1981

Merging of the Islands of Information Services

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The Vice President of Services of a large durables manufacturing firm recently faced a dilemma. She had just discovered that her request for a stand alone word processor to solve operating problems in her fastest growing sales office had been denied. It seemed a tivial request, yet its review created a mess and she felt the decision a dangerous precedent. The reason given for the denial was incompatibility with the division system's plan. When she had asked why it was incompatible, an incomprehensible series of technical arguments ensued which appeared to have no relationship to her very real productivity problem. Should she fall in line, fight the decision, or resubmit the request as an operating expense instead of a capital expenditure?

A major manufacturing company over the past four years has reduced the hardware processing capacity and staffing of its corporate data processing center by 60%. Dramatic growth, however, has taken place in divisional data centers to such an extent that overall corporate data processing expenditures have risen more than 50% during the period.

After careful analysis, senior staff of a major decentralized company recommends an orderly dissolution of the company's $25 million data center and the creation of eight smaller diversified data centers over a thirty month period.

For reasons of both efficiency and effectiveness, in the 1980's Information Services must embrace different functions than in the 1970's. Information services in the 1980's must include office automation, data and voice communications, and data processing, managed in a coordinated and, in many situations, an integrated manner. Development of this coordination will not be easy in many organizations as each of these activities in the 1960's and 1970's not only had different technical bases, but were marketed to the company quite separately. Internally, quite different organization structures and practices handling them developed.

Further, the complexity and size of office automation investments is such that they now require a systems study similar to those done for data processing, instead of the former routine expense approval. Similarly, telecommunications investments now involve large capital investment and multiple vendors instead of a routine upgrading of monthly expenses from the public utility. In addition, many applications require the physical interconnection of data processing, telecommunications, and office automation.

The key driving force of change has been innovation in the speed and cost of electronic design and manufacture. In twenty years, dramatic strides have occurred as we moved from the vacuum tube to the very large scale integrated circuits. These productivity changes are continuing as still smaller, more reliable useful circuits are being developed. Table I shows the cost trends per individual unit and circuit over the past twenty years, trends which will continue for the next decade. The cost reduction and capacity increases, caused by these changes, have reduced computer

Table 1. Costs and Performance of Electronics

Technology	1958 Vaccuum Tube	1965 Transistor	1962 Integrated	1980 LSIC
$/Unit	$8	.25	.02	.001
$/Logic	$160	$12	$200	$.05
Operation Time	$16x10^{-3}$	$4x10^{-6}$	$40x10^{-9}$	$200x10^{-12}$

hardware cost as a fraction of total DP department cost below 30% in most large data processing environments. Today, computer costs often do not exceed communications expense, and for many firms are significantly less than software development and maintenance charges. Equally significant, this technology has permitted development of stand alone "minicomputer systems" or "office automation systems" which can be tailored to specific service for any desired location, and which are physically separate from the central DP site.

This changed technology has permitted a dramatic shift in both the type of information services being delivered and the best organizational structure for delivering them. This shift has and will involve not only the coordination of data processing, teleprocessing, and office automation, but redeployment of both physical location and organizational placement of the firm's technical and staff resources that provide information services. By technical resources we mean items such as computers, word processors, private telephone exchanges, and intelligent terminals. In staff resources, we include all the individuals either responsible for operating this technology, developing new applications, or maintaining them.

This is the first of three articles identifying the critical managerial issues emerging from those changes in information services. This article considers the organizational implications of managing more closely the technological services of office automation, telecommunication, and data processing in a world of expanding products and technical change. The second article considers the range of necessary policies important for the orderly management of productive information services in the 1980's. Special attention is given to the problems of stand alone islands of automation or mini-computers. The final article examines information services planning, and how it can be done more effectively.

SPECIAL INFORMATION SERVICES ENVIRONMENTAL FACTORS

In 1981, several issues, in addition to the convergence of their technologies, have propelled the need for reexamination of how information services can be most effectively organized inside the firm. The most important of those issues are the following.

1. An increasing shortage of competent skilled people in the USA in relation to the need to translate this technology into ongoing systems and processes within organizations. These shortages, severe in 1981, will worsen in the coming decade for the following reasons:

   - The number of individuals reaching their 18th birthday is estimated to plunge by 27% in the twenty years between 1978 and 1998.

   - The 15% decline in Scholastic Aptitude test scores in the past decade and the reworking and simplification of college freshman curricula.

   - The shrinking availability of professional information systems curriculum as potential faculty choose industry over university careers. In the spring of 1981, over 100 unfilled openings in information systems existed in major universities.

2. The development of highly reliable, cheap digital telecommunication systems in the USA and expanding growth in Europe. The economics and reliability of worldwide telecommunications, however, are not consistent with the USA representing a unique environment for the immediate future. In Western Europe, tariffs run an order of magnitude more than those in the USA, often coupled with inordinate installation delays once an order is planned. However, as European countries better coordinate their government-owned system, they may develop a more cost-effective environment. In Latin America and other parts of the globe, these problems are further compounded by reliability problems. For example, one South American company was forced to shut down a sophisticated online system supporting multiple branches because of unplanned, unacceptable breakdowns (sometimes more than twenty-four hours in duration). In another situation, the company was able to achieve acceptable reliability only by gaining permission to construct and maintain its own network of microwave towers.

