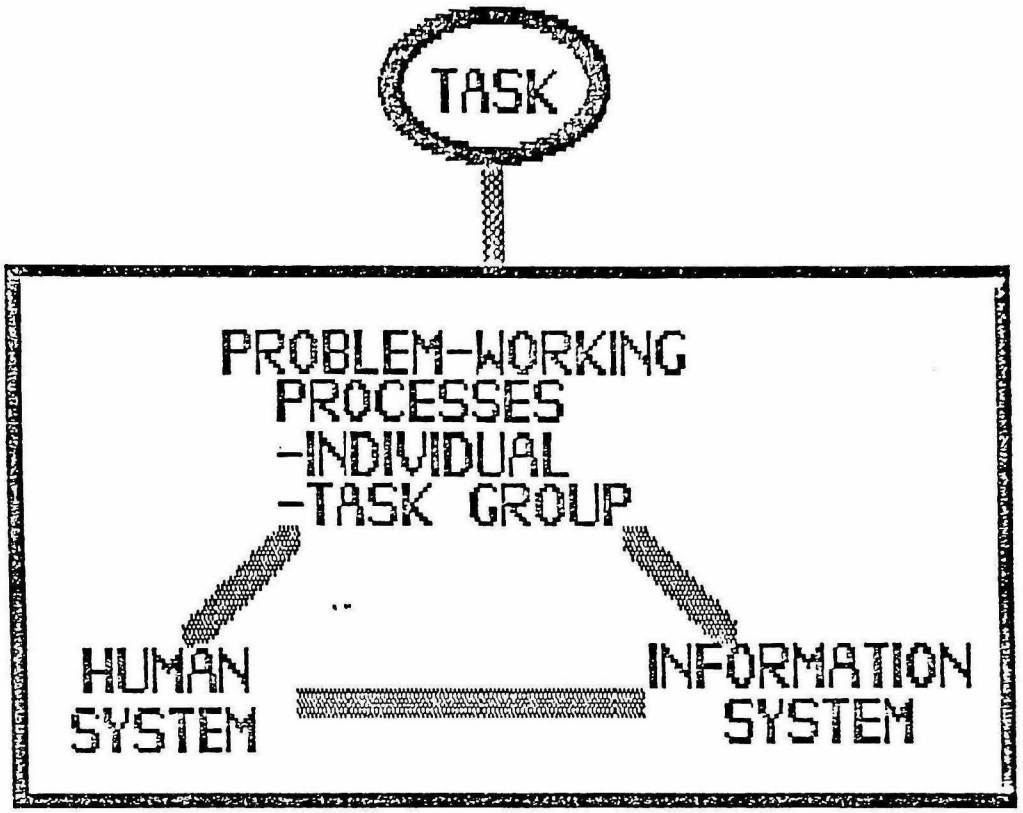


FIGURE 2-7. CRITICAL VARIABLES INFLUENCING TASK PERFORMANCE. (ADAPTED WITH MODIFICATIONS FROM C. PHILIP, C.K. MAO, R. DUNCAN).

b. the information system - both manual and computer components - which supports the problem-working processes; and

c. the human system - the set of organizational forces and relationships which impact on individual and group behavior and particularly the willingness and capacity to accept changes in the problem-working processes being used. The major components of the human system - the major types of organizational forces which must be considered - are shown in Figure 2-8.

2. In general, for change to be effective, all three elements of a task must be evolved to remain congruent. That is, to successfully accomplish desired changes in problem-working processes requires effective changes in information systems capabilities and may also require changes in some elements of the human system forces influencing individual and group performance and readiness and capacity to accept change.

In later chapters, we will discuss how this framework fits into an overall strategy for using information technology changes to improve the way an organization operates to achieve strategic objectives.

HUMAN SYSTEM:

ORGANIZATIONAL CULTURE

- VALUES-SHARED, CONFLICTING:
  - ORGANIZATIONAL
  - SUB-GROUP
    - ORGANISATIONAL UNIT
    - PROFESSIONAL GROUP
    - CAREER LADDER GROUP
    - OTHER
- STYLE
- RULES OF THE GAME

ORGANISATION STRUCTURE

- DIVISION OF LABOR
- DEPARTMENTALISATION-ORGANISATION STRUCTURE
- JOB DESCRIPTIONS- FORMAL, INFORMAL
- INTEGRATIVE MECHANISMS
- PERSONNEL AUTHORITY RELATIONSHIPS
- FORMAL COMMUNICATION NETWORKS

SOCIAL STRUCTURE

- FRIENDSHIP PATTERNS
- POWER AND INFLUENCE RELATIONSHIPS
- STATUS AND IDENTIFICATION RELATIONSHIPS
- INFORMAL COMMUNICATION NETWORKS

REWARD SYSTEMS

- COMPENSATION
- PROMOTION
- ADVANCEMENT OPPORTUNITIES
- RECOGNITION OPPORTUNITIES
- PERFORMANCE APPRAISAL
- PERFORMANCE MEASURES

HUMAN RESOURCE SYSTEMS

- DEMOGRAPHICS
- SKILLS
- MOTIVES, EXPECTATIONS
- RECRUITMENT-SELECTION
- TRAINING AND DEVELOPMENT

(ADAPTED FROM R. DUNCAN, C. PHILIP WITH MODIFICATIONS)

FIGURE 2-8. KEY HUMAN SYSTEM VARIABLES

CHAPTER III

INFORMATION TECHNOLOGY: STRATEGIC CHOICES

In this chapter, we will examine the range of information system choices open to managers. From the perspective of strategy, we will argue that the key choices affect the ways in which people work. We will extend the conceptual framework developed in Chapter II to relate information technology choices to people's work.

A. THE MICROCOMPUTER PHENOMENON

A careful examination of the microcomputer phenomenon can lead to significant insights into the role of information technology in strategy.

Microcomputers, or "personal" computers, now include a wide range of capabilities, ranging from powerful multi-user desktop machines, to "lap-top" portables (typical brand names include Apple, IBM, Compaq, AT&T, Hewlett-Packard, and many others). The microcomputer industry has of course grown tremendously over the last five years, so that today almost everyone, whether businessman or schoolchild, has some familiarity with the machines and their software. Microcomputers are becoming widely-used tools in business as well as home and education.

It is very useful to examine the microcomputer phenomenon to try to identify why it has occurred and what implications can be drawn from this major popularization of "high technology".

The key features of microcomputers which are relevant to this examination are the hardware, the software, and the behavioral impact.

Basic hardware features

Key features of microcomputer hardware are the size, cost, and processing power. Microcomputers are serious computers which have sufficient processing speed, memory, and other capabilities to do a wide range of productive jobs. The most visible tasks include word processing, financial analysis using spreadsheets, and small databases of specialized nature.

A key feature of many microcomputers is their "open architecture." This is the potential to add additional capabilities to the basic machine by inserting boards with special electronics into slots on the computer. This feature, first introduced with the Apple II, has made it possible for independent manufacturers to develop add-on capabilities for micros which were not envisioned by the original machine manufacturers. For example, add-ons include additional memory, microprocessors which enable one computer to perform as if it were another, and the capabilities to use additional input or output devices such as a mouse, a light pen, a digitizing tablet, or a video camera.

Independent producers have responded to this open-architecture feature by producing a wide variety of specialized capabilities which add significantly to the power of a basic microcomputer and allow the tailoring of a machine to meet the needs of individual users.

Software features

The software which has been developed for microcomputers has been a major force in making micros accessible. Most microcomputer software is designed for use by people who are not professionals trained in computer skills. The software is usually "user friendly," which means it is relatively easy for a user to figure out how to make programs work, and it is difficult for the user's inevitable mistakes to cause any serious damage, such as loss of data

files. While "user friendly" has become a cliche, and there are many different levels of actual "friendliness," nevertheless this is a very important attribute of microcomputer software. In addition, the software typically places high emphasis on visual displays on the computer screen (the Apple MacIntosh operating system is a present example), and usually includes good quality documentation, such as tutorial manuals and reference manuals.

While the hardware is indeed powerful - sufficiently powerful to do useful work - it is the software which, in our view, has been even more important in the development of the microcomputer phenomenon. The software and documentation, while rarely superb, have been good enough that even users without prior computer experience have been able to teach themselves how to use their computers for useful work. The user can acquire a useful capability on his own if he desires.

There is a very wide variety of software available on microcomputers for business applications. The key aspect of this software is the degree of control and power provided to users without skills in programming. From this perspective, it is useful to classify software into three groups. These groups reflect differences in the degree of control which the user has in shaping the tools with which he works:

1. prepackaged application programs are programs which perform predefined tasks of a particular specialized nature. Examples are: accounting, word processing, market share forecasting models, etc. These programs, while very useful for their original purposes, cannot perform tasks other than those for which they were designed-a word-processing program cannot be used for market share forecasting, and vice-versa.

2. application-generating programs are programs which allow the user to develop his own application program, for a new task, without having to learn a traditional programming language. These are of two types, "bounded" and "evolutionary":

   a. bounded application-generating programs: The most well-known example is a spreadsheet, such as Visicalc or Lotus 1-2-3. A spreadsheet allows the user to develop a financial or other quantitative model without learning programming. Other forms of application-generators are database programs such as DBase II or III, MicroRim, and others. Capabilities such as spreadsheets or databases are useful, but are "bounded," in the sense that only certain types of applications can be developed by the user: for example, the user cannot develop a simulation model with a database program.

   b. evolutionary application-generating programs: These are programs which allow the user to develop his own application programs with the power of a full programming language, but without having to learn such a language. Such environments do not limit the user to programs of a specific type, such as a spreadsheet or a data-base query system does. Rather, they allow a user to combine many different types of programs to do a single task: for example, to combine database management, graphics, linear programming, simulation, and other techniques in a single application such as sales management. (Note 3-1).

(In addition to these three types, there are of course programming languages such as FORTRAN or BASIC which allow the user who is willing to

learn programming to write his own tools. These are not, however, the major routes through which most business users will develop their own applications.)

As a consequence of the large number of different software programs available, the user has a rich choice of tools - so rich as to be almost overwhelming. The key point is that many specialized needs can be met either by previously-developed prepackaged application programs, or by use of application generating programs.

There is a natural progression in users' use of available programs. At first, the user has relatively well-defined tasks to do, and so a pre-packaged application program can meet the need. As user experience and capability grows, his needs expand to include basic bounded application-generating programs - e.g., a spreadsheet model- where he shapes the application directly. Eventually, the user may grow to require a level of power and flexibility which can only come from an evolutionary application-generating system. In this kind of system, the user can build very elaborate and varied ways of working on problems.

Thus, a user can grow in his ability to control the way the computer supports him, by moving along this progression of types of software.

Behavioral impact of microcomputers

Thus, the flexibility provided by both software and hardware have been key features of the microcomputer revolution. There are many choices already available for the user; and, if he doesn't find what he wants, he can develop his own by writing his own spreadsheet model by buying a particular hardware add-on, etc.

Because of the power of both the hardware and the software, one sees many people who had no prior contact with any type of computers (other than

unfriendly contact with computer-generated bills and mass mailings) now developing their own applications. Many such individuals quickly become local "gurus," "wise men" who have become sufficiently expert in some set of software or hardware that their friends and colleagues come to them for help.

One recent experience typifies this phenomenon:

> I visited a colleague at a Fortune 1000 company in the headquarters of the Management Information Systems Department. His office was in a large building surrounded by a number of powerful mainframe computers, and scattered in the corridors were a number of microcomputers. We left my friend's office about an hour after normal closing time, and walked down the dark corridors. We passed two people working at a micro in a cone of light in the dark halls. A young man in his twenties was standing, coaching an older man in the mid-fifties seated at the keyboard. After we passed, my friend remarked that that was the first time he had seen the older man come near a micro - and here he was, working late on his own time, being coached by someone much younger than himself, trying to become familiar with this new type of machine.

This is a typical aspect of the microcomputer phenomenon: people helping one another, experimenting, learning, being challenged, and responding. The microcomputer is a major psychological force, at both the individual and the organizational levels: people who previously were not computer users, or perhaps were not very motivated in their job, now have become enthusiastic, acquiring expertise and innovating in key aspects of their work. (One colleague has credited micros with what he describes as "waking the walking dead.")

It is very valuable to try to understand why this phenomenon is occurring. There does not seem to be any empirical research which seeks to explain why microcomputers are having such an impact. Nevertheless, we can formulate some hypotheses. We hypothesize that certain attributes of microcomputers have caused people to react to them in a more positive way than they might have reacted to, say, a terminal to a time-shared mainframe or minicomputer.

FIGURE 3-1: KEY MOTIVATING ATTRIBUTES OF MICROCOMPUTERS

USEFUL - PERFORM A SPECIFIC NEEDED FUNCTION

ACCEPTABLE COST - FIRST TIME, CONTINUING

EASE OF PURCHASE

HARDWARE - DESIGN, SIZE, WEIGHT, DESKTOP APPEARANCE

SOFTWARE -

- VARIETY, FLEXIBILITY
- EASE OF USE
- EASE OF LEARNING
- EASE OF EXPERIMENTATION

ADD NEW CAPABILITIES - SHORT LEAD TIME, EASY TO DO

DESKTOP PRESENCE - A PERSONAL WORKING TOOL

PERSONAL CONTROL OVER USE, PRIORITIES

IMMEDIACY OF RESULTS AND OF FEEDBACK - POSITIVE, NEGATIVE, CHALLENGE

PRIVACY IN USE -

- OPPORTUNITIES TO FAIL IN PRIVATE
- DATA PRIVACY

These attributes are listed in Figure 3-1. Among those listed I suggest that the most influential attributes are these: the sense of control, the immediacy of results and feedback, and the privacy of use. These attributes touch on deep human needs. Because micros are effective in satisfying these needs, users find them comfortable and not threatening.

Management use of microcomputers in a change strategy

While it is useful to try to understand the reasons for the significant behavioral impact of microcomputers, the major question from a manager's perspective is how to make use of this phenomenon. The answer is simple: the microcomputer can be an important catalyst to bringing about deep-seated change in an organization, if it is managed to achieve this objective. The micro catalyzes innovation, individual initiative, and the development of new ways of doing useful work. To tap this potential requires a clear management strategy. For example:

> A large trucking company has a very autonomous operation. Each of the operating units in the company - some one hundred or so - is competitive with the others, and has a strong drive to succeed. Each has certain budgetary and operating freedoms. People in technical and managerial positions pride themselves on their initiatives, and accomplishments are generally recognized and rewarded. In this environment, senior management have made a policy decision to make micros relatively freely and widely available. As a result, individuals are rushing to learn the new tools and develop a variety of practical applications, with the hope that central management will recognize and reward their progress, and that their accomplishments in microcomputer use will show up in improvement in visible performance measures for their organizational units.

