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A LIFE CYCLE APPROACH TO THE IMPLEMENTATION OF INTEGRATED INFORMATION TECHNOLOGY

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Abstract

Due to the growth in office automation and the increasing emphasis on distributed computing, data communications technology has become an increasingly important factor in the provision of information services. Since communications is the glue that interconnects the various information services, a corporation must ultimately integrate communications, data processing and office automation both organizationally and technologically in order to provide the most cost effective service to its employees. This paper discusses a life cycle framework to achieve this integration. The framework is different from the standard system development life cycle, in that a great deal of emphasis is placed on strategic issues such as the structure of the support organization and its interfaces with user organizations, behavioral issues due to the unstructured nature of work supported by office automation, and highly relevant technical issues such as standards and security.

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1. Introduction

The beginnings of distributed computing in the mid-1970s gave a great deal of impetus to the growth of digital data networks which serviced these systems. In fact, distributed processing can be said to have set the stage for the current revolution in office automation (OA) because it began a trend towards the delegation of information systems operations and management as close to the operational level as is cost-effective and technically sound [25]. Due largely to distributed processing, communications costs as a percentage of total electronic data processing (EDP) costs grew from 9% to 26% between 1977 and 1985. However, an even greater impact on digital communications growth is occurring because of the rapid growth in personal computing, which has been closely followed by local networking in the OA systems required for sharing resources, data, interpersonal communication, access to main computer resources, and access to external networks. Because "form follows function" a trend has developed in which the EDP, telecommunications and OA services have grown together organizationally in some companies, but in others they have developed independently of one another due to differences in organizational structure, management philosophy, and technological leadership roles. A recent Diebold survey of 100 large U.S. corporations [9] indicated that telecommunications is organizationally associated with management information systems organizations in close to 70% of the companies responding and that this proportion is growing. While OA is becoming a major consumer of communications services, this function is still moving through the initiation and contagion stages of Nolan's

stage model [16] in many organizations. In more advanced organizations, it is approaching the control and integration phases because of the investment involved, and because of its organizational impact. This service will increasingly merge with information systems and telecommunications functions as the technology matures and its use continues to spread (in fact, in many corporations OA either began in or has already integrated with these functions). Keen [12] notes the continued coalescence of these functions and refers to the integrated communications and information systems function as "integrated information technologies". As noted by Maggiolini [14], one may look at office technology ivestment in the broader sense of computer technology, data resource technology, and electronic communication technology as three assimilation stages of information technology.

While EDP and OA continue to merge with telecommunications as integrated information technologies, office automation has many characteristics which differ from EDP, and its implementation life cycle must be handled differently to achieve success. Ballou and Kim [4] note that these include differences in user interactions with technology, the nature of projects supported, the basic unit of information processed, the role of communication, technological assessment, and implementation strategies. And usually, because of the unstructured support role of OA, the users are likely to demand a strong role in the planning, management and control of this resource, as compared to a more passive role in the EDP function. In some corporations,

OA began life as a user-developed and supported function, and may still exist as organizational islands rather than fully integrated services. This will change as the demand for access to central data bases and communications services continues to grow. That both the technical and organizational aspects of integration are a significant issue has been shown by two recent surveys: Dickson, Leitheiser, Wetherbe and Nechis [8] found that integration of EDP, OA, and telecommunications ranked third in a 1984 survey of information systems executives, and Hartog and Herbert [11] found that it ranked seventh as a key issue in a 1985 survey of MIS directors.

Given the growth and maturity in OA, along with its continuing need for communications and data access, and the trend to organizational mergers of telecommunications with information systems, there is little doubt that these three services will ultimately be supported in most companies through an integrated information technology organization. This paper discusses the evolution of this integration process through a life cycle analysis which includes considerations of change in both the technology and the organization.

2. An Integrated Information Technologies Life Cycle

In considering a task such as integrating information technologies in a company, there are three fundamental issues: the maturity of technology available for adoption, the structure of the technical organization, and the stage of growth of the various information technologies within the company.