3. The exploding growth of office systems products, with even greater functional performance and lower cost. For example, the recent connection of word processing stations into telecommunication networks has converted the simple opportunity of automating the edit/typing function to gain operating efficiencies into one of reorganizing the total flow of the work in administrative areas of the company nationwide. The potential productivity increases offered by this technology are only beginning to be realized in most organizations.

4. Legitimate demand for information services support by users continues to vastly exceed available supply. Supplies of cost-justified applications waiting to be implemented exceeding available staff resources by three or more years, tend to be the norm rather than the exception. This has created widespread user frustration. Further, perceived unsatisfactory support and unhappy interpersonal contacts with the central information ser-

vices organization continues to persist. This has increased the users' natural desire to gain control over this aspect of their work. The new technologies increasingly permit users to gain this control. In addition, users' confidence in their ability to run a computer (through personal experience, such as a home APPLE for example) is not only growing but is likely to continue to grow (admittedly an often unwarranted self-confidence).

5. A fundamental conceptual shift has occurred in computer based systems design philosophy. The prevailing practice in the 1960's and early '70's involved writing computer programs which intermixed data processing instructions and data elements within the computer program structure. In the 1980's world, the management of data elements is clearly separated from the computer program instructions. This implementation of shift has placed enormous pressure on information services organizations as they balance investing human resources in new systems developments versus redesign of old systems, while ensuring reliable operation of the old systems until the updated ones can be installed.

6. Finally, there have not just been sharp reductions in computing costs, but also exploding breakthroughs in the cost and type of peripheral and other input/output devices which can be attached directly or remotely to the computer. Of particular importance is the continued dramatic reduction in cost and increase in size of secondary storage. This year's volume of HBR could be sorted in accessible format for less than $2 worth of memory versus $20,000 three years ago. Further, no serious student of the field believes that the pace of improved performance in these devices will slow in the next ten years. As with all technologies, a point of maturity will be reached but we are not yet close to it.

SOURCE OF CURRENT MANAGERIAL CHALLENGE

Many of today's managerial issues are a result of past management practices relating to these technologies (as shown in Table 2); the following paragraphs analyze this data in more depth.

In 1920, an operational style of information services in most corporations, elements of which continue to this day, was in place. The manager and his secretary were supported by three forms of information services, each composed of a different set of technology. For word processing, the typewriter was the main engine for generating legible words for distribution. A file cabinet served as the main storage device for output, and the various organization units were linked by secretaries moving paper from one unit to another. Data processing, if automated at all, was dependent upon cart-sorting machines to develop sums and balances using punched cards as input. The cards served as memory for this system. The telecommunication system involved wires and messages that were manipulated by operator control of electrical mechanical switches to connect parties. The telecommunication system had no storage capacity. The jump from 1920 to 1965 marked a significant shift in data processing and little change in the other two information services. In data processing the computer replaced the card-sorting system of manipulation. This added speed-of-light electronic memories to these functions and allowed many of them to be linked together into an automatically

Table 2. Islands of Technology

Functions of the Technology	Word Processing	Data Processing	Communication
1920			
Human to machine translation	Shorthand/ Dictaphone	Form/ Keypunch	Phone
Manipulation of data	Typewriter	Card sort	Switch
Memory	File Cabinet	Cards	None
Links	Secretary	Operator	Operator
1965			
Human to machine translation	Shorthand/ Dictaphone	Form/Keypunch	Phone
Manipulation of data	Typewriter	Computer	Computer
Memory	File cabinet	Computer	None
Links	Secretary	Computer	Computer
1980			
Human to machine translation	Shorthand/ Dictaphone	Typewriter	phone/type-writer
Manipulation of data	Computer	Computer	Computer
Memory	Computer	Computer	Computer
Links	Computer	Computer	Computer

controlled process which delivered a wide range of preprogrammed services to users.

This technology both enabled an enormous productivity increase in data processing and permitted development of a range of new services not originally envisioned. Attendant to this, of course, was a host of new management problems. To cope, managers learned to deal with data processing as a capital-intensive service which required their attention.

Further, problems often emerged as a result of one-time data processing design decisions that had significant unforeseen implications. For example, one firm, after developing a special-purpose inventory system for the shop, discovered to its horror that it could not link to any accounting system. An insurance company, after encouraging adaptation of a system to a unique insurance policy at great cost, then discovered the policy had lost sales appeal in the market and therefore represented wasted effort. These incidents helped managers to learn the importance of system design and top management review and, in general, to evolve through the stages noted by Nolan (Nolan & Gibson, 1974). At this time, word processing and office automation had undergone little operational change and had received limited management attention. To the extent that attention was paid to it, it was done by a manager of office services who was far removed from the DP function. In the communication system, technological shifts were enormous. However, they were unnoticed by most users as no decisions were required and only limited management review was made as it was a purchased service.

The second technological jump, which took place in one-third the time of the first, caused these formally isolated and independent technological islands to pose increasing similar managerial and technical concerns, and generated complex organizational issues. The roles required of people providing each of these services have changed dramatically.