Conclusions: the roles of microcomputers

Understanding the microcomputer phenomenon is important in understanding the ways in which information technology can and should be used in strategic management.

For the manager desiring to make changes in peoples' work, the micro is a

useful support tool. A micro can be used to provide new information and new analysis tools to support doing work in a desired new way. It is relatively low cost. It is flexible, with a wide variety of software available as well as hardware add-ons for special needs. It is decentralized; by being located physically near the user, it is more accessible, and more likely to be used.

However, the microcomputer does compete with provision of terminals to minis or mainframes. In this respect, there are cost and performance tradeoffs which can be analysed quantitatively to determine which hardware-software mix is most effective from a narrow cost-performance perspective.

In many contexts, the cost-performance issues will not be as important as the behavioral impact issues. A micro can be a catalyst to individual development of new ways of doing things. People relate to micros in positive ways not mirrored by terminals to mainframes or minis. Micros can stimulate people's imagiantion, creativity, and desire to do things for themselves that meet real needs. At the present stage of software development, micros also provide significantly lower barriers to the user's learning how to do some things for himself.

In a more general sense, the key implication of the microcomputer phenomenon is that information technology with the right characteristics can have significant positive effects on an organization:

INFORMATION TECHNOLOGY CAN BE A CATALYST TO INDIVIDUAL GROWTH AND CREATIVE INVOLVEMENT IN IMPROVING PROBLEM-WORKING PROCESSES.

The extent to which this potential is actually achieved depends not only on the nature of the technology but also on the management strategy to use that technology- whether the hardware, the software, and the organizational processes for delivering that technology are responsive to users' own perceptions of their needs and desires:

A KEY OBJECTIVE IN PROVIDING INFORMATION TECHNOLOGY SUPPORT TO USERS IS TO GIVE EACH USER THE ABILITY TO SHAPE HIS OWN SUPPORT TO HIS OWN NEEDS.

We shall return to this theme in Chapter III, Section H.

B. THE RANGE OF INFORMATION TECHNOLOGY CHOICES

How should we think about information technology from a management perspective? Before addressing this question, let us review briefly the major elements of information technology.

Major information system components

The major information technology components are listed in Figure 3-2, Major Information Technology Components. There are a wide variety of computers, ranging from desktop and portable microcomputers to large mainframes. There are also a variety of communication systems, ranging from traditional voice telephone systems, telex and telegraph, to data systems which connect computers, to the emerging concept of the integrated services data network which carries voice and data over the same links. Thus, computers and terminals to accesss them and microcomputers and telephones are now merging together into one interconnected network - or at least there is that possibility. (Our own administration here at Northwestern thought enough of this possibility that both the Evanston and Chicago campuses are now wired with an integrated voice-data network.)

Software is required to make accessible the power of the computers and the communication networks. Earlier, in our microcomputer discussion, we identified three major types of software: prepackaged application programs, bounded application-generating programs, and evolutionary application-generating programs.

FIGURE 3-2: MAJOR INFORMATION TECHNOLOGY COMPONENTS

Hardware

- Computers -
  - Mainframe, Mini, Micro
  - Batch, Remot Job Entry, Interactive
  - Single Site, Multiple Sites
  - Stand-Alone, Networks, Distributed Processing
- Communications
  - Hard-Wired, Telephone, Networks, and Gateways

Databases

- Internal, External

Software

- Pre-Packaged Applications - Either off-the-shelf or built by internal experts
- Bounded Application-generating - Data Base, Spreadsheet
- Evolutionary Application-Generating

Service Delivery Mechanisms

- Information Processing Concepts Supported
  - Transaction Processing
  - Management Information Systems (Interactive, Predefined, Data Base)
  - Decision-Support Systems
- User Support Provided
  - I.S. staff formulate specifications and develop software
  - User formulates specifications and I.S. develops
  - User formulates and developes own software
    - With support of systems expertise
      - in I.S. department
      - in functional department
    - Without support

Databases are also important components of the information system. We will not examine these here.

Evolution of service delivery concepts

Service delivery mechanisms are a major aspect of technology. How is information technology delivered to the user? To what extent can he maintain significant control over that is delivered to him?

We will first examine the historical evolution of systems concepts. This will lead us to some perspectives on user control.

The first era of information systems applications in business was concerned with transaction processing, processing large volumes of data in an efficient manner. This was the era in which large payroll, accounting, inventory and order processing systems were built.

The second era was concerned with development of Management Information Systems (MIS). Here the emphasis was on developing data useful for managers, through developing databases containing operating data as well as transaction data, and through developing a variety of specialized reports for use by managers at various levels. The key limitation of this effort was its ambitiousness: often, MIS were very large and comprehensive, and required the skills of large numbers of programmers to develope and to maintain the system. The key liability was that it became very difficult for managers to get modifications to the system, both because of its size and complexity, and because only skilled programmers could work within it. Thus, when managers found they needed to add new data, or obtain new types of reports or analyses, they were frustrated by the time delays and expenses involved in meeting their needs.

The third era has focussed on the concept of Decision Support Systems

(DSS). The basic objective became to identify a particular set of decision needs of a single manager or group of managers or a department, and develop a specialized system to support these specialized information needs. The software technology available for Decision Support Systems today provides a rich variety of financial modelling, graphic and statistical tools, with easy-to-learn languages, that allow either the user or his staff to develop and modify reports quickly. Thus, we see emerging specialized Decision Support Systems to provide information systems support for specialized management needs. Often these are implemented on minicomputers or microcomputers and so decentralized organizationally as well as technically.

Now let us look at this evolution as an evolution of service delivery concepts, in terms of who does what for whom:

1. In the transaction processing era, the Information Systems (IS) functional staff were the developers and, in a sense, the users. IS was running a production line almost like any other production line in the organization. The production of information for decision-making was secondary to the production of the product-transactions.
2. In the MIS era, the objective was to develop reports useful for users. So, elaborate program design methodologies were developed, in which users were consulted as to what they thought they wanted in terms of information and reports, and then Information Systems staff went off and designed, programmed, tested, and ran the MIS. As noted above, the users had only partial control over the process; system developers, constrained by staff and other resource limitations, and also by the complexity of any modification to a large system, were rarely able to respond to users in a timely manner.

3. In the DSS era, a style is emerging which some have called "End User Computing." In this style, the user runs the programs himself to produce the reports he needs, and, more importantly, modifies the programs to produce new reports and new graphic displays. In this, the user may be assisted by Information Systems staff in a variety of ways:

   a. they may assist in recommending hardware and software for a Decision Support System,

   b. they may offer training and technical assistance,

   c. they may provide consulting services to do tasks requiring substantial technical expertise,

   d. they may provide linkages to other computers and to company and external databases, and perform other "utility" activities,

It is particularly important to note that the technical assistance provided by the Information Systems staff may be assistance to the user in formulating his own needs, assessing alternative approaches, and implementing his own solution. In this last role, the Information Systems staff are no longer the primary "doers", but are support staff to the user in his "doing his own thing."

In fact in some companies some of these functions are being performed by technical staff hired into the end-user's own functional department - for example, when a marketing department hires its own programmers to support marketing people with personal computer and minicomputer applications using specialized marketing databases.

This broader role requires different skills than the traditional IS personnel typically have. This style of support to users requires the ability to relate well and easily to non-technical professionals, to work with senior

managers as well as clerical staff, to help understand users' poorly-articulated needs, to teach effectively without talking down to people, and so forth. This requires new types of personnel in the IS functional area, as well as development of new skills for some existing personnel.

This emerging philosophy is parallel to that implied by the microcomputer phenomenon: it is the user who has the primary control over what will be done, with support provide both through Information Systems staff expertise and through software packages which allow the untrained user to develop his own applications.

C. A USER PERSPECTIVE ON INFORMATION TECHNOLOGY CHOICES

Examination of the microcomputer phenomenon (Section B) suggests that, if designed and managed appropriately, information technology can offer individuals the opportunity to shape the ways in which they work, and to innovate, in ways that increase effectiveness and efficiency. Examination of the evolution of information systems concepts (Section B) indicates that the emerging concept is to provide assistance to the user to shape his own applications.

If we recognize that the individual user is the focal point and objective of the information system, then we can look at the technology of that system from a different perspective.

The central issue from a user's perspective is two-fold:

1. what service can the user access now, in terms of present capabilities:
    a. what information resources can be accessed, to obtain data, to provide data, or to interact with other users;

b. what functions can be performed on the information which is accessed?

2. what changes in those services can the user control, to expand his capabilities,
   a. himself, or
   b. with staff support from the Information Systems department or elsewhere?

From a manager's perspective, it is desirable to have a way of thinking through these issues. We will now begin development of such a framework.

The basic approach we take follows from the elements identified in the power dispatcher example (Chapter II):

1. Our central focus is the individual and his or her problem-working processes.
2. For each task, there is a task group, a set of individuals who participate in the work on the task.
3. The individuals in the task group have individual problem-working processes which are linked through the communications among the members of the group.

The approach is further motivated by issues identified in the power dispatcher example and in the discussions of microcomputers and information service delivery options:

4. The human system provides pressures and restraints on the ways in which the individuals in a task group work on problems.
5. If managed appropriately, information technology can stimulate individual creativity and effectiveness through offering the user control over his own use of the technology.

6. The choice of service delivery approaches can significantly influence the user's ability to control his use of information technology.

To reflect these two groups of issues, we will present two sets of concepts:

a. The workstation as the vehicle for the user to access information services.

b. Design criteria to be used in developing the workstation environment.

D. THE WORKSTATION: AN INTERFACE BETWEEN THE USER AND THE WORLD

The electronic workstation metaphor

From a user's perspective, the central element of a computer system is the workstation. This is the physical unit through which the user interfaces with the computer-based information system. Today's workstations consist of the telephone, the personal computer, the computer terminal, and other output devices such as printers. We are already seeing products which combine some or all of these into one physical unit for voice and data connections between the user and sources of information.

The workstation connects to the other components with which we are familiar: the computer (processor and memories), data storage devices, communication lines and networks, and other components.

The workstation is a user's window on the world. Perhaps the best way to visualize its use is to think of someone you know who is a very heavy user of the telephone. The telephone is today's principal workstation for many people. There are many people who "work the world" with their telephone, calling Europe or the East coast in the morning and Asia or the West coast in the evening, moving around the globe with their telephone as the hands move around the clock.

Tomorrow's workstation will provide an even more extensive access to people and information. As many of you know, with the computer to store and forward messages, you can chat back and forth with someone, each leaving messages for the other to pick up at convenient times; in this way the tyrrany of timezones is overcome. Some of you probably have worked with telephone and computer in tandem to achieve particular objectives. For example:

> I had to prepare a report quickly in collaboration with a colleague in the Netherlands. We talked about it over the telephone, conceptualizing our approach. I then drafted a written document on the personal computer on my desk meanwhile discussing the wording with my colleague over the telephone. After we signed off, I sent the document from my personal computer into a mainframe computer network. Early the next day, he used the terminal in his office to dial the same mainframe over an international data network and received a copy of the report for review and subsequent action.

The Workstation as a Focus of Strategy

Recall that the central focus of strategy is to change the ways in which people work. When changes in information technology are part of the strategy, the workstation becomes the fulcrum for moving these changes. Changes in problem-working processes can be visualized as changes in what the user is able to do through his workstation.

These choices revolve around two views of the workstation's functionality:

1. What linkages are established between the workstation and sources or destinations of information, including other workstations?
2. What activities of the individual user are supported through the workstation, and how?

We now address these two aspects.

E. THE EXTERNAL FUNCTIONS

Linkages Among Workstations and Resources

The external functions provided by the workstation establish linkages to

the external world, relationships between the user and the outside world accessed through the workstation. Figure 3-3 and 3-4 show the ways in which the user can access multiple information sources and destinations through one or more workstations:

a. Information sources and destinations include hardcopy such as newspapers, books, magazines; memos and reports; personal conversations, etc., in addition to computerized databases, both internal and external to the organization.

b. The linkages take place through a wide variety of media, including personal conversation, reading, telephone or telex, etc., as well as through electronic communication of computer to computer.

c. While we are here interested primarily in the Electronic Workstation (EWS), capable of voice and data transmission, we need to keep in mind the totality of linkages between the user and the external world.

In today's world, people operate through multiple workstations, and only a small portion of available information sources are reached through telephone, telex, or computer-based communications. Over time, as the electronic workstation evolves, and also the external sources of information and communication links, a higher fraction of sources will be accessed through the EWS.

Figure 3-3 and 3-4 illustrate the role of the workstation. In Figure 3-3, we suggest the present situation, with the telephone and the computer terminal serving small but useful roles, but only tapping a small fraction of the sources of information with which the user interacts. In Figure 3-4, we suggest the role that is emerging, in which one integrated voice-data

