MANAGING THE REVOLUTION IN INFORMATION TECHNOLOGY

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Business today is experiencing a revolution in computer technology, a revolution that is as dramatic and far reaching as the Industrial Revolution of the last century. Information technology will be a vital component in the strategy of firms that succeed in the future; leading companies will be able to take advantage of and manage information technology.

Increasingly, new technology is forcing decisions on managers that they have not had to make in the past. Managers are uncomfortable with their new role in controlling information processing, and many are ill-prepared to deal with it. The purpose of this article is 1) to outline the information processing problems faced by contemporary managers and 2) make suggestions for solving them.

The biggest danger is inaction; left alone trends in technology will result in management losing control over information processing. In the future when the firm wants to share hardware, software, and applications and when it is ready to develop an integrated communications network, today's inaction will prove costly.

HOW WE REACHED THIS POINT

For business the computer age dawned in the 1950's when a few firms acquired first generation, vacuum tube computers. The programming and operation of these machines was left to professionals, generally personnel who had previously worked with electronic accounting machinery and punched card processing. Management and the end-user of computer systems had little contact with the specialists who were located in a data processing department.

The 1960's witnessed widespread disappointment with computers. The promise of "management information systems" was never achieved. Neither managers nor systems designers knew what information a manager needed nor how to provide it through computers, except in a few rare instances. The use of computers expanded rapidly during this time, but the emphasis was on transactions processing and managerial control systems.

Advances like database and online systems which began in the 1960's flourished in the 1970's, bringing users closer to computers. Users worked directly with computers whether or not they influenced the design of systems. Older, batch processing systems hid the computer from users and buffered them from it; that buffer was removed with online systems so that lapses in service became painfully obvious to users.

As the 1970's drew to a close and we entered the 1980's, new problems in information processing in organizations became apparent. The information services department was seen at best

as unresponsive to users, and at worst as totally incompetent. The backlog for new applications was discouraging and was continually increasing in size. A user might be faced with a wait of two or three years before a new application was started, unless he or she could make a strong enough case to get the application moved to the front of the queue. Once the information services department started work on an application, it was likely to encounter large time and cost overruns, often delivering a product that did not meet original specifications.

Lack of responsiveness was not confined to new applications; requests for maintenance and enhancements to existing systems also waited, seemingly forever. To overcome some of these problems, firms established maintenance committees to set priorities on requests for changes. I heard one manager of an information services department, when pressed about when a request would be completed, respond, "It's up to the maintenance committee. If they put a high priority on it, we can do it next month. If it has a low priority, chances are it will never be done."

TRENDS IN THE TECHNOLOGY

Information technology has developed rapidly over the last five years; the technology itself offers some solutions for overcoming the problems described above <u>if it is managed well</u>. Management must control this technology and its use in the organization; new developments have created an even larger challenge to management than it faced in the early days of

computers. Too many managers are letting the technology drive decisions rather than actively managing the technology. (See Lucas and Turner, 1982, for a framework for managing information processing.)

Strategy and Technology

What are the trends in technology that should concern management? First, a number of firms are using information technology as a part of corporate strategy. Merrill Lynch gained a significant competitive advantage in the securities industry with its Cash Management Account, a product made possible by information technology. This innovation brought an estimated 450,000 new brokerage accounts to Merrill. The firm also gained $60 million in annual fees for managing the three liquid assets funds associated with the Cash Management Account (see Wiseman and MacMillan, 1984).

American Hospital Supply offers another example of a company which has used information technology to gain a competitive edge. In this case, AHS developed an order entry system called ASAP which features terminals in customer hospitals. The average order on this computer-based system is for 5.8 items compared to the industry average of 2.7 items per order. Three times more is spent by hospitals with ASAP than by those on the manual ordering system. See Index Systems, 1985 and the Wall Street Journal references.