In 1920, as shown in Table 3, the designer of each of the three islands had significantly different roles. For word processing the office manager directed the design, heavily influenced by the whim of his/her manager. Although office system studies were emerging, word processing was primarily a means of facilitating secretarial work. The prime means of obtaining new equipment was through purchasing agents, and involved selecting typewriters, dictaphones, and file cabinets from a wide variety of medium-sized companies. Standardization was not critical. Data processing was the domain of the controller-accountant and the systems design activity was carried out by either the chief accountant or a card systems manager whose job it was to design the protocols for the flow of information to the processing steps. Both data processing and teleprocessing were sufficiently complex and expensive that they required that managers develop an explicit plan of action. Thus, the operation of both these systems was dominated by individuals following a plan, be it from machine to machine or an operator connecting switches or transforming cards.

However, a key difference between data processing and telephones starting in the 1920's was that the service of data processing was normally purchased and maintained as a system from one supplier. Thus, from the beginning, a systems relationship existed between buyer and seller. Teleprocessing, however, evolved as a purchased service. As AT&T had made available a network of cheaper inner city telephones, companies responded by ordering the phones and the utility developed a monopoly of the phone system. All three islands, therefore, were served in a different manner in 1920; one by many com-

Table 3. Islands of Technology

Roles of Use	Word Processing	Data Processing	Communication
1920			
Design	Office Mgr.	Card design	AT&T
Operate	Secretary	Machine Operator	AT&T
Maintain	Many Companies	Single supplier	AT&T
User	Manager	Accountant	Manager
1965			
Design	Office System Analyst	Systems Analyst	AT&T
Operate	Secretary	Operator/Analyst	AT&T
Maintain	Many	Single supplier	AT&T
User	Manager	Manager/Accountant	Everybody
1980			
Design	Systems Analyst	Systems Analyst	Systems Analyst
Operate	Mgr./Secy./Editor	Mgr./Secy./ Secretary	Mgr./Secy.
Maintain	Many or single	IBM/other	AT&T/other
User	Everybody	Everybody	Everybody

panies, one by a systems supplier, and one by a public utility.

In 1965, the servicing and management of all three islands was still institutionalized in the 1920's patterns. Word processing had a design content but was still very much influenced by the manager and centered around the secretary. Services such as typewriters and reproducing systems were purchased as independent units from a range of competitors offering similar technology. There was little one-term planning, with designs and systems evolving in response to new available technical units. Data processing, however, had emerged as an ever more complex management process. It was dominated by a serious evaluation of major capital investments in computers and software, as well as multiyear project management of the design and development of systems support. In addition extensive training sessions for all employees and users were required to effectively take advantage of the productivity of the new system. At times, even the corporate organization was changed to accommodate the new potential and problems caused by computer technology. These changes were very much influenced by the nature of the business and its internal organization culture. For communications, however, in 1965 AT&T completely dominated the provision of communication service and, from a user's perspective, its management was a passive purchase problem. In some organizations, managing communications implied placing three minute hourglasses by phones to reduce the length of calls.

By 1980, however, the management concerns for word processing and teleprocessing had become integrated with those of data processing for two important reasons. First, these areas also now require large capital investments, large projects, large complex implementation, and extensive user training. The managers of these activities, however, had had no significant prior expertise in handling this type of problem. For office automation, a special problem is the move from multiple vendors with slamm individual dollar purchases to one vendor that will provide integrated support. The size of the purchase decisions and the complexity of the applications are several orders of magnitude, larger and more complex than those faced a decade ago. For telecommunications, the problem revolves around breaking the psychology of relying on a purchased service decision from a public utility, and looking at multiple sources for large capital investment decisions. In both cases, this represents a sharp departure from past practices, and creates needs for a type of management skill which fifteen years ago was added to the data processing function.

The second linkage to data processing is that increasingly key sectors of all three components are physically linked together in a network; consequently the problems of one component cannot be addressed independently of those of the other two components. For example, in one manufacturing company, the same WATS line over a 24-hour period is used to support online data communications from assembly-line terminals to the central computer, voice communications, and finally, an electronic mail message switching system. The potential linkage of these technologies has raised important organizational issues such as:

1. Should DP, given its expertise in these management problems, be in charge of office automation?

2. Should data and voice communication be merged in a single department because of the common sources of service and potential for cost savings?

3. Should control of telecommunications systems acquisitions be assigned to DP?

Unfortunately, the addressing of these concerns all too often appears driven by creation of new technology and lobbying of one or more vendors, and are not placed in organizational perspective. In 1981, for each of the three islands, a dominant supplier is attempting to market his product island position as the natural technological base from which the company can evolve into coordinated automation of the other islands. For example, IBM is attempting to extend its data processing base into products supporting office automation and communication. AT&T is attempting to extend its communications base into products supporting data processing and office automation. Xerox is attempting to expand its office automation effort into communications and data processing.

In our judgment, failure to constructively address these management issues poses great risk to an organization. Over the next few years, through addressing these issues, we believe that those organizations which have not already done so will consolidate at least policy control and perhaps management of the islands in a single information services unit. The key reasons for this include:

1. Decisions in each area now involve large amounts of money and complex technical/cost evaluations. Similar staff backgrounds are needed to do the appropriate analysis in each case.

2. Great similarity exists in the type of project management skills and staff to implement applications of these technologies.