INFORMATION NODES

WORKSTATIONS

USER

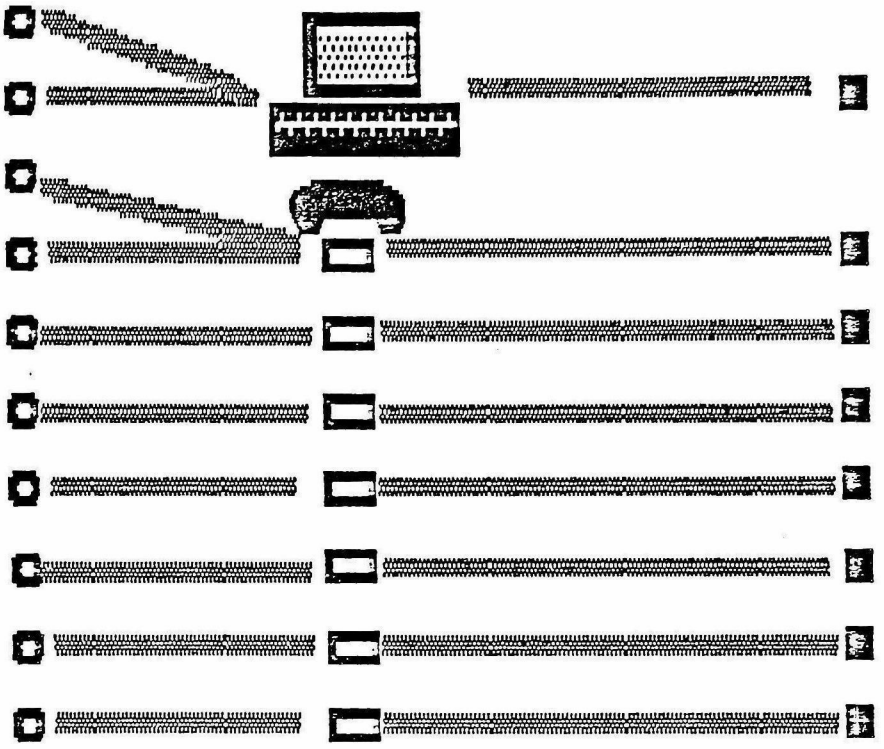


FIGURE 3-3

THE WORKSTATION - TODAY

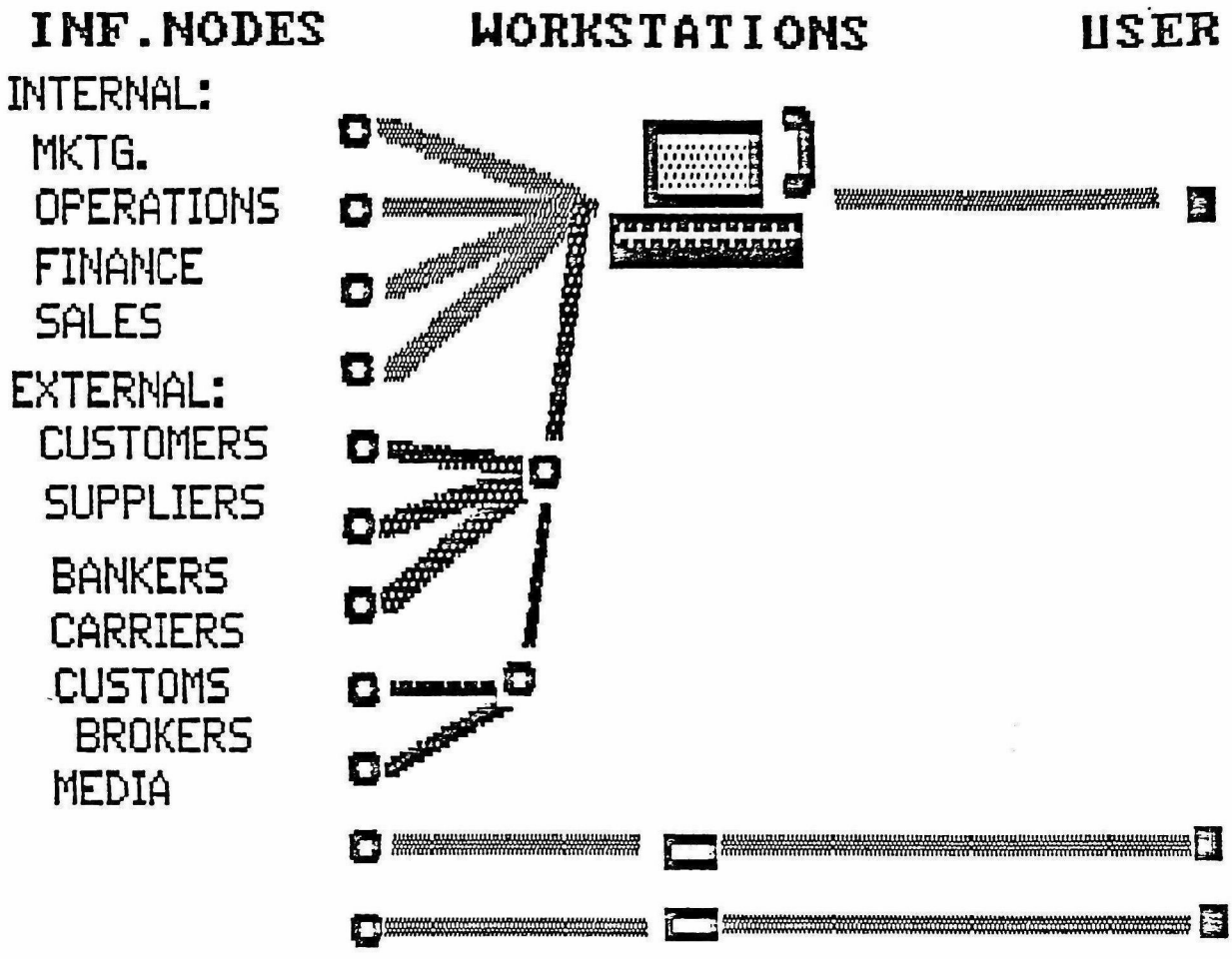


FIGURE 3-4

THE INTEGRATED VOICE-DATA WORKSTATION AND ITS STRATEGIC LINKAGES

electronic work station will be a very major interface for a large number of the transactions in which the user engages. This will probably be supplemented by more limited special-purpose electronic work stations, such as portable and home voice-data, voice-only, and data-only devices.

It is highly unlikely that the EWS will cover all sources -- we will certainly never eliminate the face-to-face meeting, though we will certainly reduce the number of such meetings -- but the EWS certainly may rank among the largest, as suggested by the figure.

This diagram, the "Workstation Map," is a useful way of visualizing many of the major choices being considered by managers, as we will now show. (Note 3-2)

Strategic Workstation Linkages

Obviously, there are many feasible types of connections of workstations to sources and destinations of information, and to other workstations. While the number and types connected is useful information, it is especially important to look at these connections from the viewpoint of strategy choices.

From a strategy viewpoint, it is useful to classify information flows in an organization as follows (Note 3-3):

I. Intra-organizational linkages -- information flows to and from other individuals within the organization:

   A. vertical flows -- upward and downward from the user; reflect managerial control processes, broadly defined

   B. lateral flows -- horizontal flows reflect the degrees and types of lateral coordination among individuals in different organizational units

C. intragroup flows -- mixtures of lateral and horizontal flows among the participants in a task group (individuals who interact in performing a particular task).

II. Inter-organizational linkages -- information flows to and from other individuals or organizations external to the user's organization:

A. Customer flows -- information to and from the customer, including intermediaries such as transportation carriers

B. Supplier flows -- information to and from suppliers, including intermediaries such as transportation carriers, suppliers of financing, etc.

C. Competitor flows -- information to and from competitors

D. Environmental flows -- information to and from other individuals and organizations in the environment of the company, such as the public, regulatory agencies, governmental bodies, etc.

One way of visualizing strategic choices is in terms of these linkages. Figure 3-4 suggests the role of the EWS in terms of the linkages reached by the logistics department of a company engaged in international trade. Choices about strategy of the firm get translated into desired changes in some of these flows.

Attributes of linkages

Some of the attributes of these flows which may be the focus of strategic actions include (Note 3-4):

1. Characteristics of the information transmitted

a. Types of information

1. What data

2. Quality of data -- accuracy, precision, perceived reliability, completeness
3. Patterns of data -- in addition to items transmitted, there may be value added in the combining of data from various sources in unique or otherwise useful ways.

b. Timeliness of information -- degree of currency

c. Cost

2. How it is transmitted

a. Media, formats, equipment required of the receiver,

b. Knowledge required of the receiver

3. Interactions of sender and receiver

a. Whether two-way interactions are required or are available

b. Degree of dependency established

For example:

> An of-cited use of information technology as a tool of competitive strategy is American Hospital Supply Corporation's placement of terminals in customer hospitals. With these terminals, hospital staff could place orders directly through AHSC's mainframe computers. Further, once staff became used to this process of ordering, they tended to place repeat orders with the same supplier. In our terminology, this reflects a strengthening of the links between customer and the company. The data transmitted was sufficiently complete, accurate, and timely to meet the receiver's needs, and the interactions of sender and receiver served to establish a degree of dependency on the part of the customer.

Returning to the previous discussion, however, it is also important to note that improving this inter-organizational linkage may be insufficient by itself; it may be necessary to improve the lateral linkages between sales and shipping departments to achieve a competitive advantage. Thus,

A STRATEGY OFTEN REQUIRES ESTABLISHING OR CHANGING LINKAGES AMONG A NUMBER OF INTERNAL AND EXTERNAL WORKSTATIONS.

This is suggested by the inclusion in Figure 3-4 of linkages to internal sources in addition to external.

> As a second example, several transportation carriers and forwarders are developing improved linkages between shippers and themselves by establishing direct computer linkages. Thus, a shipper's workstation can now access the carrier's data about actual status of shipments or information about alternative services and prices. These linkages are important first steps at changing the relationships between shipper and carrier.
>
> A third example: some major manufacturers are adopting "just-in-time" and related management strategies. To implement these strategies, manufacturers and suppliers may link their information systems so that either can determine the current status of production, inventories, and problems in the other's domain.

Thus, one way of thinking through strategy alternatives in a particular situation is to examine what they would mean for changes in the interconnections between workstations and information sources and destinations, as reflected in part in the "workstation map."

F. THE USES OF THE WORKSTATION: PROBLEM-WORKING PROCESSES

Of course, simply having information flow to or from the workstation is a necessary, but not sufficient condition. The central issue is, how do people work -- how does the electronic workstation offer opportunities for changes in the ways people work?

We know from our examination of the power dispatcher (Chapter II) that we need to look at the user of the workstation in terms both of his individual problem-working processes, and his processes as part of one or more task groups. We will focus here only on the individual processes.

From a strategy perspective, the important questions are: How does the workstation support the individual's problem-working processes? What functions does it provide? The workstation provides the environment. The

question from a strategic viewpoint is, how does management want people to make use of this environment? What new processes of working is it desired to bring about, in terms of: functions performed, style of performing them, etc.?

> Consider the example of a transportation carrier in today's deregulated, highly competitive environment. Competitive strategy calls for a major shift in the style of marketing. As mentioned in Chapter I, the old style, where clerks simply looked up rates in a tariff, must be replaced by aggressive, intelligent marketing. This requires understanding costs and operating possibilities, and also developing a good understanding of the customer's needs and opportunities. Out of this comes the possibility of developing imaginative pricing and service strategies which are mutually beneficial.
>
> As many transportation carriers have learned, achieving this objective requires multiple actions. Attitudes and skills must be changed. New techniques or formulas must be developed, for costing, for pricing, for analysing changes in operations, for coordination between marketing and sales, and between those departments and transportation or operations departments, in effective working ways. Thus, not only are inter-organizational linkages affected -- between the carrier and the customer -- but also intra-organizational linkages must be changed.
>
> In addition, new techniques of problem-working are required, involving significant changes in the problem-working processes of many individuals. One means of achieving this is to provide certain functions in the computer support environment. What functions should these be? Only simple costing or pricing models? Or things which can stimulate fundamentally different styles of reasoning and working? Should "creativity-support" techniques be provided to stimulate invention of innovative service strategies? (Note 3-5) Should "negotiation-support" techniques be provided to assist in developing more effective negotiation strategies?

Once we recognize the need for change in problem-working processes, the question becomes, how do we think about functions to be provided at the workstation to bring about desired changes in problem-working processes?

What functions are supported?

One classification of functions to be provided in an electronic work station is by means of interaction: voice input or output, keyboard input,

telephone and other communications input and output, graphic input or output, etc. While interesting, this is not central to our concerns.

A second classification is by the functions that the individual can perform using the workstation. Figure 3-5 gives a list of basic types of activities in which a person engages when working on problems. This list illustrates the variety of types of procedures which might be available in a workstation (Note 3-6). There are several schools of thought among scholars about ways of characterising these functions. The list in Figure 3-5 is one we have found useful.

Note that these are functions which are related to the problem-working processes, one of the three key variables shown in Figure 2-7. The administrative support functions also provided by a workstation -- electronic mail, basic word processing, general-purpose data base management, spreadsheet, telephone directory, notepad -- are not included.

To illustrate what this list means, let us return to the case of the power dispatcher (Chapter II). The dispatcher engages in search when he looks for possible locomotives which he can use to provide power for a scheduled train departure; we have already seen the types of approaches dispatchers may take to this search problem. When he has located several possible locomotives, he assesses the consequences of using one or another, from various locations; he looks at factors such as the time required to reposition the locomotive, the horsepower needed for that train, whether the locomotive in question is scheduled shortly for maintenance, and other factors. This is the activity of prediction, prediction of consequences of alternative actions. Then, given the consequences, the dispatcher evaluates the advantages and disadvantages of several possible actions, and makes a decision (choice).

The list in Figure 3-5 is intended to be a "complete" categorization of the functions necessary to support problem-solving processes. It is useful to

Figure 3-5

Problem-Working Process: Types of Activities in Working on a Problem

Basic Analysis Procedures:

- Goal Formulation/Revision
- Search
- Prediction
- Evaluation
- Choice

Primary Supporting Procedures:

- Intelligence
  - Data Acquisition
  - Data Analysis
- Hypothesis Formulation and Testing
- Procedure Construction/Revision

Problem-Structuring

- Problem Identification
- Problem Definition
- Problem-Solving Strategy
  - Problem Decomposition
  - Problem Structuring -- Levels of Abstraction
  - Other Strategies

Involvement

- Communication and Presentation
- Negotiation and Conflict Resolution

Implementation

- Action Specification
- Monitoring
- Evaluation and Review

examine the functions for which software is now available by comparison against this list. For example, the typical spreadsheet application supports only one of these activities: prediction of the consequences of alternative actions. A database package supports only a few of these activities: data analysis and some aspects of hypothesis formulation. A statistics package supports only hypothesis testing. The integrated software packages for microcomputers which are getting a lot of attention today (e.g. Framework, Symphony) support little more than prediction, data analysis and a little bit of hypothesis formulation and testing.

Thus, all of the presently-available software covers only a small portion of the necessary functions.

We are beginning to see some new types of software coming available which do support other functions. For example, there are several packages to support search processes, the processes of searching creatively for solutions to difficult problems. Other examples include several packages to support developing a negotiation strategy, and packages to develop sales and marketing strategies. In our own research, we are experimenting with techniques to support creative problem-working, an aspect of search. (Note 3-7) These new packages are the beginning of a richer library of potentially-useful tools.

How are functions implemented?

The ways in which the functions are implemented will vary greatly, depending upon the tasks which the individual faces. Herbert Simon (Note 3-8) proposed a classification of tasks as:

1. structured
2. semi-structured
3. unstructured.

The degrees of flexibility in the functions provided will vary, with less

flexibility, or none, required for "structured" tasks, while a high degree of flexibility, and diversity of functions and ways of accomplishing functions, would be necessary to support "unstructured" tasks. For example, the approaches to search will vary greatly with the nature of the task. For very structured tasks, mathematical methods like linear programming may be useful. For unstructured tasks, like inventing a good marketing strategy, very different kinds of procedures are required, such as brainstorming or morphological analysis (Note 3-9).

Consider the changing world of word processing. There are numerous packages available for dealing with standard, formal documents such as memoranda, reports, letters, and so forth. There are also packages for dealing with index card files of notes, address lists, and most recently, outlines. The outlining software is a good example of the potential evolution of this area: an outlining package is an environment to support creative thinking, in the limited form of wrestling with verbalization of ideas into a formal document. (Note 3-10).

Several researchers who have studied the ways in which people actually think and work are proposing that looser, more flexible structures or ways of dealing with verbal data are needed. Brooke has suggested the need for "soft data", verbal data linked to quantitative data such as that in a spread-sheet. Isenberg has suggested that to be useful to senior managers, software is needed which can deal with fragments such as words, phrases, sentences, and paragraphs, all connected in loosely-structured dynamic networks rather than tightly-sequenced prose pages. (Note 3-11).