End-User Computing

The next major trend of concern to management is the explosion of end-user computing. This term describes computing

that is actually performed by the user of the technology rather than by a systems professional for the end-user. The proliferation of microcomputers for individual users and divisional and department minicomputers are examples of this trend. With powerful applications packages, users are developing systems and installing them more quickly than possible through the efforts of the traditional, centralized information services department.

Alternatives for Development

A third trend of interest concerns the options available for systems development. No longer is there but one way to develop an application: classical custom developed systems. Now, we have prototyping, packages and/or Fourth Generation Languages to ease applications development.

A prototype is a representation of a system under development. The prototype might correspond to some part of the system such as the input and output seen by the user. The prototype might be a version in miniature of the entire application, developed on a microcomputer to test design before a system is programmed for a mainframe. A prototype may also grow itself to be the final application. This approach provides quick feedback to users who can see something concrete from the development effort early on in the design process.

Packages are used in a number of different ways to speed applications development. A package is a program that is purchased from a third party for use in the organization. The first kind of package is general purpose; the user works with the

package to solve a problem. A good example of this kind of package is Lotus 1-2-3. This micro spreadsheet program is intended for use in solving a wide variety of problems that can be cast into the format of a spreadsheet.

A dedicated package, on the other hand, represents a solution to a specific problem like processing accounts receivable, order entry, or controlling inventory, to name a few. The package is the solution; the buyer usually has to modify company procedures or modify the package to employ it successfully. If changes can be kept to a minimum, a dedicated package provides debugged and working code and should shorten applications development time. The demands on the user, however, may be greater than with custom development because installation is faster and more intensive.

Fourth Generation Languages are languages which are considered to be at a higher level than COBOL or FORTRAN. These languages like Focus, NATURAL, RAMIS II and NOMAD, accomplish many tasks with one or two language statements. A single statement in one of the Fourth Generation Languages might take five or ten statements in COBOL. The higher level nature of the language hides the computer more than do COBOL-like languages. As a result many users have had success working with Fourth Generation Languages. Some firms are moving away from COBOL as their primary programming language and are using a Fourth Generation Language instead. The higher level of these languages results in greater programmer productivity for professionals in the computer field as well as for users.

Managerial Workstations

We are close to the development of managerial workstations, systems that serve the manager in the same way that engineering workstations contribute to the productivity of technical personnel. The purpose of this system, constructed around one or more microcomputers, is to support the manager in whatever work he or she has to perform. The functions which might be included in a workstation are:

1. Spreadsheet processing with a program like Lotus.
2. Word processing for preparing memos and reports.
3. Database management and file systems for setting up simple, personal applications.
4. Presentation graphics for meetings.
5. Electronic mail.
6. Access to external databases like D&B or Dow Jones.
7. Connection to various networks to share data and programs.

Such a workstation will increasingly become an invaluable part of the knowledge worker's support system.

CAD/CAM

The use of computers has spread well beyond traditional business information processing. Computer aided design and manufacturing (CAD/CAM) are becoming increasingly common as manufacturers struggle to meet competition. Engineers, factory managers and others involved in factory operations are making decisions on the acquisition and installation of many different types of computer-based devices. These decisions involve the

expenditures of large amounts of capital and have significant implications for all of the information processing in the firm.

Networks

There is a trend toward networking, that is, tying many of a firm's computers together with communications links. What are the advantages of networking? One of the first uses for a network is to distribute mail and memos electronically. For example, DEC has an intercompany electronic mail network that includes over 6000 nodes. The system has had a major impact on Digital and its chairman has stated that it is difficult to imagine doing business without it; see Crawford, 1982.

Another reason for networking is to share data thoughout a corporation. Users may also need the computational power or a special program on a computer located somplace else on the network. A communications path through the network makes it possible to access the computer and/or its programs. Networks facilitate the sharing of devices. It is expensive to provide each managerial workstation with a laser printer, though one printer shared by eight or ten workstations on a network would probably be more than adequate.

Cost/Performance Improvements

A final trend of interest to management is the continuing decrease in the cost of computation combined with an increase in the power of computers. There will be more and more user-oriented software to take advantage of increased computer processing power. While these costs are dropping, it will be a rare organization whose entire budget for information processing

does not increase because so much more processing is being done!