While data processing and office workstation technology

continue to change, they are still stable and relatively well-understood by most users. However, the state of some alternative communications technologies is immature from the customers' point of view, due primarily to the speed of evolution and the slowness of vendor adoption of communications standards [27]. The structure of a technical support organization and the stage of growth of office technology within a company will vary widely among companies, depending upon such factors as corporate policy and culture, the size of the firm, the industry in which the firm is involved, the rate of growth of the firm, the leadership role assigned to technical support organiztions, etc. For these reasons it is impossible to develop a rigid integration life cycle framework, and the approach taken here will be to develop a life cycle "guideline" as shown in Table I. The activities listed for each phase are described in the following sections.

2.1 Strategic Evaluation

The first phase in the proposed integration life cycle relates to the strategic evaluation of both the organizational and technical aspects of integrating the information services. It is impossible to divorce the organizational structure and placement of the support organization(s) within a company from the process of integrating the technology. For example, suppose a company has a strong telecommunications organization which is considering the installation of a digital PBX for voice, video and facsimile to service both internal and external communications requirements. At the same time the data processing organization continues to expand its distributed

processing functions into OA services and to install its own data communications facilities. Clearly there will be overlap among these information services and it is crucial to merge the organizational functions so that the services can be supported cost-effectively. Planning and organization of this type is as important as the related technical change process [2].

Table I.

Integrated Information Technology Life Cycle Guideline

1. Strategic Evaluation
   - Organizational factors
   - Technological factors

2. Feasibility Study
   - Proposal definition
   - Organizational level communications requirements analysis
   - Technological evaluation of potential solutions
   - Cost benefit estimation

3. Requirements Analysis
   - Communications requirements
   - Conceptual design
   - Support personnel
   - Cost benefit analysis

4. System Design
   - Detailed evaluation of technological alternatives
   - Standards evaluation
   - Network design
   - Hardware and software needs analysis
   - Vendor selection

5. Development
   - Corporate standards
   - Security controls
   - Operations and training procedures

6. Implementation
   - Adaptation and preparation of existing systems
   - Phased integration and testing of communications system
   - Training
   - Conversion

7. Post Implementation
   - Evaluation
   - Refinement

Due to the growth and pervasiveness of information technology support functions, some companies have begun to adopt an organizational structure in which an executive who is independent of other functional departments is placed in charge of information technology. This person frequently reports to the company's president or executive vice president. The role of this executive, regarded as a "chief information officer" [3], is as a facilitator and provider, not an owner or czar of information technology. The responsibilities include the provision of access to corporate data, making external information available to users, and providing communication networks. This person is also the primary source of policy on information, continuing education on information technology, and oversees the integration of OA and EDP systems. Given a person at such a high level and and with a wide mandate, the task of integrating information technologies can be greatly facilitated. However, studies have shown that the MIS department is not perceived by other departments as having much power [22], so this information executive will have to rely on persuasion rather than edict to attain the organization's goals.

During the first phase of the life cycle the support organization and the technology are both examined to determine whether the organizational structure is suitable for the technological direction desired for the firm. If the direction is contrary to the current organizational structure and the organization is to be changed, then this should occur before any further steps in the system integration process. User organization involvement is critical during this phase of the

cycle [21]. In fact, for projects such as OA, the user organization itself may be affected in several ways by the technology [19], and this may reflect back as an issue for the support organization. In terms of a plan, the current status of each department should be assessed, and a liaison structure should be established to involve the user organizations in further studies and plans. Support should be supplied where necessary to advise user committees on technical issues.

The second aspect of the strategic evaluation involves evaluation of technology and how it will affect the provision of integrated services. The planning of this integration process is an extremely important yet complex task [24]. In the case of technology which is well ahead of the stage of growth of either of the three services in the firm, then the technology should be examined to determine where it will fit into the plans for a possible extention of these services. Each of the technologies has an important part to play [5], but because of the more immature state of OA and related communications facilities, this will be the most likely area of close examination.