In addition to the question of what functions to provide, a related issue is whether there is a natural sequence of activities - of ways of performing these functions - which people follow in a clear, orderly way. Some scholars have argued that there is, or there should be, such a sequence. For example,

textbooks in engineering, in systems analysis, and in economics often argue that the desirable sequence is as follows: formulate goals, search for alternative actions, predict their consequences, evaluate the actions relative to the goals, and choose the best course of action. Substantial research in recent years has shown that this simple logic, as appealing as it is, is just not a valid descriptor of how people actually work on complex problems (Note 3-12).

In fact, recent research has broadened our views quite significantly. Isenberg has shown that for senior managers (at least) the process is much more complex:

1. Managers are typically working on a number of problems simultaneously, not just a single decision problem; "having an interrelated network of problems allows a manager to seize opportunities more flexibly and to use progress on one problem to achieve progress on another, related issue."
2. "Managers often combine gut feel with systematic analysis, quantified data, and thoughtfulness."
3. Managers "synthesize isolated bits of data and experience into an integrated picture, often in an 'aha!' experience."
4. Managers "use intuition to bypass in-depth analysis and move rapidly to come up with a plausible solution." (Note 3-13).

While these observations are based on studies of senior managers, similar implications probably apply to people at all levels of an organization, certainly for unstructured and semi-structured tasks, and probably also for aspects of tasks that appear to be structured.

Values and objectivity

Another important question is whether the process of working on a problem

is wholly free of value questions and therefore totally objective and neutral. This belief is widely held by designers of software and others. The implication of this belief is that software is designed in an antiseptic manner, ignoring the existence of personal values on the part of the user.

To illustrate the implications of this antiseptic assumption, compare a technical approach to evaluation with that proposed by two psychologists, Janis and Mann.

A technical approach to evaluation is illustrated by the typical spreadsheet application. This usually involves building a financial model of a firm or a proposed transaction. This model is then used to explore alternatives -- "what-ifs?"; such as alternative marketing strategies for a new product line. Using the spreadsheet model, alternatives are analysed in terms of quantitative financial criteria such as return on invested equity, market share, and so forth.

Janis and Mann propose embedding the analysis in a much different evaluation process. They identify the major sources of stress that will arise in an individual as a result of having to deal with a difficult decision. They suggest looking at the impacts of alternative actions in terms of four categories of consequences, which reflect the results of their analysis of sources of individual stress in decision-making:

1. utilitarian gains or losses to self -- the direct gains or losses to the individual doing the analysis;
2. utilitarian gains and losses to others who are important to the individual doing the analysis;
3. self-approval or disapproval -- how the individual doing the analysis will feel about the choices made;
4. self-approval or disapproval by others who are important to the individual doing the analysis (Note 3-14).

Thus, these scholars propose that an individual doing an analysis of alternative actions should be, shall we say, brutally frank with himself in assessing those actions, and not pretend that the choices can be made in a wholly rational, objective, and value-neutral way.

G. IMPLICATIONS: DECIDING ON FUNCTIONALITY

Our purpose here is not to argue for or against a particular evaluation approach, but simply to illustrate the wide range of styles with which functions can be implemented in the workstation environment.

Several things should be clear from these brief remarks.

There are many different types of activities in problem-working processes to be supported at a workstation, but techniques exist now for dealing only with a small fraction of the important types. While electronic mail and on-line telephone directories may save time and effort, they don't get at the heart of the issue, improving people's problem-working processes. While numerous special-purpose programs are being developed for various specialized applications, e.g. sales management, production planning, financial analylsis, these only cover small portions of the overall tasks in which individual workers or managers are involved. There is much more that will be needed to provide full-function support to problem-working processes:

1. While researchers are beginning to address the issue of what types of functions to provide and how to provide them, this field of research is, in my view, in its infancy. The glamorous field of artificial intelligence has surprisingly little to say about this. Most AI research is oriented to replacing humans, rather than augmenting human problem-solving capabilities, as we are trying to do.
2. Therefore, we can expect that there will be substantial

experimentation required to develop new approaches to computer-assistance in human problem working, and that there will be a number of years of rapid evolution of capabilities provided in the electronic work station.

How then should managers deal with this question, what types of functions to provide? We suggest several basic elements of an approach:

1. Provide workstations with open-ended software environments, so that capabilities can be easily evolved.
2. Make the workstation capabilities one of the focusses of the people-based technology change process outlined in this paper.
3. Place priority on user-involvement in the process of implementing workstation capabilities, including encouraging innovation and experimentation, through both software features and service delivery mechanisms.
4. Have a clear set of design objectives to guide the difficult process of deciding what should be done.

We now examine some possible design objectives.

H. CRITERIA FOR INFORMATION SERVICE SYSTEM DESIGN

What objectives are we trying to achieve, which should guide us in the design of the services provided by the information system through the workstation?

The basic objectives in designing the information service system are to stimulate individual productivity, effectiveness, and job satisfaction. The approach to doing this should capture the spirit of the lessons we have learned from the microcomputer revolution: we want to stimulate productivity and satisfaction by stimulating individual innovation and learning, in the context of daily work. The microcomputer suggests this is possible with

information technology today if we have a clear vision of what we want to achieve.

To assist in developing such information system environments, we have formulated criteria for evalution of the support provided by a workstation. These criteria draw heavily upon research by Hackman and Oldham on work design in the field of organization behavior and upon research by Malone and Lepper on educational strategies, particularly ways of making learning enjoyable by designing "intrinsically-motivating learning" environments. Drawing on this work, we propose the following set of criteria (Figure 3-6):

A. Job challenge -- provides a continuously optimal (intermediate) level of difficulty for the user:
   1. Skill variety -- requires a variety of different activities in carrying out the work, involving the use of a number of different skills and talents of the user.
   2. Goals -- either presents clear, fixed goals or provides an environment in which users generate goals for themselves at appropriate levels of difficulty; presents both near-term, immediate goals and longer-term goals which pertain to achievement over time.
   3. Uncertainty of outcome -- generally provided by the difficulty of the task being worked on; sufficiently uncertain to be challenging but not so uncertain as to be beyond control.
   4. Curiosity -- stimulates the user's curiosity by providing an optimal (moderate) level of information complexity.

B. Autonomy and control -- promotes feelings of self-determination and control on the part of the user:
   1. Choice -- provides and emphasizes moderately high levels of

USER SATISFACTION: CRITERIA FOR WORK STATION DESIGN

TASK SUPPORT

CHALLENGE

- SKILL VARIETY, GOALS, OUTCOME UNCERTAINTY CURIOSITY

AUTONOMY AND CONTROL

- CHOICE
- CONTINGENCY
- POWER

FEEDBACK

- PERFORMANCE FEEDBACK
- SELF-ESTEEM
- PERSONAL RELEVANCE

PERSONAL GROWTH

- PROGRESSIVELY HARDER TASKS
- OPPORTUNITIES TO LEARN

TASK IDENTITY

TASK SIGNIFICANCE

PERSONALLIZATION

COOPERATION

COMPETITION

RECOGNITION

(ADAPTED FROM HACKMAN AND OLDHAM, AND MALONE AND LEPPER, WITH MODIFICATIONS BY THE AUTHOR)

FIGURE 3-6

USER SATISFACTION: CRITERIA FOR WORKSTATION FUNCTIONAL DESIGN

choice over various aspects of the user's task environment; provides substantial freedom, independence, and discretion in scheduling the work and in determining the procedures to be used.

2. Power -- permits the user to produce powerful results, by allowing wide latitude in the user's approach to the task.
3. Contingency -- provides a responsive environment, in which the complexity of the task presented to the user varies as a function of the user's demonstrated strengths and weaknesses.

C. Job feedback -- carrying out the required tasks provides the individual with direct and clear information about the effectiveness of his or her performance:

1. Performance feedback -- frequent, clear, constructive, encouraging
2. Self-esteem -- gives recognition to different levels of achievement, especially for different levels of difficulty
3. Personal relevance -- employs personally meaningful goals that have instrumental, fantasy or social relevance for the user.

D. Personal growth:

1. Increasing levels of difficulty -- enables the uses to shift to more difficult tasks, task comprehensiveness, or approaches to tasks as the user gains expertise
2. Requires learning -- user must work to learn how to do something new

E. Task identity: The degree to which a task requires completion of a "whole" and identifiable piece of work, that is, doing a job from beginning to end with a visible outcome:

1. Aware of role in entire process

2. Information about results of individual and task group activities is fed back to the user

F. Task significance: The degree to which the task has a substantial impact on the lives of other people, whether those people are in the immediate organization or in the world at large.

G. Personalization -- provides opportunities for personalizing the environment:

1. Cognitive aspects -- provides appropriate metaphors or analogies for various parts of the tasks.

2. Emotional aspects -- uses fantasies to appeal to the emotional needs of users.

H. Cooperation -- provides motivation to cooperate with others.

I. Competition -- provides motivation to compete with others.

J. Recognition -- user performance achieves successful social recognition

These criteria are intended to be used as a guide in managing the evolution of workstation functional capabilities. They imply that the user should be able to have a high degree of control over his environment.

Note also that this list of criteria reinforces our earlier observations about microcomputers. Microcomputers have been so successful precisely because the hardware and software meet many of these criteria, especially autonomy and control, job feedback, job challenge, and personalization. In many situations for many users, the microcomputer also supports such interpersonal motivations as cooperation, recognition, and even competition -- "It took me less (more?) time to learn how to do X than it took you," or "My report is more detailed and has prettier graphics than yours."

Note that this control should extend in two major dimensions:

1. Capability use: What approach to take to a particular task

2. Capability expansion: What new capabilities to add to the resources available in this individual's personal workstation environment.

It is clear that if we do provide such workstation environments, the technology itself will not be sufficient. We will have to complement this technology with extensive programs of people-oriented actions: for example, training, consulting services, job description changes, and recognition programs.

CHAPTER IV.

A GENERAL METHODOLOGY FOR INFORMATION TECHNOLOGY-BASED STRATEGIC MANAGEMENT

The purpose of this chapter is to lay out, in a preliminary way, a general methodology for strategy formulation and implementation when information technology is a major consideration, building on the concepts developed in preceding chapters. We will also identify several specific techniques which can be useful in this process.

There are two major elements in the methodology:

A. what is to be changed, as a result of strategy formulation and implementation; and

B. how it is to be changed -- the process of formulation and implementation.

A. RELATING STRATEGY TO PROBLEM-WORKING PROCESSES

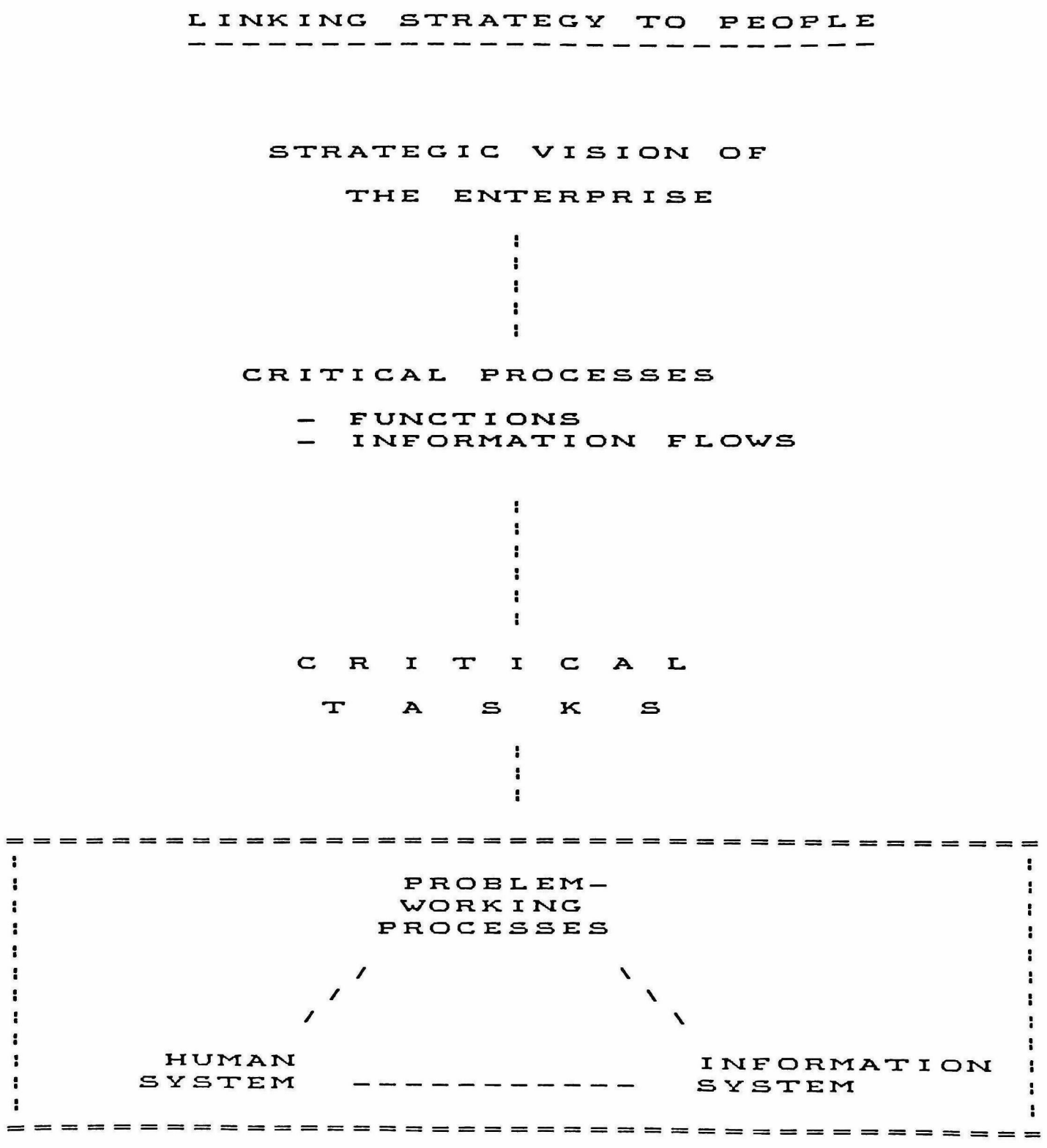
While in Chapter II we discussed the need to reflect strategy in changes in problem-working processes, we have not indicated how this might be done. We turn to this issue now.

The overall approach is shown in Figure 4-1 Linking Strategy to People. This figure shows the key elements which are potentially to be changed in strategy implementation.

The first step in managing information technology effectively is to have a clear strategic vision of what the organization's business is to be. This strategy may be based heavily on the use of information technology, or information technology may play only a supporting role.