Implications

These trends in the technology have a number of implications for the firm. First, information processing will become even more pervasive; there is no end in sight to the increasing demand for computers and processing power. Firms will move toward greater integration of their computers, forming networks of mainframes, minis and microcomputers. Compatibility among hardware and software will be a major issue in building networks.

Firms will increasingly seek ways to use information technology creatively to gain a competitive edge. Senior management will be more concerned with computers than ever before.

Due to packages and fourth generation languages, there will be more applications developed at a faster rate than in the past. While increased development speed will reduce user complaints, it means increasing demands for computer resources and a rapid pace of organizational change as new systems are implemented. Also as a result of more applications development and end-user computing, more managers and staff members at all levels in the organization will make hands on use of computers.

We expect knowledge workers to embrace the concept of managerial workstations. These stations will become an integral part of the worker's job and will become as essential as a telephone.

All of these trends will create strong pressures for more user autonomy and control over processing. Unless constrained by

management or company policy, the natural tendency will be for users to acquire hardware and software without any consideration of overall corporate goals.

CHALLENGES FOR MANAGEMENT

The trends and their implications above present a major challenge to three groups of managers: senior management of the firm, divisional and departmental managers, and the manager of the information services department. This section presents a seris of questions for each of the three groups of managers. In the section later in the paper on recommendations, all of these questions are grouped into five categories of concerns in order to offer concrete suggestions for managerial action. The trends above lead directly to the questions raised here and the five concerns into which the questions fall.

A major point of this article is that if these three groups of managers do not actively control information processing and meet the management challenges of this new technology, the firm will be severely hindered in the coming years. To do nothing is tantamount to admitting that management is incapable of controlling information processing. The results of such a policy, given the pace of technology, will be uncontrolled growth leading to a future information processing environment that will be both chaotic and costly.

Senior Management

Senior management needs to answer the following questions:

1. How do we control information processing?

2. What is the best organization structure for information processing?

3. How do we coordinate the acquisition of hardware and software.

4. How do we coordinate distributed users?

5. What role does information technology play in corporate strategy?

6. What are our communications needs?

Divisional Managers

In today's processing environment, divisional and middle managers are confronted with making decisions and supervising operations that used to be delegated to computer professionals. Now these managers have to respond to the following questions:

1. How do we structure information processing in our organizational subunit?

2. How do we control the local acquisition of hardware and software?

3. How should we manage networks and distributed processing?

4. What needs to be done to develop hardware and software interfaces with other computers and among the division's computers?

5. What are the appropriate systems development strategies for us?

6. Should we try to integrate voice, data and video communications?

7. What are appropriate database strategies for access

and query from various locations?

9. What kind of micro to mainframe links and networks are needed?

The Information Services Manager

New technology has caught most information services department (ISD) managers in a vise. The movement toward end-user computing is clearly a loss of power and influence for this computer professional. Nolan (1982) describes a manufacturing plant which is probably typical of much of American industry. In 1970 the manager of information services controlled 80% of the firm's budget for information processing. By 1980, he controlled only 36% of a much larger budget and, furthermore, his control extended over only 60% of the business use of computers.

The ISD manager recognizes the risks for the company of too much end-user control, but is almost powerless to stop it. This computer professional knows that the widespread proliferation of vendors for hardware and software will create immense support and integration problems when the firm decides to move toward a networked environment. He or she also knows that most users do not bother with documentation, and careful testing and debugging of their applications; few show concern over data integrity.