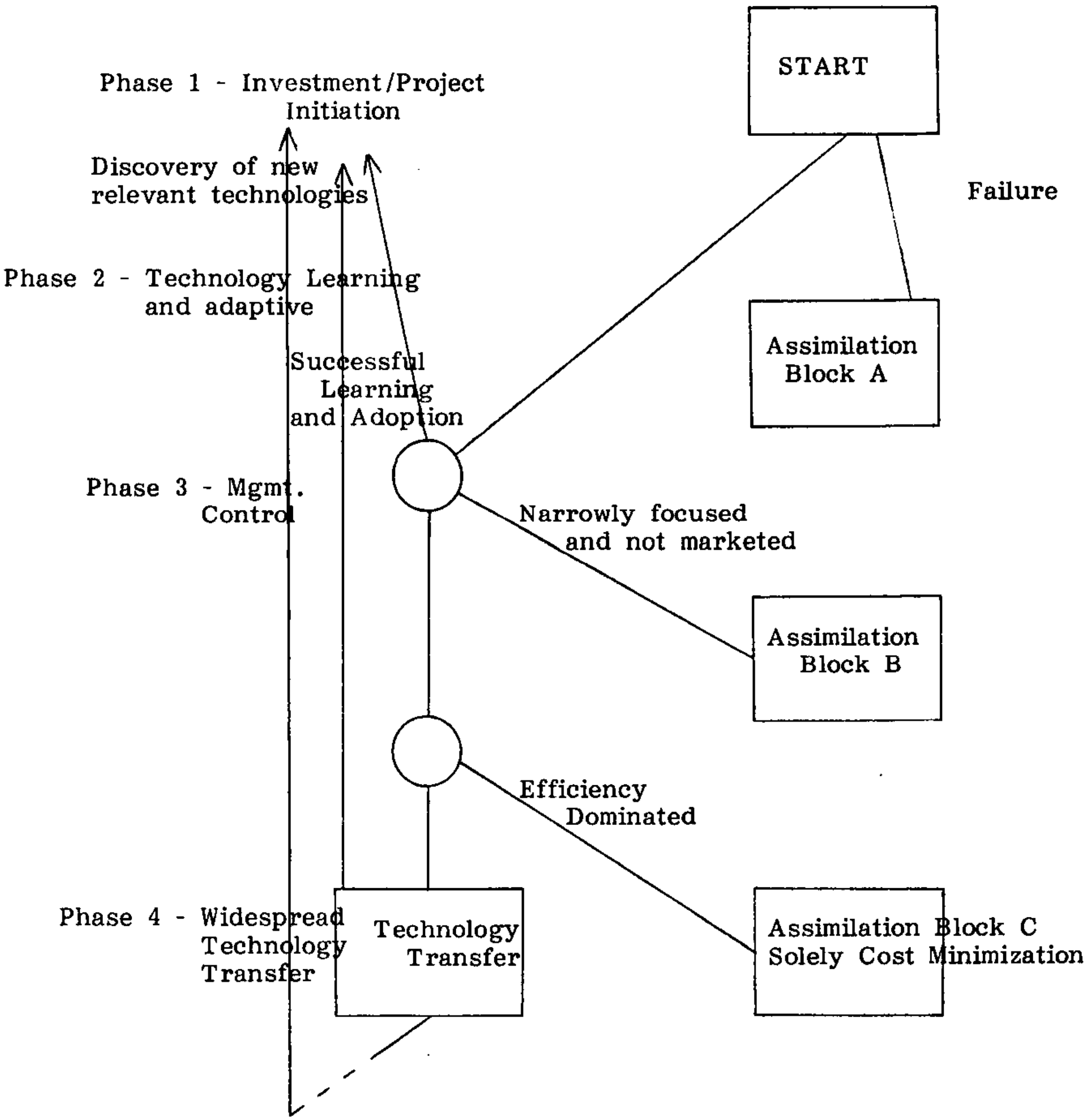
3. Many systems require the combined intertwining of these technologies into integrated networks which comprise handling computing, telecommunications, and office automation in an integrated way.

The specific timing and nature of this organizational merger, of course, will be influenced by the very different history and consequent organizational status of these different units within a company, the speed at which the firm has been investing in staying modern in these technologies, individual career paths, and other general organizational considerations. The direction of the trend is clear.

PHASES OF TECHNOLOGY ASSIMILATION

Organizations change much more slowly than technology and must grow to productively assimilate new information services. As Nolan demonstrated for data processing, an organization progresses through stages in assimilating technology. Recent work in office automation and data processing, has discovered this model to be a special case of the broader problem of the learning cycle of adapting a technology to an organization's needs (McKenney). Distressingly, there has been surprisingly poor transfer of skills learned in managing the DP stages of office automation. A recent study of thirty-seven firms found thirty had not built on their DP technology experience when moving into word processing and office automation (Curley, 1981). Of equal importance, over two-thirds had not progressed beyond Nolan's Stage 2 of automation of tasks and experimentation with respect to word processing, and were in a state of arrested development. Another study tracing an organization's use of information services technologies in all three components found four phases of evolution which both relate to Nolan's original stages and are consistent with organizational change concepts developed by Dr. Edgar Schien. These phases are characterized in Table 4 as Investment/Project Initiation, Technology Learning and Adaptation, Rationalization, and Maturity.

Table 4. Phases of Technological Use



The first phase is initiated by a decision to invest in a new (to the organization) information processing technology, and involves one or more complementary project development efforts, and initial individual training. The second phase seems to follow, unless there is a disaster in Phase I, such as vendor failure or poor user involvement which results in Assimilation Block A.