The strategy of the organization must be translated into a vision of the processes of the organization that will make the strategic vision work. For any strategy, there will be certain processes the performance of which is

FIGURE 4-1


LINKING STRATEGY TO PEOPLE
STRATEGIC VISION OF
THE ENTERPRISE
CRITICAL PROCESSES
- FUNCTIONS
- INFORMATION FLOWS
C R I T I C A L
T A S K S
PROBLEM-
WORKING
PROCESSES
HUMAN
SYSTEM
INFORMATION
SYSTEM

critical to the successful execution of the strategy. These critical processes must be identified. Then, for these processes, the functions to be performed and the information flows to support the performance of those functions must be identified.

For each critical process, there will be one or several tasks whose performance is critical to the successful working of that process. These critical tasks must be identified

Tasks can be characterised usefully in terms of the individual and group processes by which people work on the problems posed by the task (Figure 2-7). These problem-working processes (Figure 3-5) are supported by, and influenced by, the human system around the tasks (Figure 2-8) and the information system (Figure 3-2) (See Chapter II).

The electronic work station is the interface between the individual or task group's problem-working processes and the resources reached through the information system. The workstation's linkage functions link the user to resources both within and outside the organization. The workstation's problem-working functions support the individual's activities of working on problems:

STRATEGIC INFORMATION TECHNOLOGY PLANNING AND IMPLEMENTATION SHOULD BE VISUALIZED IN TERMS OF POTENTIAL CHANGES IN THE LINKAGE AND PROBLEM-WORKING FUNCTIONS PROVIDED BY THE WORKSTATIONS.

B. STRATEGIC AND USER-ORIENTED INFORMTION SYSTEM DESCRIPTION: STRATEGIC INFORMATION MAP

Based upon the concepts developed in Chapters II and III, we see that we can describe the information system in terms relevant to the user's perspective as follows.

We view the information system in terms of the "Strategic Information Map." This "map" is a conceptual diagram which expresses the nature of the organization's information system in ways directly relatable to the organization's strategy.

The key elements of information strategy choices are, in terms of goals rather than means (the "means" are the technology choices identified in Figure 3-2: computer and communications hardware, software, databases, service delivery mechanisms, etc.):

a. who is to be served?

b. how are they to be served?

Put more specifically, the answers to these questions can be sketched schematically in the Strategic Information Map through identifying these key elements:

1. the processing nodes
    a. users
    b. information resources - sources and destinations
2. the linkages among the nodes

A full description of the system would include these elements in the Strategic Information Map:

1. nodes
    a. users
        i. problem-working processes supported through the functionality of the workstation (at both internal and external nodes)

ii. attributes of the workstation environment (e.g. job challenge, autonomy and control, job feedback, etc., as in Figure 3-6)

b. information resources - databases, other resources

2. linkages

a. nodes linked

b. linkage type -

i. manual, computerized

ii. internal (vertical, horizontal, intragroup); external (customers, suppliers, competitor, environment)

c. linkage attributes

i. types of information (what data, data quality, patterns of data, timeliness of information cost)

ii. how transmitted (media, formats, equipment required of receiver, knowledge required of receiver)

iii. interactions of sender and receiver (whether two-way interactions required or available, degree of dependency established)

3. critical tasks: for each task, identification of

a. nodes involved

b. linkages involved

c. problem-working processes invoked - individual

i. human processes

ii. workstation functions supporting the human processes

d. problem-working processes invoked - task group

i. human processes

ii. linkages utilized (See further section III-E).

C. THE HUMAN SYSTEM

Planned change must include both the human system and the information system. Potential human system change actions include:

a. Early and full involvement in the planning of change.

b. Education and training

   i. on information system techniques

   ii. on ways of improving problem-working processes

   iii. on basic work and management skills

c. Different job experiences, through job rotation and through temporary assignments

d. Involvement in peer group networks

e. Career development support

   i. timely and accurate revision of job descriptions and career ladders

   ii. counseling and guidance

f. Recognition of achievements

g. Active support of job enrichment (Note 4-1).

D. SUMMARY: WHAT IS TO BE CHANGED

So, to effectively manage technology change in an organization, we must consider the strategic vision of the business, as it is translated into the design of the critical processes of the organization and into the design of the critical tasks. The information system changes are characterized in terms of the Strategic Information Map. The information technology change is only part of the forces influencing the problem-working processes, and therefore task performance; the human system offers incentives and constraints on the

processes as well, and planned change must be described in these terms, as well.

This set of elements define the major components of what is to be changed. The next question is, how should change be managed?

E. DEALING WITH CHANGE

Major changes in an organization threaten people, and especially changes in information systems. People resist change of any kind; it is a natural reaction: "The degree of people's resistance to change depends on the kind of change involved and how well it is understood. What people resist is not change but loss, or the possibility of loss." (Note 4-2).

Types of loss

According to Marris, there are two major kinds of change: "loss of the known and tried," and "loss of personal choice."

The "loss of the known and the tried" occurs whenever there is a change:

> "Change often involves a shift away from a known situation, with all its familiarity and possible advantages. The people concerned are exchanging the known for the unknown; certainty for uncertainty; stable, existing patterns of behavior and adaptation for the need to evolve new patterns; tried rewards for untested ones. In addition to the uncertainty of the satisfactions to be gained from the new situation, the people being asked to make the change are required to spend a great deal of effort and psychological energy in getting to know the new situation and in tolerating and coping with frustrations until they can evolve new work or living patterns." (Note 4-3)

The very fact of change is a source of stress in itself. People are likely to change willingly only when they perceive that the advantages of the new environment are desired sufficiently much that they outweigh the magnitude of effort required to actually make the transaction.

The "loss of personal choice" is a second major source of resistance to change. "People resist the IMPOSITION of change.... When one's feeling of freedom is in jeopardy, the immediate reaction is likely to be an attempt to regain this sense of freedom..." People will resist if they perceive that their freedom to behave in a certain way is threatened or eliminated.

As a consequence, involvement of those affected by a change has many benefits: "A common-sense principle of human behavior that is corroborated by considerable research is that, the more people are involved in decisions that directly affect them, the more they will be committed to implementing those decisions." If people have not been actively involved in a decision, they will not be committed psychologically to its implementation. "This lack of psychological commitment does not necessarily cause complete resistance to implementation, but the best that can be expected (unless organizational loyalty is extraordinarily high) is passive compliance." (Note 4-4).

Several operational implications flow from these observations.

First, for the above reasons, involvement in the planning of change of those affected by a change is almost always desirable.

Further, most information technology changes are sufficiently complex that implementation should take place in stages.

Finally, resistance to change can be a resource. When people resist, that is an indication that there are problems or issues which have not been clarified. Once having identified sources of resistance, managers can use this information to work to try to understand and resolve those issues.

Stages of change

One model that has been presented for implementing change in stages identifies three phases:

1. unfreezing
2. moving
3. refreezing (Note 4-5)

This is a useful basic model, because its simplicity is very suggestive of what needs to be done. If the technology itself appears appropriate for staged implementation, then these basic steps are repeated in each stage of the change process:

> **EFFECTIVE MANAGEMENT OF TECHNOLOGY CHANGE REQUIRES A PLANNED CHANGE APPROACH IN WHICH CHANGE IS SEQUENCED IN STAGES AND THOSE AFFECTED BY THE CHANGES ARE INVOLVED IN THE PROCESS OF PLANNING AND MANAGING THE CHANGES IN EACH STAGE**

Figure 4-2 shows an expanded version of this basic model. Here, we have included several steps in the process which are the basis of a systematic approach to managing change. For example, the unfreezing process begins with the collection of information through interviews, observations, and other activities. This then serves as a basis for a diagnosis of the various aspects of the existing situation. This in turn serves as a foundation for the development of specific objectives for change.

To apply this model in practice, in a complex organizational environment such as is typical of a transportation company, it is useful to have some detailed guidance as to what to look for at each step of the process. This guidance can come from what we will call

FIGURE 4-2

PLANNED CHANGE PROCESS

Basic Steps (Single Stage)

- Unfreezing
  - Assess the present situation
    - Collect information
    - Diagnosis
  - Formulate Change Objectives
- Moving
  - Develop and evaluate alternative improvement strategies
    - Formulate change alternatives
    - Analyse alternative strategies
  - Choose a strategy
  - Implement
    - Monitor
    - Evaluate
    - Adjust
    - In multiple cycles within the stage with heavy involvement of those to be affected
- Refreezing
  - Assessment
  - Generalization and stabilization of change

an "Assessment Guide." This guide is based on an overall conceptual framework which draws together the concepts we have been discussing.

F. TOOLS FOR INFORMATION GATHERING - ASSESSMENT GUIDES

Management of technology change in an organization is a complex management task. To assist in doing this well, it is useful to have a detailed framework or "checklist" which can be used to stimulate an explicit assessment of the situation at key points in the process of planning and implementing change. Such a checklist can also stimulate the design of actions to be taken.

The Information Technology Strategy Assessment (ITSA) is such an "assessment guide." It is in two parts. The first part is primarily designed for use as an initial assessment guide, and is called the "Initial Information Technology Strategic Assessment (IITSA)." This is concerned primarily with assessing the strategy and strategic planning processes currently existing in the organization (Note 4-6).

The second part is more detailed and is designed for use throughout the planning and implementation process. This is called the "Information Technology Implementation Assessment (ITIA)." The key elements of the ITIA are the elements shown in Figure 4-1 (See also Figures 2-7, 2-8, 3-2, and 3-5) (Note 4-7).

The ITSA is a basic management tool, to be used in each stage of the change process. It is especially useful in diagnosis of the present situation, in formulation of change objectives, and in formulation and analysis of alternative change strategies. The ITSA is based on the conceptual framework presented in this and preceding chapters, and includes analysis of elements such as these. The major elements of an assessment guide are as follows:

1. identification of critical processes, critical tasks, and critical task elements, including: the problem-working processes, relevant human system elements, and the information system; and
2. The Strategic Information Map

G. PRODUCTS OF PLANNING

The theoretical concepts presented in the previous pages suggest that there are two major elements of an information technology - based strategic plan. These are: (1) the strategy to be implemented, and (2) the implementation plan.

The strategy to be implemented in turn consists of two parts: (a) a strategic concept, and (b) an implementation concept (See Figure 4-3).

Strategic Concept

The strategic concept (1a) is the vision of the business that is desired. This concept should be summarized in what Hofer and Schendel call a "strategy statement" which should have these characteristics (Note 4-8):

1. The strategy statement "should describe each of the major components of the organization's strategy (that is, its scope, its resource deployments and distinctive competences, its competitive advantages and how they will be produced, and its intended synergy)."
2. The strategy statement "should indicate how the strategy will lead to the accomplishment of the organization's objectives."

FIGURE 4-3

PRODUCTS OF PLANNING

Strategy to be implemented

- Strategic concept
- Implementation concept

Implementation plan

- Integrated Action Program.

3. "The strategy should be described in functional, rather than physical, terms."
4. "The strategy statement should be as precise as possible."

Implementation Concept

The implementation concept (1b) is a statement of the key elements of the organization which need to be changed, and the key elements in the change process, to achieve successful implementation of the organization's strategy. Based on the concepts presented previously, we suggest that the implementation concept should include statements of:

1. the critical processes - those functions and activities which are critical to the successful performance of the organization in the strategic vision:

2. the critical tasks - those specific tasks which are critical to the critical processes;

3. the critical task elements - those aspects of the three major types of task elements which are critical to the critical tasks: the problem-working processes, the information systems, and the human elements.

The implementation concept should identify these critical elements, and state the goals for any needed changes in these elements.

Implementation plan and Integrated Action Program

The implementation plan (2) should be a time-phased program of actions designed to achieve successful implementation of the strategy by addressing the critical elements and change goals described in the implementation concept. One way to visualize the implementation plan is in terms of the concept of an Integrated Action Program.

An Integrated Action Program is an implementation plan described at the operational level of a list of tasks in a work program. The Integrated Action Program identifies the specific tasks to be accomplished, phased over time, in these five major categories (reflecting the discussion of this and previous chapters):

a. management tasks - activities of the management of the implementation program, not explicitly included below, such as program monitoring, program planning (budgeting, staffing, etc.), program evaluation, etc.;

b. involvement tasks - activities to communicate with those affected by the planned changes, especially activities designed to promote two-way communication and to influence the implementation plan and even the strategic concept (see Note 4-2);

c. people system tasks - activities to change critical elements of the human system (Figure 2-8), especially such activities as training, reexamination of job descriptions and career ladders, changes in formal organization structure, changes

in incentive and reward systems, and others. Many aspects of Human Resources Management are likely to be incorporated;

d. information system tasks - activities such as software development, user testing, procurement and installation of new hardware components, etc. Almost all aspects of Information Systems Management should be incorporated (Figure 3-2);

e. work process tasks - activities to develop, modify and implement new or changed problem - working processes for critical tasks (Figure 3-5).

A schematic illustration of an Integrated Action Program is given in Figure 4-4.

H. DEVELOPING A STRATEGIC PLAN

Methodology Principles

The approach to be used in developing an information-technology based strategic plan could be structured similarly to the products (i.e., first develop the strategic concept, then the implementation concept, then the Integrated Action Program). However, after careful reflection about the nature of people-based technology change, one concludes that the approach has to be more subtle than simply developing the products in sequence.