Many times the information services manager is seen as unresponsive based on a history of rather credible evidence. To discourage end-user programming and the proliferation of computers looks like an attempt to retain power. The ISD manager must figure out how to work with senior managers and users to help the firm control information processing. He or she must

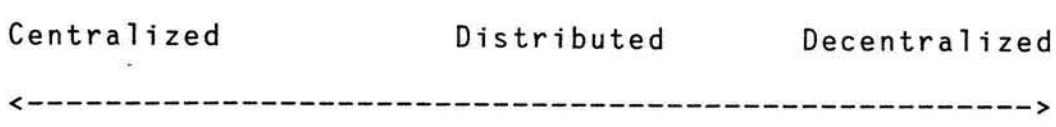
address the following questions:

1. What kind of information processing plan should the organization develop?
2. How do we organize the staff in the ISD to support end-user computing?
3. What type of architecture is appropriate for a corporate communications network?
4. How do we deal with heightened user expectations; if a micro application can be done so fast, why should a multi-user system on a mainframe take so long?
5. How can we educate end-users on all aspects of information processing?
6. How do we advise, support and control hardware and software acquisition?
7. What new technology and tools for systems development are best?
8. How can we control data integrity in a distributed, database environment?
9. Is the firm ready for office automation?

We shall offer some suggestions for these three groups of managers after we discuss the key issue of the control and coordination of information processing and how it interacts with the structure of the oganization.

CONTROL AND COORDINATION

The most difficult management decision with respect to information processing today is how much control to give each of



Control of Information Processing

Exhibit 1

the three groups of managers above. Exhibit 1 depicts three points on a contiuum of processing control.

In a centralized environment, all control for information processing remains in a central information services department, including decisions on hardware and software acquisition and user support. In a decentralized environment, we find the opposite extreme: decisions are left to the user with no coordination from a central group. Users and divisional managers have total control.

Distributed processing is characterized in theory by shared control, but there is great potential for lack of control and ambiguity. Some standardization will be forced upon users because distributed processing implies a communications capability among various computers. However, there is still great latitude on how much control is given to local managers and how much authority to coordinate is given to the ISD manager.

What is the role of senior management under these

alternatives? Under centralized control, senior management can probably continue to ignore information processing until the noise level from users becomes too high. Then managers will be forced to adjudicate between the central ISD group and users who want more freedom.

Under decentralized management, senior managers will also be able to ignore information processing, at least in the short run. Of course, it will be necessary to review budgets and to prevent a local manager from spending a disproportionate amount on information systems, but in general one can continue a laissez faire approach to systems. In the long run, this strategy may lead to disaster. One major bank has equipment from 47 different vendors. Supporting this equipment and establishing a network are formidable tasks which would have been simplified with prior planning and control.

Distributed processing is probably the direction in which inertia will tend to take firms who do not make a conscious choice. Vendors are only too ready to sell hardware and software to anyone in the firm and prices are low enough that it is easy to purchase substantial computing power without anyone noticing.

The Tradeoffs

What then is the best organizational structure for your firm? There is no one best structure for information processing. Right now, the majority of firms are distributed with respect to equipment, but the locus of control is not as clear. Exhibit 2 presents some of the tradeoffs senior management should consider in structuring the information processing organization.

	STRUCTURE		
	Centralized	Distributed	Decentralized
Coordination Control	Little effort	Heavy demands	Extreme demands
Service	Poor	Good	Good
Support	Market services	Joint effort	Users alone
Technology	Tight control	Policies needed	Keep up with technology?

Organizational Structure Tradeoffs for ISD

Exhibit 2

In a centralized environment, coordination is achieved through the authority of the ISD organization and requires little effort, except to police the local divisions. Service perceptions are likely to be poor and the ISD will have to market its support activities. There will be tight control over the technology.

In a decentralized mode, it is extremely hard to coordinate processing if management wishes to do so. Control is antithetical to the philosophy of decentralization. Evidence suggests that local control is associated with more favorable user perceptions of service, though it is quite likely that the local divisions will vary greatly in their adoption of technology. Some division managers will make good decisions while others will not.

With a "go it alone" approach service will be perceived as good and users will have to provide their own support. Decentralized users may become complaisant and fall behind in technology or become fascinated with and adopt every costly advance.

Management can achieve distributed control and still provide local managers with a great deal of autonomy. The demands for coordination are heavy, but the results, if managed carefully, should be highly favorable user perceptions of service and adequate corporate control over processing.