Assimilation Block A typically generates a two-year lag before new investments in this technology are tried again--normally along with a complete change of personnel. The decision to disinvest normally is a result of increased work and little benefit from the system; sources of these problems range from vendor failure, lack of real management attention, incompetent project management, or merely bad choice. Rarely are the problems leading to Assimilation Block A recognized quickly. The complexity and time requirements of implementing new information technology normally hides understanding of the developing failure for 18-36 months. The failure typically is not a clear technological disaster, but rather an ambiguous situation which is perceived as adding more work to the organization with little perceived benefit. Hence, rejection of the system follows. All projects studied which aborted in Assimilation Block A had significant cost overruns. Each failure created anxieties and prevented development of coordinated momentum. Typically organizations frozen in this state end up purchasing more services of a familiar technology and become relatively adept at adapting this technology to this use. They control the loss of blood by preventing experimentation.

The second phase involves learning how to adapt the technology to particular tasks beyond those identified in the initial proposal. In none of thirty-seven office automation sites studied was the first utilization of technology implemented as originally planned (Curley, 1981). In each case, significant learning took place during implementation. If the second phase is managed in an adaptive manner that permits managers to capture, develop, and refine new understanding of how this technology could be more helpful, the organization moves to phase three. Failure to learn from the first applications and to effectively disseminate this learning, leads to Assimilation Block B.

A typical Assimilation Block B situation occurred in a large manufacturing company and involved automation of clerical word processing activities which were under the control of a very cost-conscious accounting function. Highly conservative in its approach to technology in data processing, the firm had developed automated accounting systems centrally controlled in a relatively outmoded computer operating system and had yet to enter into database systems. Having developed this narrow word processing application to reduce costs, the department exhibited no interest in expanding its scope beyond automating the editing function in a typewriter. Expertise has been gained but it was not disseminated; consequently, over several years the learning on how to introduce and utilize this technology efficiently was lost.

Phase 3 typically involves a change in the organization, continued evolution of the uses of the technology to ones not originally considered, and, most important, development of precise controls guiding the design and implementation of systems using these technologies to ensure latter applications can be done more cost efficiently than the earlier one. If, in this phase, control for efficiency does not excessively dominate, and room for broader objectives of effectiveness is left, then the organization moves into a phase 4, which involves broad based communication and implementation of technology to other groups in the organization. Assimilation Block C comes when excessive controls are developed, which are so onerous as to inhibit the legitimate profitable expansion of the use of the technology. An example of Assimilation Block C controlled system use with respect to data processing was a manufacturing company which entered into large scale centralization with distributed input systems. To justify the expense of the new operating system, it focused significant attention on gaining all the benefits of a very standardized, highly efficient production shop. In the process of gaining this efficiency the organization had become so focused on standard procedures and efficiency that it lost its ability and enthusiasm for innovation and change with respect to this technology, and began to actively discourage users. Further, the rigorous protocols of these standard programs irritated their users and helped set the stage for surreptitious local office automation initiation experimentation, phase 1 in a different technology. Too rigorous an emphasis on control had prevented logical growth. The first incident described at the article's beginning was from that company.

Quite naturally as time passes, new technologies will emerge which offer the opportunity either to move into new application areas or to restructure old ones (see Table 4). Each of the three components of information services is thus confronted over time with a series of waves of new technologies, and at any point must adapt different approaches to managing and assimilating each, as each is in a different phase. For example, in 1981, a manufacturing company studied was in phase 4 in terms of its ability to conceptualize and deal with enhancements to its batch systems over a multiyear period. At the same time, it was in phase 3 in terms of organizing protocols to solidify control over the efficiencies of its online inquiry and data systems whose growth had exploded in the past several years. Finally, it had made an investment in several word processing systems and was clearly in phase 1 with respect to this technology.

In a subsequent article, we will examine how this notion of phase of technology assimilation dramatically impacts the appropriate ways to plan and control the information services function. In the context of this article, it is important because it represents a major organizational challenge. As the islands of technology merge, for example, it is critical that the dominant phase 3 approach being used in the technology of one island not be blindly and incorrectly applied to the phase 1 and phase 2 technologies in that island or in another island. Not only has there been difficulty in transforming appropriate expertise from one island to another, but often the wrong lessons are being transferred.

In summary, organizations go through a series of learning experiences to adapt specific information technologies to their needs. However, many organizations have found it difficult to transfer the lessons from one technology to another. A successful cycle with one technology does not necessarily evolve to a happy ending for all technologies. Active management of each technology is required to ensure that it does not prematurely abort at an early Assimilation Block.