There is, as noted earlier (Note 1-1), a large literature on methods for strategy formulation in general, and a small literature on information-technology based strategies. Elements of a

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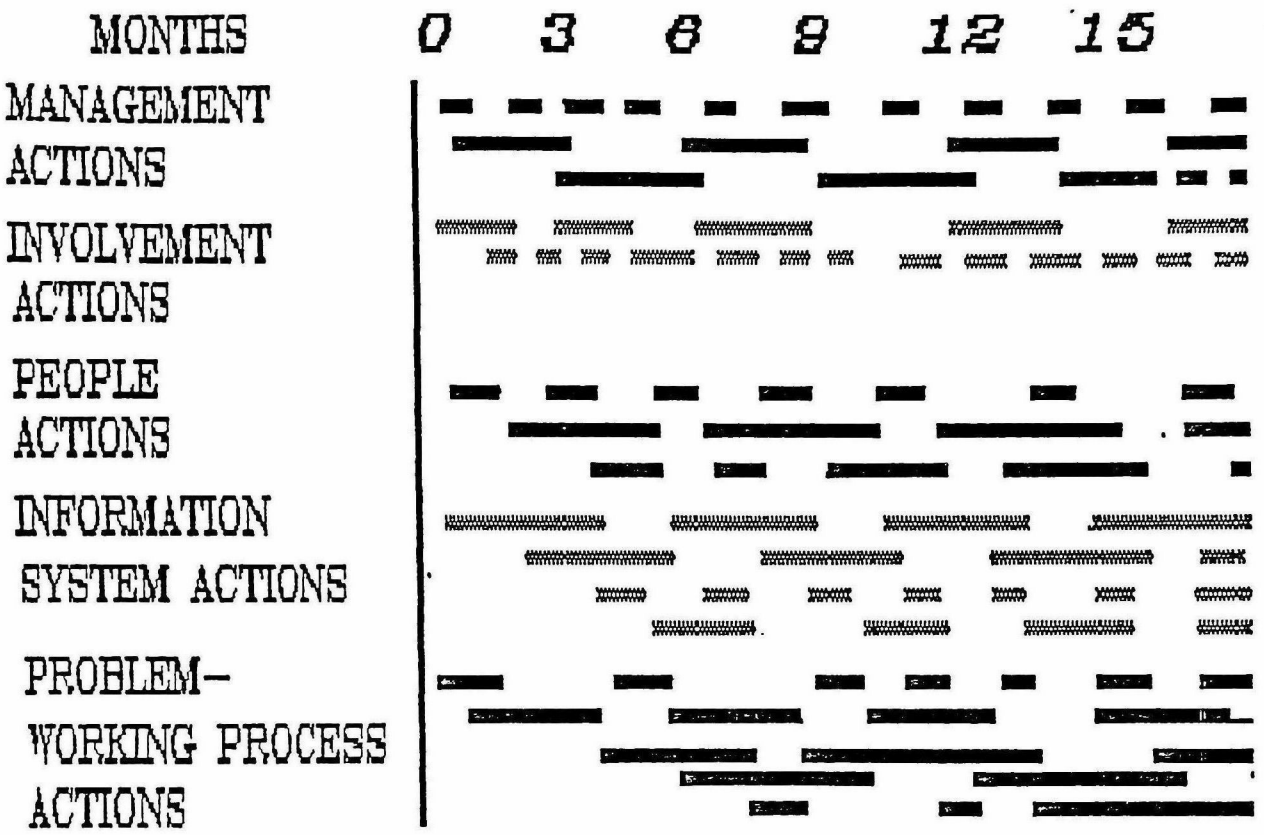

FIGURE 4-4

INTEGRATED ACTION PROGRAM

methodology for developing information-technology based strategy concepts are beginning to emerge but are not yet clearly formulated into a well-defined methodology. The total methodology for producing a strategic concept is not clear at this time and is the subject of continuing research. However, the theoretical discussions in this paper do provide us with a basis for identifying a number of key elements of such a methodology, for producing an information technology-based strategy.

We will focus on several of these elements, primarily those which are motivated by the principle of people-based technology change. Those knowledgeable about, or already using, particular methods for strategy formulation can readily see how their present methods might be broadened and adapted to include the elements addressed here. (See further references in Note 1-1).

Our approach to developing an information-technology based strategy reflects several premises. These premises, and their implications for planning method, are (Note 4-9):

a. Premise I -- Integrated strategy formulation and implementation planning: Because people change and technology change must be highly integrated, strategy formulation and strategy implementation planning must also be integrated. Most approaches to strategy view formulation and implementation as two very different activities, and often the implicit premise is that formulation has a discrete end before implementation planning proceeds. In our view, formulation and implementation planning must be intertwined.

As a practical matter, this implies these steps in an overall methodology:

i. strategy formulation - initial: In a first phase, there is a process of developing and analyzing alternative strategy concepts, leading to the tentative selection of one or a few concepts for further examination.

ii. implementation planning - initial: Implementation planning then proceeds for the tentative concept(s). This includes identification of critical processes, critical tasks, critical elements of tasks, and change actions, as described below. In this process, substantial insights are gained that stimulate major modifications of the selected strategic concept(s) and/or identification of potential new concepts. Therefore, cycling back to strategy formulation is essential and inevitable.

iii. strategy formulation - revision and/or refinement: Further development and analysis of strategy concepts based upon insights gained in initial implementation planning.

iv. implementation planning - revision and/or refinement: Further work based upon revised or new tentative strategic concept(s).

Additional recycling through strategy formulation may be appropriate. Within the appropriate time frame and budget for strategic planning, the objective is to evolve a strategic concept and implementation concept, and Integrated Action Program, which are consistent and realistic in both technology change and people change components.

b. Premise II - Incremental implementation: Whether a strategic concept calls for a radical or incremental change from present strategy, the realities of human organizations make it desirable to implement the strategy in an incremental, evolutionary way. (In most situations; there are obvious exceptions, such as major acquisitions or mergers, or major divestitures or reductions in scale.) Even when there is to be a major shift in technology, such as bringing a complete new information system on-line or installing a highly-automated factory or facility, conservative planning should anticipate an incremental approach to building the new human organization to work with that system. This means a staged implementation plan, with explicit review points and feedback to revision of the implementation plan based on actual experiences.

c. Premise III - Need for focussed assessment: A key component of strategic planning is assessing the existing situation. This requires assessing not only the firm's current business

position (analyses of markets and industries, resources and constraints, supplies and competitors, and such aspects of the firm's environment as economic, social, political, legal and other forces and trends), but also, in our judgement, assessing the internal functioning of the organization. This is essential because, again, of the close need to interrelate technology and people change. Therefore, we see an essential need for an information acquisition and diagnosis activity as the first phase of the planning process.

However, it is impossible as a practical matter to do all the assessment at the beginning of the process. As a consequence of Premise I, in-depth assessment is required of the present situation with regard to not only the general characteristics of the organization, but also the critical processes, the critical tasks, and the critical elements of those tasks. Yet, which process, tasks, and elements are critical depends on both the strategic concept being considered and the results of prior assessment. Therefore, as the strategic concept evolves, and as the designations of the critical processes, critical tasks, and/or critical task elements evolve, there will clearly be identified needs for additional assessments focussed around those areas of the organization and on those issues.

Clearly, assessment must be phased, with the initial broad-based assessment followed by focussed, more in-depth

assessments as the strategy formulation and implementation planning process evolves.

Basic Methodology:

Therefore, we visualize a basic methodology with three major phases:

I. Initial assessment

II. Strategy formulation - initial

III. Implementation planning

As implementation proceeds, a fourth phase is required:

IV. Implementation monitoring and plan revision

We will now examine elements of these phases in more detail.

I. Initial assessment:

The objective in this first phase is collect basic information about several elements, analyze it, and assess the strengths and weaknesses of the existing situation.

The Information Technology Strategic Assessment(ITSA) (Section F) is a methodology for structuring this information acquisition process. The information to be collected covers topics such as these:

A. the nature of the existing strategic planning process, strategy, and strategic plans, insofar as they exist; in general for the business as a whole, and for information systems and technology in particular, and whether and how general strategy planning and implementation interact with information technology strategy and planning

B. the nature of the information systems strategies in place and planned

C. if explicitly known, or if they can be identified as implicit in the existing strategy:

1. identification and assessment of the critical functions and processes with which present strategy and strategy implementation is concerned;

2. identification and assessment of the critical tasks, and

3. for each critical task, identification and assessment of the critical task elements. In assessing the critical task elements, as outlined in Chapter II attention is focussed on the three elements of (1) problem-working processes, (2) human system, and (2) information system.

   The important components of each of these are shown in Figures 2-8, 3-2, and 3-5.

   In this assessment, the sense of "critical" is with regard to the degree of essentiality to successful achievement of the strategic concept or of the implementation plan (explicit or implicit).

II. Strategy Formulation - initial

The objective of this step is to develop an initial strategic concept. Essentially, this step is similar to the process of strategy formulation and analysis which is widely described in the literature.

The most effective techniques to use for this step are not yet clear, but are the subject of continuing research (see references to general strategy techniques and to information-technology based strategy techniques in Note 1-1).

There are two key differences between conventional strategic planning and our approach in this step. The first is of course the introduction of information-technology based considerations. The second is that we explicitly emphasize that the strategic concept developed in this stage will likely be revised substantially in the process of implementation planning in the subsequent stage.

As aids to developing a strategic concept, the following constructs introduced in previous chapters are useful. We suggest that various concepts for information-technology based strategies be described in part in terms of how they will affect the elements of the Strategic Information Map:

- nodes, including problem-working process
- linkages
- critical task

III. Implementation planning

The objective of this step is to develop a strategic concept and implementation plan which are consistent. The starting point is the strategic concept developed in the preceding step. The

strategic concept which emerges may be significantly different, dependent on the considerations which emerge in the implementation planning process.

The implementation plan will be described in terms of an Integrated Action Program.

A. implementation planning - initial phase: Based upon the strategic concept(s), implementation planning begins.

   1. focussed assessment: Additional information collection is done extending beyond that collected in I. Initial assessment, focussed on aspects related to the strategic concept(s) being considered. Again, the Information Technology Strategic Assessment (ITSA) is a useful methodology for structuring this information acquisition process. The new information to be collected focusses on topics such as these:

      a. identification and assessment of the critical functions and processes whose performance would be critical to the success of the proposed strategic concept(s);

      b. identification and assessment of the critical tasks involved in the performance of the identified critical functions and processes, and

      c. for each critical task, identification and assessment of the critical task elements: (1) problem-working processes, (2) human system, and (3) information system.

These assessments would compare present performance with future performance needed to be consistent with the strategic vision.

2. development of plan for changes in critical elements where necessary: Includes formulation of goals, development of alternative change actions, evaluation of actions, choice of changes to be accomplished and means of accomplishing them; for
   a. critical functions and processes
   b. critical tasks
   c. critical elements of ways people work, information systems support, and human system (expressed in part in terms of changes to the Strategic Information Map).
3. development of Integrated Action Program: The change actions selected are structured, together with other necessary actions, into a work program, consisting of a set of tasks, staged over time, including management, involvement, people system, information system, and problem-working process tasks.

B. strategic concept revision or reformulation: Based upon the results developed in initial implementation planning, some or all of the initial candidate strategic concept(s) require refinement or revision. This may become clearly desirable well before completion of all of the preceding activity.

C. implementation planning - refinement and/or revision: Based upon the new strategic concepts, some or all of the earlier implementation planning is refined, revised, or redone.

The final result is an Integrated Action Program

(additional recycling of strategic concept formulation and implementation planning may be required):

1. focussed assessment;
2. development of plan for changes in critical elements where necessary;
3. development of Integrated Action Program.

IV. Implementation monitoring and plan revision

In this phase, implementation of the strategic concept begins by executing the tasks laid out in the Integrated Action Program. As implementation proceeds, it is inevitable that new facts and issues will arise. Sometimes, these will trigger the need for minor or major replanning, requiring some adjustments in the Action Program, and perhaps even requiring rethinking of the adopted strategy.

I. CONCLUSION

We stress that the elements and outline of a methodology presented in this Chapter are preliminary. This sketch is intended to show the operational implications of the theoretical concepts developed in this paper. It does not include details on many other aspects of strategy formulation and implementation planning. However, this methodology should be a useful starting point for further research, and for implementation planning.

CHAPTER V

ACTIONS MANAGERS CAN TAKE

In this chapter, we examine the concepts presented in earlier chapters to see what these concepts imply as possible action steps for managers.

A. Take charge of change

In Chapter I we listed several reasons why information technology is an imortant issue for senior management: improvements in information technology may be an important element of competitive strategy, either for the firm or for its competitors, or it may be an important element in supporting the implementation of strategy. Even when not related to the basic strategy of the business, the changes in information technology require senior management attention because they may affect the organization in profound ways.

Senior managers must consider carefully whether they should place high priority on managing information technology-based change themselves, and how they should do it. Our basic argument is that information technology change should be managed as people change, and to our view this by definition requires senior management attention. Technology managers such as heads of information systems or data processing activities should play a major role in the process, but technical skills and experience are not the major need for managing change in people's work. The senior executive managing this process should have the experience, perspective and authority of a senior general manager. Further, he or she should have the breadth or vision, understanding of the business and of the strategy of the business, and the people skills and orientation, required to shape and implement major people-based technology change.

As part of the change program, careful thought must be given to how general and functional area managers at various levels in the organization should participate in the process.

B. Manage technology change as people change with a strategic vision

Technology change must be managed with a clear vision of the strategy of the business, and with a strong emphasis on how that vision will get translatd into changes in the ways that people will work. Figure 5-1, Linking Strategy to People, shows the conceptual framework which summarizes our discussions and which can guide the process of planning and managing people-based technology change. As discussed in Chapter IV:

a. The first step in managing information technology effectively is to have a clear strategic vision of what the organization's business is to be. This strategy may be based heavily on use of information technology, or information technology may play only a minor, supporting role.

b. The strategy of the organization must be translated into identification of the critical processes of the organization that will make the vision work. These include the functions to be performed and the information flows to link those functions.

c. The identification of the critical processes is then used as a basis for identifying the critical tasks necessary to effective performance of these processes.

d. Tasks can be characterized usefully in terms of the problem-working processes: the processes by which people work on the problems posed by the task.