RECOMMENDATIONS

The challenges and questions for each group of managers presented in the beginning of this article can be grouped into five categories, each of which needs to be addressed by senior, divisional and information services management.

The first task for management is strategic. Managers have to identify opportunities where the technology will provide a strategic advantage. It is also necessary to look for threats created by competitors who are using technology strategically.

Second, as described above, management must design a structure for information processing. While distributed is probably the most popular organizational form, it is not necessarily the best for every organization.

Third, the organization structure of information processing determines how management will control processing. A structure featuring a highly centralized computer staff has different

implications for control than a decentralized structure. What are the variables that management should consider in controlling information processing?

It is easiest to manage when the policies and control exercised are seen to be in the best interest of those for whom the controls are intended. Keene and Woodman, 1984, have presented an excellent example of this approach in describing one firm's control over microcomputers. The authors argue that control should not be equated with prevention, something typically ascribed to the manager of the information services department.

The firm established a computer store and consulting services to help users and to control microcomputers in the organization. It was easier and more convenient for users to work with the store and consulting services than to look outside the organization. By keeping computers and software packages the company was ready to support in the store, the firm influenced end-users to make acquisitions that fit corporate plans.

This central issue of control involves setting policies for the acquisition of hardware and software, the coordination of requests for new applications, the coordination of distributed users and approaches for supporting end-users.

The fourth management concern is with communications and networking. Trends suggest that firms are moving toward a networked environment. The organization needs to develop an architecture of hardware and software and plans for communications.

Finally, management must consider systems development strategies. As an example, a firm might require that at least three alternatives be considered for any suggested application, a custom designed system, a package and a simple system on a micro. Management may also encourage the use of Fourth Generation Languages as a replacement for COBOL in custom-developed systems where feasible.

Recommendations for Senior Management

What should senior management do to address the five concerns above?

1. Look for strategic uses of the technology. Firms are increasingly using technology to gain a competitive edge and senior management is responsible for corporate strategy. See Wiseman and MacMillan 1984, for some ideas on how to find strategic opportunities.

2. Define the organizational structure for information processing. Will the firm be centralized, decentralized or distributed? If distributed, to what extent? How will the firm make decisions about information processing, eg. through a corporate steering committee?

3. Work with the ISD staff to define an architecture for hardware, software and communications. It is important to have one's future computer environment and network in mind in making today's decisions about hardware and software.

4. Determine how computer support will be provided, by whom and how it will be charged. End-users become easily frustrated when they encounter difficulties and they need

quick, easy access to help.

5. Determine the amount of coordination required over information processing. One policy might be to establish an approved list of hardware and software for purchase; no further approval is required if items on this list are to be acquired. Exceptions must be approved by the corporate VP of Information Systems who will respond within two weeks to a written request for an exception.

6. Establish a mechanism for the approval of suggested applications and look for common systems. One policy might be to require that all applications beyond those by a single end-user for his or her own use must be sent for review to the corporate VP of IS and/or a steering committee. The review will normally be completed within two weeks. The purpose of the review is to see if the firm already has such a system or if there are other division working on one that is similar.

7. Establish coordination mechanisms. For example, all local information processing personnel are to meet every six months with the corporate VP or IS and his or her staff to discuss common problems, new applications and new technology. Encourage the local divisions to set up users' groups for popular software like Lotus 1-2-3.

8. Require that local budgets and plans for information processing be reviewed by the corporate VP of IS, not for approval, but to keep aware of what will be happening in the divisions.

Actions***	Senior Management Areas of Concern 1 Strategy & tech	2 Org struct	3 Control & coord	4 Comm & nets	5 Systems develop
1 Seek strategic uses of information technology	x				
2 Define organization structure		x			
3 Define technical architecture			x	x	
4 Support end-users			x		
5 Determine coordination required		x	x		
6 Establish applications approval mechanism					x
7 Establish coordination mechanisms			x		
8 Review budget			x		

Senior Management Actions
Exhibit 3

See Exhibit 3 for how these recommendations help senior managers meet the concerns described earlier.