CURRENT ORGANIZATION STRUCTURES IN MERGING THE ISLANDS

Data Processing and Telecommunications

It is clear why data processing and teleprocessing of data merged some years ago in many organizations under DP leadership. In those organizations early data processing applications had to support multisite situations; thus, the DP staff was forced to become conversant with the technical aspects of data communication. Expertise subsequently developed to deal with minimizing the changes caused by the Bell rate structure and to resolve the technical issues of getting terminals to communicate to computers. In the early 1970's the technical issues were formidable as there was a clear dichotomy between voice and data communication since the Bell system was designed for voice and converting it to data transmission was a challenge requiring significant captial investment to obtain quality digital signals between comptuer oriented systems. In this situation, it was natural to separate data communications (technically complex) from voice communications, and assign data communications to data processing and voice communications to office services. In the mid-1970's, technical changes in the way information was represented to a telecommunications system permitted voice and data to be dealt with similarly. On several nontechnical dimensions, however, initially they continued to pose dissimilar management problems: voice (the telephone), a purchased service, was still a carefully regulated utility, while data communication demanded increased sophistication on evaluating capital investments in complex technologies from multiple vendors. However, as the size of data communications has exploded, the economic advantages of merging voice and data communications have become significant. In 1981, the trend is to merge voice and data communications policy and operations in a single department, typically located within the DP department. For example, a large bank recently installed a system to manage voice and data traffic by controlling switches and line utilization. The system reduced their communication bill 35% with improved service to both the data processing effort and voice communication. For the reasons described earlier, however, it has not been an easy task to implement this merger.

Data Processing and Office Automation

A less frequent path followed by organizations has linked DP to word processing. This path was followed by technologically innovative DP managers, through extension of their terminals for data processing into remote sites. These managers learned to move words (as opposed to numeric data) through computers from one site to another. As their experience grew, these innovators found a great demand for systems which could store and forward words to other sites. Often, the remote terminals evolved to become more word than data communicators. As word processing software developed, these DP managers upgraded their terminals to include WP activities. Thus, DP assimilated all communications, voice, and data, and initiated word processing. This pattern's success has been determined by whether the mature DP organization has been able to develop the sensitivity to nurture the new phases 1 and 2 technologies, instead of smothering them with phase 3 controls.

In summary, at present a wide array of organization structures is in place for dealing with the totality of information services. We see this heterogeneity as transitional, with the eventual merger of these islands into a central hub occurring in most organizations; certainly for policy-making, planning, and control purposes, and in many settings for line control and execution. The timing of these moves in any organization is situation dependent involving technology phases of development, current corporation structure and leadership style, individual retirement plans, current development priorities, and so forth.

PATTERNS OF HARDWARE/DATA DISTRIBUTION

Within the context of the evolution of the islands of technology, critical organization issues are embedded which relate to how hardware and data should be distributed within the organization. At one extreme is the organization form which has a large centralized hub connected by telecommunications links to remote input/output devices. At the other extreme is a small or non-existent hub with most or all data and hardware distributed to users. In between these two extremes lie a rich variety of intermediate alternatives.

The early resolution to this organization structure was heavily technology influenced. The higher cost per computation of hardware in the early 1960's, when the first large investments in computing were instituted, made consolidation of processing power into large data centers very attractive. In contrast, the technology of the early 1980's permits, but does not demand, cost effective organizational alternatives. (In the 1980's, technological efficiency of hardware per se is not a prime reason for having a large central data center.)

To retain market share, the vendors of large computers are suggesting (as the comparative difference in efficiency of large computers versus small ones is eroded) that many members of an organization have a critical need to access the same large data files; hence, the ideal structure of an information process is a large central processing unit with massive data files connected by a telecommunications network to a wide array of intelligent devices, often at great distance. While certainly true in many situations, unfortunately, the problem is more complex, as is discussed below. Key factors influencing resolution of this include management control, technology, data, professional services, and organizational fit. The impact of each of these factors is discussed below with Table 5 summarizing the discussion.

Pressures Toward a Large Central Hub of a Distributed Network

Multiple presssures, both real and perceived, can generate need for a large hub of a distributed network.

Management Control Related: The ability to attract, develop, maintain, and manage staffs and controls to assure high-quality cost-effective operation of existing systems is a key reason for a strong central unit. The argument is that a more professional, cheaper, and higher quality operation (from the user's perspective) can be put together in a single large unit than through the operation of a series of much smaller units. This administrative skill was what caused the major decentralized company identified at the beginning of the article to not eliminate its corporate data center and move to regional centers. In the final analysis, they were unconvinced that eight small data centers could be run as efficiently in aggregate and, even if they could, whether it was worth the cost and trauma to make the transition.

Provision of better backup (in case of machine failure) to users on key online systems is another advantage of the hub. This backup occurs through the ability to have multiple CPU's in a single site; when hardware failure occurs in one CPU, switching the network from one machine to the other can take place by simply pushing a button. Obviously, this does not address the problems of a major environmental disaster which impacts the entire center.

Technology-related

The ability to provide very large scale processing capacity for users who need it, but whose need is insufficient to require their own independent processing system is another strong reason for a large hub. In a day of rapid explosion in the power of cheap computing, it has become easier for users to visualize doing some of their computing on their own personal computer, such as an APPLE, or a stand alone mini. However, at the same time some users

Table 5. Summary of Pressures on Balancing the Hub

	For Increasing HUB	For Increasing Distributed
Management Control	- More professional operation - Flexible backup - Efficient use of personnel	- User control - User response - Simpler control - Local reliability improved
Technology	- Access large scale capacity - Efficient use of capacity	- Small is efficient - Telecommunications $ reduced
Data Related	- Multiple access common data - Assurance of data standards - Security control	- Easier access - Fit with field needs - Data only relevant to one branch
Professional Service	- Specialized staff - Reduced vulnerability to turnover - Richer career paths	- Stability of work force - User career paths
Organizational Fit	- Corporate style - central - functional - Past history of IS	- Corporate style - decentralized - Business need - multinationals

have other problems such as large linear programming models, and petroleum geological reservoir mapping programs that require the largest available computing capacity. The larger the computer capacity available, the more detail they can profitably build into the infrastructure of their computer programs.