LINKING STRATEGY TO PEOPLE

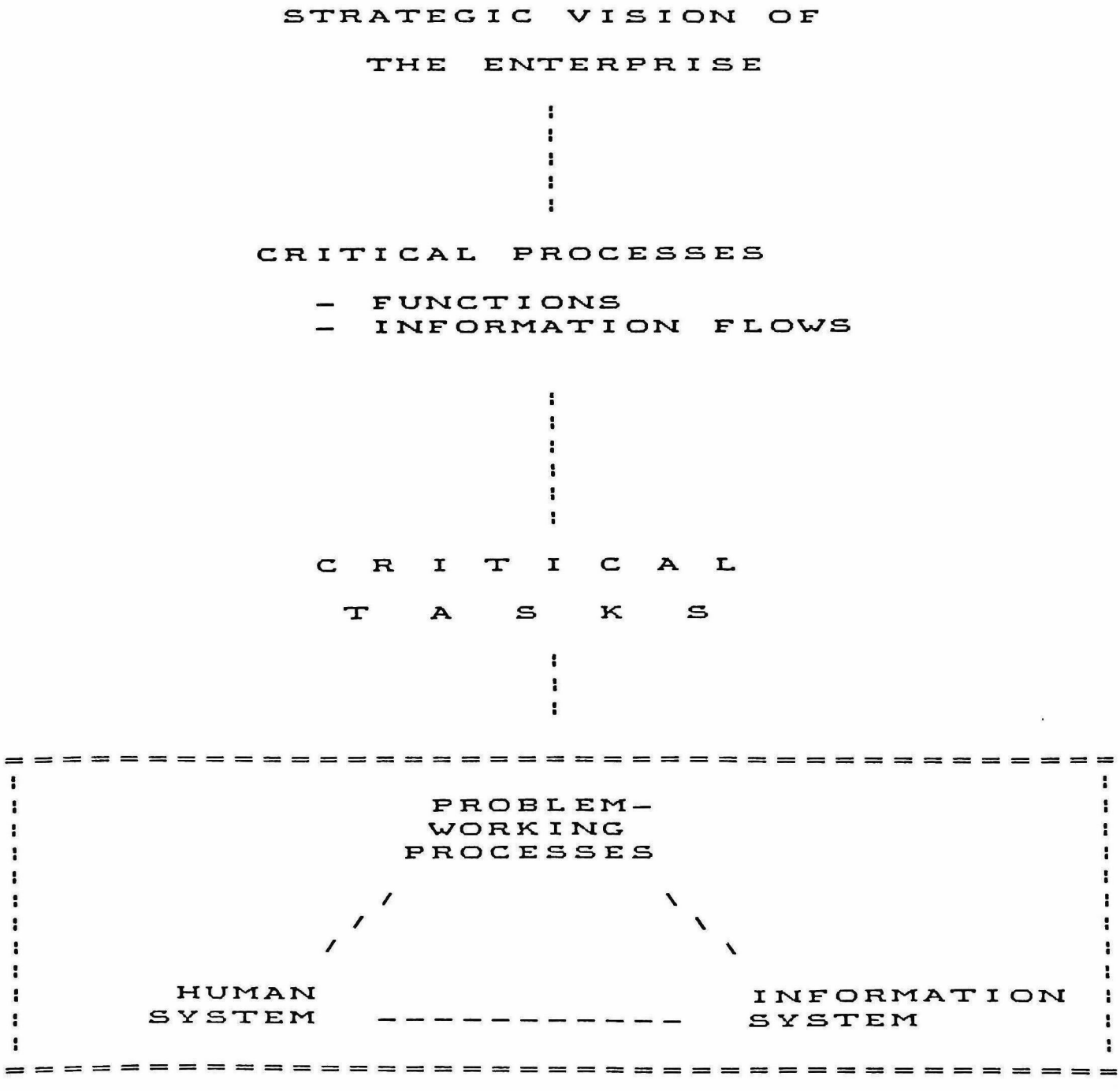

FIGURE 5-1

e. These problem-working processes are supported by, and influenced by, the information system and the human system around the tasks.

So, to effectively manage technology change in an organization, we must consider the strategic vision of the business, as it is translated into the design of the critical processes of the organization and into the design of specific tasks. The information technology change is only part of the forces influencing the problem-working processes and, therefore, task performance; the human system offers incentives and constraints on the processes as well.

C. Integrate people change and technology change

Managing changes in information technology as people-based change requires an integrated, planned change approach.

The approach should be integrated, in that the planning of change should begin with a vision of the strategy of the business, which is then translated into a vision of the processes that will make that vision work. This, in turn, should then be the basis of planning changes in the tasks that will be performed by individuals and by groups.

These changes in tasks become the specific goals on which change is focused. To bring about changes in tasks requires changes in how people do their work - their "problem-working processes." To support these changes, we may design changes in information systems. These changes will be focused on the workstations and their external and internal linkages.

To support these changes usually will require changes in the human system. Sometimes, this will involve simply some training and

minor organizational changes; other times, successful implementation of the desired changes in problem-working processes will require significant change in the human system. Job descriptions and career ladders may need revision; career counseling may be important. Many other elements may be required as well, as discussed in the preceding section.

Key to successful implementation of an integrated change program is the planning and management of the change process. Change should be implemented in steps, such that the individuals affected by the change can effectively absorb each increment of change. Change should be open and participatory, in that those to be affected by the change should be actively involved in the planning and implementation of the changes, to the extent consistent with the goals of the changes. The implementation of change should be managed with close monitoring of the effects of change so that the change program can be quickly adjusted as problems are encountered or new opportunities developed:

1. Develop an Integrated Action Plan

   One way to crystallize the operational implications of this approach is illustrated in Figure 5-2. This shows a schematic of a work plan for a change program with five major categories of action:

   a. management tasks
   b. involvement tasks - activities focused on continuous and periodic involvement of those affected by the change of the various aspects of the program
   c. people system tasks - activities such as training, reexamination of job descriptions and career ladders,

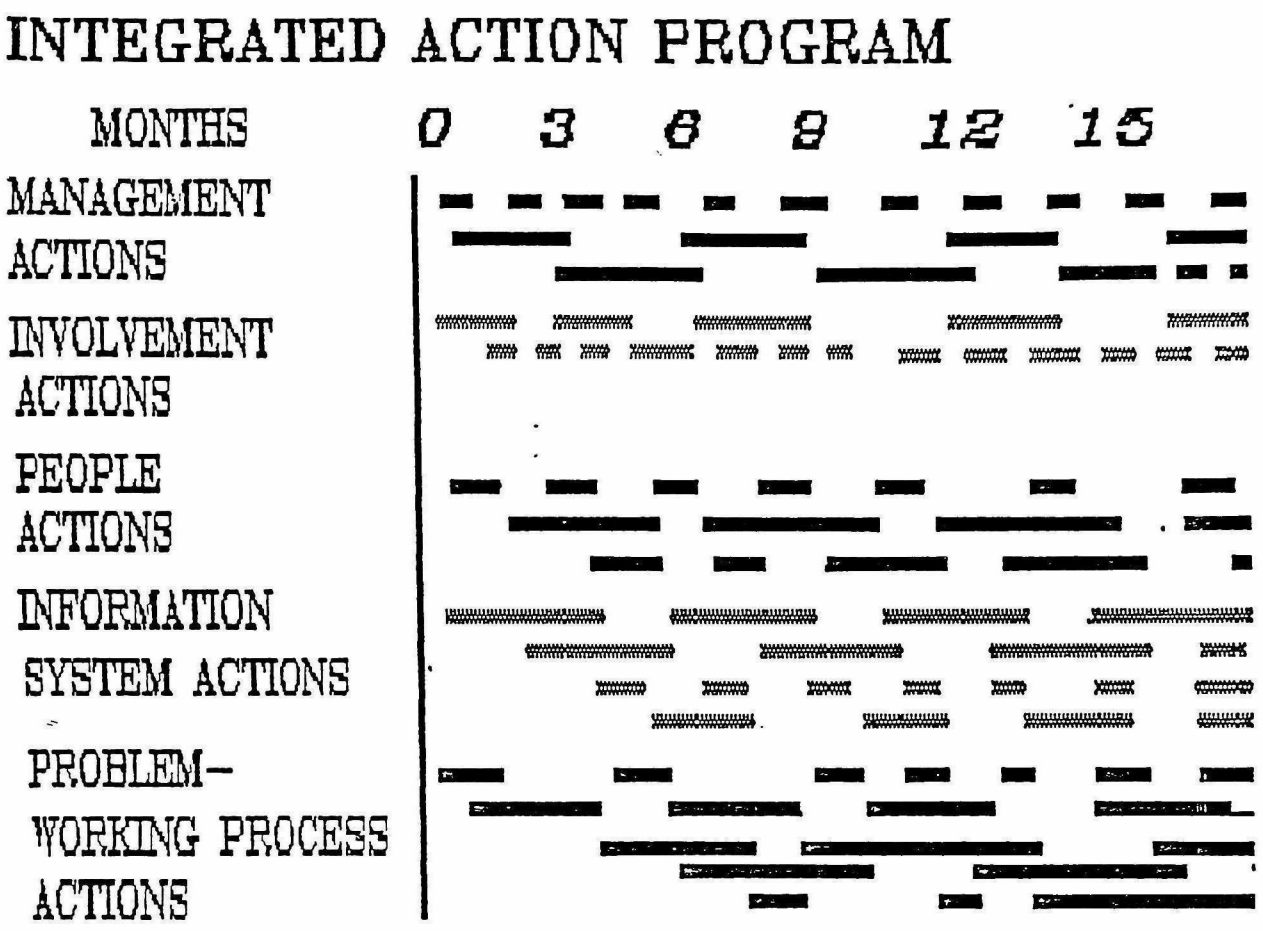

FIGURE 5-2

INTEGRATED ACTION PROGRAM

changes in formal organization structure, etc. Almost all aspects of Human Resource Management are likely to be affected and should be assessed for inclusion in the Action Program.

d. information system tasks - activities such as software development, user testing, revision, installation of new hardware components, etc. Almost all aspects of Information System Management should be incorporated in this program.

e. problem-working-process tasks - activities to develop and modify new processes of working on particular aspects of particular tasks.

The Integrated Action Plan should reflect the stages of planned change identified in Chapter IV.

2. Conduct an Information Technology Strategic Assessment

An Information Technology Strategic Assessment is an in-depth examination of the organization's present capabilities. This can be done in a preliminary way, as a reconnaissance tool to identify if a major effort can or should be undertaken. Alternatively, or subsequenty, an in-depth analysis can be done to develop the strategic concept and implementation plan.

The Information Technology Strategic Assessment is a useful aid to developing an Integrated Action Program.

3. Manage the Microcomputer Revolution to Stimulate Innovation

Clearly, the microcomputer can provide a major opportunity for managers to achieve broader objectives. First of all, it is clearly a useful tool for certain kinds of tasks. But

much more importantly, because of the psychological attributes discussed earlier, it is a tool which can be deployed to achieve significant impacts on people's work.

Senior management should determine how best to use micros as part of an overall strategy for implementing its vision of the business. When a complete information technology planning process is being undertaken, including an Information Technology Strategic assessment and development of an Integrated Action Program as described above, actions utilizing micros will usually be part of Action Program.

Even when it is not feasible or timely to do a complete Integrated Action Program, a Microcomputer Action Program can be initiated quickly in order to achieve more limited objectives.

Planning a Microcomputer Action Program should reflect the basic philosophy espoused here, people-based technological change. Management should:

a. Develop explicit objectives for the changes in people's work which it is desired to achieve. Consider placing particular priority on promoting an atmosphere of innovation and experimentation, and individual responsibility for improving one's own working processes; these are objectives for which micros are particularly useful.

b. Assign responsibilities for managing and supporting the Microcomputer Action Program consistent with the objectives. Consider carefully alternative forms of relationship with the existing MIS and data processing staff, and alternative forms of centralization or decentralization of microcomputer support staff.

c. Identify needs for People Actions, such as training, restructuring of selected tasks, development of local "gurus" or experts in functional departments, recognition programs to recognize and reward particularly useful achievements, and other steps.

d. Identify needs for Information Technology Actions, including not only various elements of the microcomputer hardware and software mix, but also possible matching actions in the mainframe or minicomputer operations (for example, steps to make access to mainframe database feasible from micros). In addition, examine user support strategy options, in terms of possible software to be made available and alternative service delivery strategies.

e. Work out clear policies for supporting the microcomputer program in ways which balance organization objectives with the basic goal of stimulating individual creativity and productivity. From an organization's global perspective, it is important that user applications be documented, that data be protected, that consistent data be used in reports and analyses done by different departments, and that the work of the individuals be recorded and disseminated so that the corporate investment is protected when individuals change jobs. From the point of view of promoting individual creativity and productivity, however, users should be encouraged to develop their own approaches to particular problems, and their own data and programs, when appropriate. Even when a particular program is developed by users or by systems staff, and disseminated to user's

flexibility might be provided to allow individual users to develop their own personalized variations.

f. Use the micros to establish new personal networks and relationships. In addition to the recognition program, it is also useful to stimulate users groups which cut across organizational boundaries, develop newsletters and electronic bulleting boards, and similar actions. These actions can stimulate significant improvement in interpersonal relationships and in individual satisfactions with job-related accomplishments. They also add significantly to the momentum of individual creativity and improvements in working processes.

The general thrust of this type of strategy is to use microcomputers to develop innovations throughout the organization, in a decentralized way. Later, the best of the innovations can be recentralized and disseminated more broadly, either as microcomputer programs polished by professional programmers in the systems department, or as mainframe programs added to the capabilities of the organization's basic mainframe computing environment.

D. Focus change on the individual

The primary objective of change is to change the ways people work, in order to enhance their productivity and effectiveness consistent with the strategy of the business. In Chapter III, we discussed some specific goals in improving people's job satisfaction and productivity. Now let's see what kind of specific actions flow from these:

1. Use a User-Dominated Development Strategy

A number of factors have caused a significant growth in the user's role in developing his own computer applications. First, the increasing backlog for MIS and DP departments have made it difficult for the user to get the reports and analyses he wants, when he wants them. Second, the development of software which allows users to generate their own applications without needing to know a programming language has made user application development feasible. These "application generator" languages are available on both large computers and microcomputers, and include spreadsheets, database managers, "decision support systems," and other types of software. Third, the proliferation of microcomputers has been aided by, and has stimulated further development, of user-developed applications. The best example of this is the symbiotic role of Visicalc (a spreadsheet package) and the Apple II microcomputer.

In a user-dominated development strategy, the user is responsible for developing his own applications. Sometimes, the user literally does it all himself - for example, developes his own spreadsheet analysis, or his own report drawing data from a database. Sometimes, the user has staff in his own functional department who assist him or do the development work for him. Often, the Information Systems department (MIS or UP) is also involved, in one of several roles. IS can assist the user, offering training, expert advice, or on-call consulting; IS can work directly with the user, helping him to develop a new applicaton; or IS can

work on a capability for the user based upon user specifications. In all of these modes, the user is dominant.

In this kind of process, the software can be expected to go through a number of cycles of revision. The first early versions of an application serve as prototypes, to help the user clarify what he wants. The ultimate system may look very unlike the initial designs. Often, the system will evolve in use. While this may make documentation, standardization, and maintenance more difficult, the basic objective is met: systems are developed which are used, because the user finds them useful (Note 5-1).

2. Humanize the Technological Environment

In Chapter III we presented a set of criteria for evaluating the performance of a work station in terms of factors relevant to user satisfaction in the work performed at the workstation (Figure 3-6). These criteria can be used as design objectives for the design of software (and hardware) to support individuals and task groups.

Often, the software environment for a task is designed in a relatively static, "cold" and impersonal way: display formats are fixd, tasks accomplished with the computer are fixed, the functions available are fixed. There is little the user can do to change it. This is especially true for software designed for structured or semi-structured tasks in operating organizations, such as: reservation agents, forms entry or examination, or even many management information system applications.

Managers should ensure that systems designs are examined to ensure that opportunities for creating more satisfying workstation environments are pursued aggressively. In particular, efforts should be made to develop software that is more effective in supporting user creativity in problem-working (Note 5-2).