Recommendations for Divisional Managers

Divisional managers must make decisions about information processing in their divisions. The following actions are recommended:

1. Look for opportunities for the strategic use of the

technology at the divisional level.

2. Determine an organizational structure for processing in the division.

3. Following the guidelines above for senior management, establish policies for whatever degree of coordination and control is required at the local level.

4. Maintain involvement in systems analysis and design. Insist on alternatives for each application, attend review sessions and agree on system logic.

5. Encourage the use of new technologies to improve design like prototyping, the use of Fourth Generation Languages, etc.

6. Support end-user computing, experiment with workstations and control micros through support.

7. Consistent with corporate policy, develop network and communications strategies including links among varous types of computers.

See Exhibit 4 for how these recommendations help meet the challenges of the technology for the divisional manager. The manager of local divisions will undoubtedly receive more responsibility for information processing in the future. Just as with any other aspect of the business, this technology can be managed if one is willing to spend time and take action.

Actions***	Division Managers Areas of Concern 1 Strategy & tech	2 Org struct	3 Control & coord	4 Comm & nets	5 Systems develop
1 Seek strategic uses of technology	x				
2 Define organization structure		x			
3 Determine coordination required			x		
4 Encourage involvement in systems analysis					x
5 Encourage use of new technologies					x
6 Encourage end-user computing			x		x
7 Plan networks				x	

Divisional Manager Actions
Exhibit 4

Recommendations for Information Services Managers

The ISD manager is in the middle of the revolution in computer technology. The role of this individual is changing, from a person with almost absolute control to one who consults with, educates and trains users. I believe that most ISD managers will eventually find this a more appealing role than trying to satisfy users while being in complete control over information processing, something that has proven almost impossible to achieve.

For the computer professional, more end-user involvement is a mixed blessing. End-users can help reduce maintenance and enhancement requirements and enhance productivity. However, computer professionals must teach users to be concerned about documentation, database integrity, compatibility and the maintainability of the systems or programs they develop. The ISD manager can help the organization most by:

1. Designing systems development, operating procedures and communications to support the type of organization structure for information processing desired by senior and divisional management.
2. Encouraging the use of advanced technology like Fourth Generation Languages and managerial workstations.
3. Setting a policy that multiple alternatives will be considered for each new application such as a dedicated package, a small system for a micro, a custom developed application, etc.
4. Generating ideas for senior management on how information processing technology might be used strategically in the firm.
5. Taking the lead in developing networks and hardware and software architectures for the future.
6. Recognizing the changing role of computer professionals as consultants and educators.

Information Services Manager
Areas of Concern

Actions***	1 Strategy & tech	2 Org struct	3 Control & coord	4 Comm & nets	5 Systems develop
1 Support firm's information processing structure		x			
2 Encourage use of new technologies					x
3 Provide multiple alternatives for each application					x
4 Generate ideas for strategic use of technology	x				
5 Develop future network and computer architectures				x	
6 Recognize changing IS staff role			x		x
7 Coordinate information processing for the organization			x		

Information Services Manager Actions
Exhibit 5

7. Performing the information processing coordination role for the corporation as a whole deemed appropriate by senior and divisional management.

See Exhibit 5 to see how these recommendations help meet the concerns for information services managers posed earlier.

CONCLUSIONS

There is no one best way to organize and manage information technology. Regardless of the organizational structure chosen, there is a need for management to control and coordinate information processing in the organization. Information technology offers opportunites that will be crucial to the success of firms through the remainder of the 1980's and beyond. Management needs to put mechanisms in place today so that information processing will make its maximum contribution to the firm now and in the future. The recommendations above should help senior, divisional and information services management meet the challenge of managing the revolution in information technology.

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***Editors: Please expand the column headings of each of these tables when they are typeset as follows:

1 Strategy and technology
2 Organization structure
3 Control and coordination
4 Communications networks
5 Systems development