Also, in many firms as opportunity is perceived to exist to better manage aggregate computing capacity in the company reducing total hardware expenditures: With many machines present in the organization, if each is loaded to 70%, the perception is that there are a vast number of wasted CPU cycles that could be eliminated if the processing was consolidated. Clearly an important issue in the technology economics of the 1960's, the significance of this as a decision element has largely disappeared in the 1980's.

Data Related: Another pressure for the large central hub is the ability to provide controlled multiple user access to common corporate data files on a need-to-know basis. An absolutely essential need from the early days for organizations such as airlines and railroad, the sharp reductions in storage and processing costs have made this access economically desirable for additional applications in many other settings. Management of data at the hub can also be a very effective way to control access and thus security.

Personnel Services: Development of the large staff which accompanies the large IS data center provides an opportunity to attract and keep challenged specialized technical staff. The ability to work on challenging problems and share expertise with other professionals, not only to attract them to the firm but to keep them focused on key issues, provides a necessary air of excitement. Existence of these skills in the organization permits individual units to undertake complex tasks as needed without incurring undue risks. Furthermore, in a limited staff skills availability world, consolidation of them in a single unit permits better deployment from a corporate perspective. Further, the large group's resources at a hub permit more comfortable adaptation to inevitable turnover problems. Resignation of one person in a distributed three-person group is normally more disruptive than five persons leaving a group of 100 professionals.

The large unit provides more potential for the technically ambitious individual who does not want to leave the IS field to find alternative stimuli and avenues of personal development (perceived technical and professional growth has proven to be one of the key elements which can slow down turnover). This is a critical weapon in postponing the so-called burnout problem.

Organizational Fit: In a centralized organization, the above mentioned set of factors take on particular weight since they lead to congruency between IS structure and overall corporate structure and help eliminate friction. The point is particularly important for organizations where IS hardware was introduced in a centralized fashion and the company as a whole adapted their management practices to its location in this way. Reversal of such a structure can be tumultuous.

Pressures Toward a Small Hub and Primary Distributed Environment

In 1981, important pressures push toward placing significant processing capacity and data in the hands of the users, and only limited or nonexistent processing power at the hub of the network.

Management Control Related: Most important among these pressures is that such a structure better satisfies the users' expectations of control. The ability to handle the majority of transactions locally is consistent with their desire to maintain a firm grip on their operation. The concept of locally managed data files suggests that the users will be the first persons to hear about deviations from planned performance of their unit, hence have an opportunity to analyze and communicate their understanding of what has transpired on a planned basis.

Also, the users are offered better guarantees of stability in response time by removing them from the hourly fluctuations in demand on the corporate network. The ability to implement a guaranteed response time on certain applications from the users' perspective has turned out to be a very important feature.

This distribution of hardware to the users provides a way for them to remove or insulate themselves from the more volatile elements of the corporate chargeout system. It permits the users to better predict in advance what the costs are likely to be (therefore reducing the danger of having to describe embarrassing negative variances) and not frequently appears to offer the possibility of lower costs.

Distribution of processing power to the users offers a potential for reduction of overall corporate vulnerability to a massive failure in the corporate data center. Companies with very large IS budgets where this technology supports essential parts of the firm's operations have found it increasingly desirable to set up two or more large data centers and split the work between them in a way that, if something happened to one data center, the core aspects of the firm's operations could run at the other data center. The firms that have gone this way have in general been such large users of data processing services, that the possibilities of arranging backup at some other neighboring site has been impractical. The medium-size firms have had the practical option of making backup arrangements with other organizations (frequently these have sounded better in theory than they have turned out to be in the hour of utilization) or buying into something such as the SUNGUARD solution (where for $6,000/month you have access to a fully equipped unloaded data center in case of an emergency). For less dramatic events, a network of local minis can keep key aspects of an operation going during a service interruption at the main location.

A simpler operating environment from the users' perspective is possible in the distributed network both in terms of feeding work into the system and in terms of the construction of the operating system. The red tape of routing work to a data entry department is eliminated and the procedures can be naturally built right into the ongoing operation of the user department. (Surprisingly, in some cases regaining this control has been viewed with trepidation by the users.) Similarly, with the selection of the right type of software, the problems in interfacing with the basic operating system can be dramatically simplified (to use the jargon of the trade, they are "user friendly").

Technology related: The efficiency of large central processing units in relation to much smaller ones was true in the early days. In the 1980's, however, several important changes have occurred in the external environment:

- The economics of CPU's and memories in relation to their size have altered and this law no longer applies (Cole, Gremillion, & McKenney, 1979).

- The economics of Grosch's Law were never claimed to apply to peripheral units and other elements of the network. The CPU and internal memory costs are a much smaller percentage of the total hardware expenditures in 1981 than they were in 1970.

- The percentage of hardware costs as a part of the total IS budget has dropped dramatically over the past decade as people costs, telecommunication costs, and other operating and development costs have become more significant. Efficiency of hardware utilization consequently is not the burning issue it was a decade ago. When these factors are taken in conjunction with the much slower improvement in telecommunication costs (11%/year) and explosion of user needs for online access to data files which can be generated and stored locally, in many cases the economic case for a large hub has totally reversed itself.