Specific actions that can be considered include:

1. provide multiple alternative screen displays and other forms of interaciton
2. provide ability for users to individualize screen displays or other elements; consider providing ability for users to create personalized metaphors (fantasy worls), especially around very routinized tasks
3. provide multiple levels of complexity of tasks to be accomplished, so that workers can tackle more complex tasks if they wish
4. provide learning capabilities, so users can progress to more difficult levels of complexity of tasks or of approaches to tasks as they are motivated to do so, and with tutorial aids in the workstation environment
5. provide multiple approaches to accomplishing particular tasks, allowing individual choices of approach to vary
6. provide mechanisms through which users and systems support staff can add new capabilities to the system and experiment with their use
7. provide mechanisms for recognizing and rewarding individual accomplishments in working on particular complex problems or in developing particularly effective approaches to problems

3. Focus Attention on Problem-Working Processes

The major objective of information technology-based strategic change is to improve the ways people work on problems. To do this, it is useful to get people to think about how they are working, to stimulate discussion of alternative approaches, to identify possible innovations, and to recognize and reward important improvements. Managers can use several techniques to do this:

1. encourage informal discussions of problem-working issues, approaches, and innovations, both successul and unsuccessful
2. target systems support to implement user-suggested improvements
3. target support for training, organizational changes, and other people-system actions which are identified as important to support improvements in problem-working processes.

E. Implement change in a controlled, managed manner

The process of people-based technology change is a continuing one. This process must be managed with a strategic view and a focus on near-term actions to be implemented:

1. Monitor and Evaluate

Effective change implementation requires monitoring of actions taken, evaluation of those actions, and adjustment of planned actions as necessary.

The conceptual framework laid out in Chapter IV can be used as a guide for monitoring and evalution.

2. Commit Needed Resources to Research and Training

It is not clear what will work well in a particular organization. It will often be highly desirable to undertake research within the organization on certain key issues, such as:

1. unique issues in the problem-working processes to support particular tasks
2. planning and design of particular people-technology options, especially those unique to the business or unique to its competitive strategy
3. successes and failures in implementing change in people and technology; this requires monitoring and evaluation of many changes, using methodologies such as implementation path analysis (Note 5-3).
4. effectiveness of alternative approaches; this may be done by implementing several prototypes or pilots in parallel with different approaches and structuring careful research designs to learn from the differences.

Internal research on topics such as these may be important for several reasons: when there are potential strategic advantages that may result, or when the changes are occurring too quickly for a company to wait for results of research to be developed by others.

Important needs will exist for training of managers and employees, including:

1. specific training in particular skills required for use of new technology and for adaptation to changes in problem-working processes and in tasks

2. preparing line managers to manage people-based technology change in their own units, including development of managers' abilities to monitor and assess their own change implementation activities
3. preparing staff elements which will play major roles in these changes to do so, such as human resources management and information systems staff (see following)

F. Provide effective staff support to line managers

Senior managers should lead the people-based technology change program, but line managers in particular functional areas will have to implement the changes most important for their missions. To assist line managers and senior managers, well-equipped corporate staff support is essential.

In the information systems area, professionals are needed who are fully knowledgeable about, and fully skilled at, the new techniques of information service delivery. In addition to the traditional skills required in data processing and in Management Information System development and operations, new skills are required. These are the skills to provide effective end-user support in a direct way: knowledge of microcomputers, user-application development software, communications technology, problem-working processes, and other elements.

Particularly important are people-related skills: the ability to work closely with end-users in a wide variety of functional areas, the ability to teach users, whether in large formal classes or in

one-to-one modes, and the ability to be sensitive to, and effective in, the complex organizational situations which may arise as major technology-based changes are introduced.

In the human resources area, professionals are needed who can play major roles in helping with the many different people system needs and issues. Human resources personnel will have to be major participants in shaping the overall change strategy, in understanding the personal and organizational issues and forces around proposed or planned changes, and in developing a wide range of different support services. These services include:

1. training, especially in managerial and team skills required as tasks change or organization realignments occur as part of technology-based change;
2. training in new techniques and approaches, for problem-working skills, for use of new technology, and for use of new techniques;
3. conceptualization of new professional skills, and definition of new or changed job descriptions and career ladders;
4. counseling and assistance to individuals to deal with perceived threats and resistance to change, or with other elements of stress induced by technology change.

Figure 5-3 shows the integrated support required for the individual worker: actions to support changes in individual or group problem-working processes include people-system actions by the human resources staff and others, and information system actions by the information systems staff. Figure (b) shows the line manager's need for this support to help him work effectively with his employees.

EFFECTIVE SUPPORT TO LINE MANAGERS
FOR PEOPLE-BASED TECHNOLOGY CHANGE

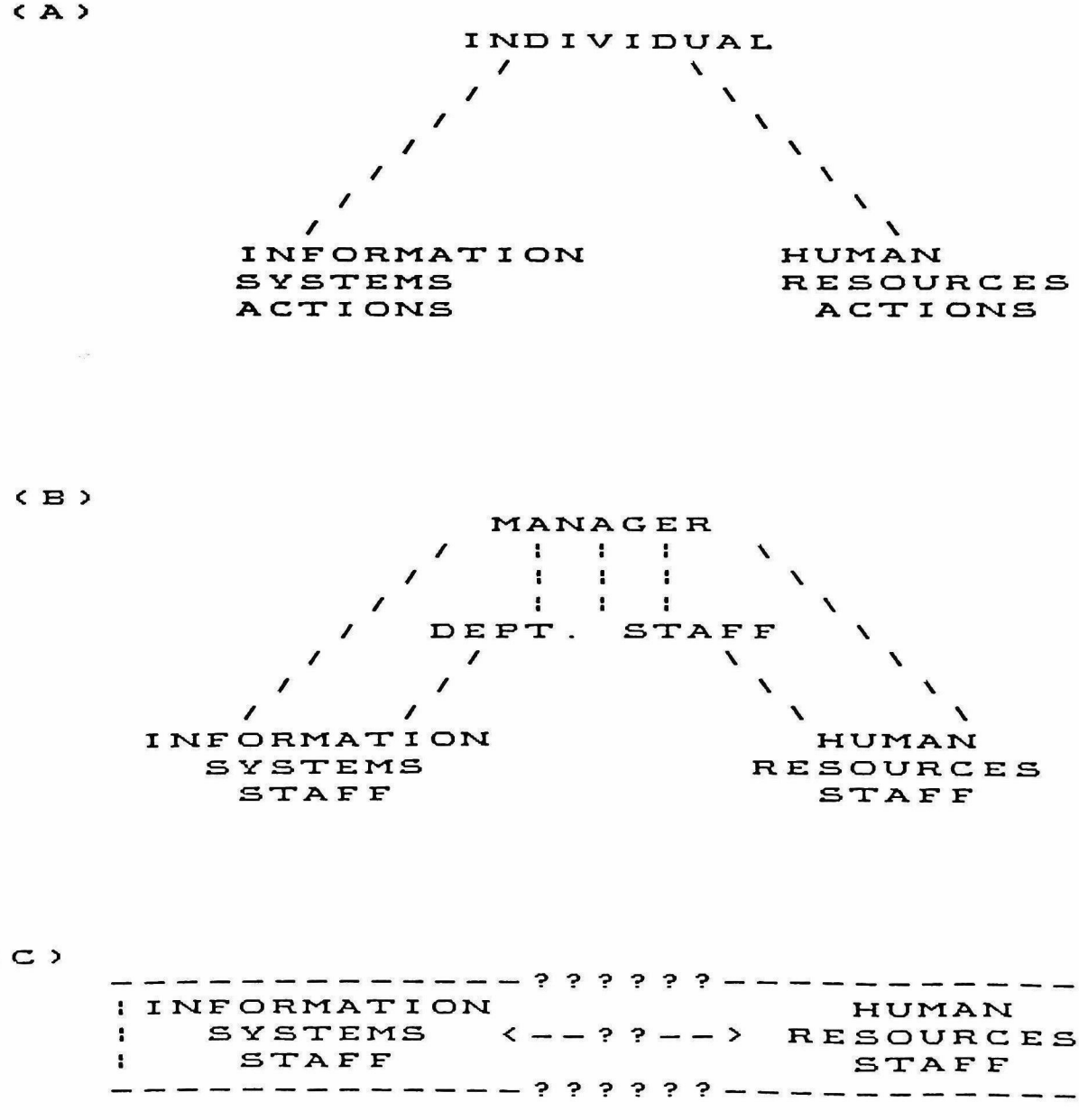

FIGURE 5-3

PROVIDING EFFECTIVE SUPPORT TO LINE
MANAGERS FOR PEOPLE-BASED TECHNOLOGY CHANGE

him plan for and implement people-based technology change in his organizational unit. This change has to involve coordinated actions in all three major dimensions: human systems, information system, and problem-working processes.

Because the management of this support is so critical, senior managers may want to reconsider the present functional organizations of human resources (HR) and information systems (IS) staffs [Figure 5-3(c)]:

a. should there be a new organizational unit established, pooling selected staff from HR and IS to provide this support to line managers?

b. should there be a single senior executive to whom both HR and IS report, and who coordinates the delivery of their services to line managers?

c. or, to be truly effective in providing people-based technology change support to line managers, should HR and IS be combined into a single staff function?

CHAPTER VI

ACTIONS FOR RESEARCHERS AND EDUCATORS

As indicated at the beginning of this paper, the concepts presented here need to be subjected to careful testing and refinement. Let us assume for the moment that there does turn out to be substantial validity in these ideas. What then does this imply for actions by researchers and educators?

First, with respect to research: Substantial research is needed to develop and test both concepts and techniques for information technology-based strategic management. Such research should be at both the theoretical and practical levels. Research involving strategic planning efforts at specific companies would be particularly valuable (Note 6-1).

Research is especially needed on (see Note 6-2):

1. the structure of problem-working processes and on ways of designing computer support to enhance human problem-working. This is a high priority area and would have major impact in transportation distribution, computer - integrated manufacturing, and numerous other applications (see Note 6-2).

Other important topics include:

2. techniques for assessing strategic choices incorporating information technology considerations (Note 1-1)
3. testing and refinement of the conceptual framework described here (or alternative frameworks), through application in developing information technology-based strategies and implementations plans

4. case studies of transportation and distribution organizations and their uses of information technologies for strategic purposes
5. development of software systems that support user-dominated applications development (evolutionary application-generating systems)
6. development and testing of practical techniques for managing the phased change implementation process outlined here
7. examination of alternative approaches to organizing and managing support to line managers (e.g., alternative forms of human resources and information system organizations), including necessary training for existing personnel to adopt new roles.
8. development of management training programs to better equip senior managers and line managers to manage technology change as people change.

More important than specific topics is the question of general research approach. It is essential in our view to form interdisciplinary research teams, combining the skills and perspectives of organization behavior, psychology, information systems, and managerial strategy. Such teams would do basic research and would also work closely with industry to test research results in practice. The transportation industry could take a lead role in this type of research-industry cooperation.

Second, with respect to education: It is essential that we educate students (and professionals) with the skills of both people change and information technology change. These people are needed in transportation and in many other industry sectors. Appropriate educational offerings need to be designed for bachelors, masters and

doctorate degree levels, and for continuing education for managers. (Design has already begun for a management program to help managers deal with technology change as people change.)

CHAPTER VII

CONCLUSION

We began our discussion with a basic premise: change in information technology should be managed as people change. We explored this premise, looking at the example of railroad power dispatching and also the phenomenon of the microcomputer revolution. We then developed some theoretical ideas, dealing with the electronic workstation and how to think about it, and with the notion of planned change. Next, we described a conceptual framework which pulled these ideas together from a theoretical perspective. We then looked at the implications of these ideas for actions by managers and, briefly, by educators and researchers.

We come at these issues as transportation professionals, interested in figuring out how to manage the priority issues in our industry. Yet, we find ourselves having to dig deeply into issues which are of general interest and which are applicable to many other sectors as well.

We hope the reader has found these concepts useful in organizing his or her own thoughts on how to deal with information technology. We look forward to critical discussions of these ideas as we try to shape these concepts further and carry them into practice in industry.

NOTES

Chapter I

1-1 For the general literature on strategy formulation and implementation, see for example: Porter, 1980, 1985; Hofer and Schendel, 1978; Galbraith and Nathanson, 1978. For approaches to using information technology for competitive advantage, see: Bakopoulos and Treacy, 1985; Barrett and Konsynski, 1982; Benjamin et al., 1983; Gerstein and Reisman, 1982; Ives and Learmonth, 1984; Keen, 1981; Mcfarland, 1984; Notowidigdo, 1984; Parsons, 1983; Rockart and Flannery, 1983; Rockart and Scott-Morton, 1984; Wiseman, 1984, 1985. Ives and Learmonth contains a good summary of previous literature.

Chapter II

2-1 This section draws heavily on Mao, 1982.

2.2 This philosophy of user-dominated development and incremental implementation was the original focus of the Decision-Support Systems (DSS) approach. see the classic, Keen and Scott-Morton, 1978; also Keen, 1980; House, 1983; Martin, 1984; Alter, 1980; Bennett, 1983.

Chapter III

3-1 Manheim, Thompson, and Simkowitz, 1983; Cambridge Information International, 1984; Manheim, 1985b.

3-2 This concept evolved out of discussions with Peter Keen.

3-3 This categorization evolved out of discussions with Rafael Amit.

3-4 This list of attributes expands on and modifies concepts initially proposed by Bakopoulos and Treacy, 1985.

3-5 See for example Manheim, 1985a. Also, Adams, 1979; Alexander, 1962; Alexander and Manheim, 1965; Hadamard, 1945; Jones, 1980; Lawson, 1983; Moore, 1966; simon, 1981; Wickelgren, 1974.

3-6 Manheim, 1985a.

3-7 Manheim, 1985a.

3-8 Simon, 1977.

3-9 See Manheim, 1985a; Jones, 1980; Adams, 1979.

3-10 Elam, 1985.

3-11 Brooke, 1985; Isenberg, 1984a.

3-12 Braybrooke and Lindbloom, 1963; Mintzberg, 1980; Isenberg, 1984, 1985, various.

3-13 Isenberg, 1984a; pp. 84-66. See also Isenberg, 1984.

3-14 Janis and Mann, 1977, pp. 137-139.

Chapter IV

4-1 Hackman and Oldham, 1980; Manheim, 1984.

4-2 Marris, as quoted in Burke, 1982, pp. 51-53/

4-3 Same as 4-2.

4-4 Same as 4-2.

4-5 Lewin, as quoted in Burke, 1982, p. 48.

4-6 The Information Technology Strategic Assessment concept was developed by Benjamin Mittman.

4-7 See Chapter II.

4-8 Hofer and Schendel, p. 82.

4-9 See Manheim, 1979a, b for earlier formulations. See also Braybrooke and Lindblom, 1963; Quinn, 1980, 1984. There is a close relationship between an iterative, incremental approach to planning and implementation, and the cognitive process model that Isenberg has labelled "strategic opportunism." Isenberg, 1985, various.

Chapter V

5-1 See Note 2-2.

5-2 See Note 3-5.

5-3 Levinson, 1985a,b.

Chapter VI

6-1 Research at Northwestern is planned as a collaborative effort of the Transportation Center and the Center for Technology in Management at Kellogg.

6-2 Research in this area is also underway at Northwestern.

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