Data Related: Universal access of users to all data files is not a uniformly desired goal. Telecommunications costs and the very occasional needs of access to some data files by users, other than at the site where they are generated, means that in many settings it is uneconomical or undesirable to manage all data in a way in which central access is possible. Further, inability to relate data may be in accordance with corporate strategy. A case in point is the large company mentioned at the beginning of the article which recently considered abandoning its corporate computing center. The corporate computing center was a service bureau for its eight major divisions (all development staff resided in the divisions). No common application or data file exists between even two of the divisions in the company (not even payroll). If the company's survival depended on it, it could not identify in under twenty-four hours what its total relationship as a company was with any individual customer. In senior management's judgment, this organization of the development staff, and the lack of data relationships between divisions, appropriately reinforced the company's highly decentralized structure. No pressure existed anywhere in the organization for change. The corporate computing center, an organizational anomaly, was conceived simply as a cost-effective way of permitting each division to develop its network of individual systems.

It is exceedingly easy for technicians to suggest interesting approaches for providing information which have no practiccal use and may even threaten soundly conceived organization structures.

Professional Service: Moving functions away from the urban environment toward more rural settings, offers the opportunity to reduce employee turnover, the bane of metropolitan area IS departments. While the recruiting and training process is very complicated to administer in these settings, once the employees are there, if sensitively managed, the relative lack of headhunters and nearby attractive employers, reduces turnover pressures.

When the IS staff is closely linked to the user organization, it becomes easier to plan employee promotions which may take technical personnel out of the IS organization and put them into other user departments. This is critical for a department with low employee turnover, as the former change agents begin to develop middle-age spread and burnout symptoms. Two-way staff transfers between user and IS is a way to both deal with this problem and facilitate closer user IS relations.

Organization Fit: Also important in many settings, the controls implicit in the distributed approach better fit the realities of the corporation's organization structure and general leadership style. This is particularly true for highly decentralized structures (or organizations which wish to evolve in this fashion) and/or organizations which are highly geographically diverse.

Finally, highly distributed facilities fit the needs of many multinational structures. While airlines reservation data, shipping container operations, and certain kinds of banking transactions must flow through a central location, in many settings the overwhelming amount of work is more effectively managed in the local country, with communication to corporate headquarters being either by telex, mailing tapes, transmitting bursts of data over a telecommunications link, etc., depending on the organization's management style, size of unit, etc.

Assessing the appropriateness of a particular hardware, data configuration for an organization is very challenging. On one hand, for all but the most decentralized of organizations, there is a strong need for central control over standards and operating procedures. The changes in technology, however, both permit and make desirable in some settings the distribution of the execution of significant amounts of the hardware operations and data handling.

SUMMARY

Re-examination of the deployment of hardware/software resources for the Information Services function is a priority item in the 1980's. Changing technology economics, merging of formerly disparate technologies with different managerial traditions, and the problems of managing each of the phases of IS technology assimilation in different ways, have obsolesced many appropriate 1970 organization structure decisions. To ensure that these issues are being appropriately addressed, we believe five steps must be taken.

1. Establishment as part of the mission of a permanent corporate group, the development of policy for guiding organizational decisions, and the development of a program to implement them. This policy group must assess the current program toward merging the islands, guide the process of balancing the desires for a strong hub against the advantage of a strongly distributed approach, and ensure that different technologies are being guided in an appropriate way.

2. The policy group must ensure that uniformity in management practice is not pushed too far, and appropriate diversity is accommodated. Even within a company, it is entirely appropriate that different parts of the organization will have developed and will continue different patterns of distributed support for hardware and data. Different phases of development, with respect to specific technologies, geographical distance from potential central service support, etc., are all valid reasons for different approaches.

3. The policy group must show particular sensitivity to the needs of the international activities. It is inappropriate to enforce, without great care, common approaches to these problems internationally, either for companies operating primarily in single country, or for the multinational which operates in many countries. Each country has different cost and quality structure of telecommunications, different levels of IS achievement, different reservoirs of technical skills, different culture, etc. These differences are likely to endure for the foreseeable future. What works in the USA often will not work in Thailand.

4. The coordinating group must ensure that it addresses its issues in a broad strategic fashion. The arguments and reasoning leading to a set of solutions are more complex than simply the current economics

of hardware, or who believes they need access to what data files. Corporate organization structure, corporate strategy and direction, availability of human resources, and current operating administrative processes are all additional critical inputs. Both in practice and in writing, the technicians and information theorists have tended to oversimplify a very complex set of problems and options. A critical function of the group is to ensure adequate R&D investment (Phases 1 and 2). A special effort must be taken to ensure appropriate investment occurs in experimental studies, pilot studies, and development of prototypes. Similarly, the group must ensure that proven expertise is being distributed appropriately within the firm to appropriate places that are often unaware of its existence of potential.

5. The policy group must ensure an appropriate balance is struck between long term and short term needs. A distributed structure optimally designed for the technology and economics of 1981 may fit the world of 1989 rather poorly. Often it makes sense to postpone feature development or to design a clumsy approach in today's technology which is anticipated to meet the technologies of the late 1980's. As a practical matter, the group will work on these issues in a continuous iterative fashion rather than implementing a revolutionary change.

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