2.2 Feasibility Study

The feasibility study should only begin when the desirability of integration and the direction of that integration is established at a strategic planning level, with approval at high executive management levels to investigate in more detail the potential of integration. The outcome of the feasibility study may be an overall integration plan which will spawn a number of smaller related projects, depending upon the size of

the company and the scope of the planned change.

Organizational communications requirements analysis should be undertaken in a manner adapted from the organizational information requirements analysis discussed by Wetherbe and Davis [28]. In this approach, information may be gathered on communications requirements by interviewing key management personnel about their organizational subsystems. Some of these subsystems may not yet exist. If, for example, an integrated electronic mail system has not been installed, estimates may have to be developed from those parts of the organization which already are using such a service.

Given the requirements for communications and related new services, a preliminary technological evaluation can be carried out. This should be based on the status of current systems, and their potential integration. This in turn can lead to cost benefit analysis of the possible alternative strategies. The cost benefit analysis must be tempered by the fact that in the unstructured part of the office systems environment, such as personal communications and decision support, it is difficult to estimate benefits in advance of some actual experience. It is therefore critical to gather information from those parts of the company which already are using integrated technology. If there is no experience within the company, then a pilot study [4] should be undertaken to gather information and to gain technical and behavioral experience with the most promising alternative.

2.3 Requirements Analysis

The main task in this phase is a more detailed requirements analysis at the database and data processing applications level, and an in-depth study of the requirements for communications in OA [17,23]. Traffic estimation and growth projections can be developed for communications which are intra- and inter-department, and extra-corporate. The conceptual design for the corporate network may then be developed, projected from existing systems and networks. At this point any technical difficulties with system integration should appear and be noted for further detailed analysis. These problem areas include communications interfaces among incompatible computer systems and local networks, and incompatibilities among data structures in use in the currently isolated systems.

The requirements for technical support and network management personnel may now be estimated (for OA, network management personnel requirements can be quite large, a fact which usually takes the organization by surprise during its first experience with OA). Permanent coordination committees are required to ensure a steady flow of information between the support groups and the user groups. An in-depth cost benefit study can now be made to quantify the costs and the benefits where it is feasible to do so [e.g. 15,18]

2.4 System Design

During the system design phase a detailed evaluation is made of the feasible technological alternatives for networking and extension of EDP and OA services. Standards now become very important in planning for full integration, because a detailed

analysis must be made of interfaces among incompatible networks and systems so that estimates may be made for gateway requirements. Record and file redesign must also be considered if data are to be shared among departments, and consideration given to conversion to common software packages with common data structure design. The development of acceptable communication and database standards could involve a great deal of negotiation and change among departments which have already gone down independent paths to office information systems. Similar problems have been faced in converting centralized EDP to distributed systems [26].

Security issues will also become more important as communications traffic increases [10,13], particularly in confidential documents and data, and initial consideration must be given to this issue prior to vendor selection. This will allow communications systems alternatives to be selected which will fit well with existing systems and grow with demand, but at the same time have the potential capability to cope with security issues as they become apparent.

The final aspect of system design is vendor selection, based upon the integration path selected.

2.5 Development

In the development phase, corporate standards are finalized for communication protocols [6,7] and data structures, and implementation timetables are established. Security procedures and guidelines [20] are also developed. Enforcement mechanisms and positive employee motivations must also be developed in

concert with the user organizations to ensure that security is taken seriously throughout the organization. Technical issues for both standards and security are still evolving and should be addressed by a standing committee of users and support staff.

Operations and training procedures for users and support staff are also developed in preparation for the system installation.

2.6 Implementation

Typically, implementation of a communications network to integrate EDP and OA functions is a complex and time-consuming project. It would normally be installed in phases with, say, the main communications trunk network being installed initially to join existing major systems, followed by phased installation of departmental projects. A centralized electronic mail and/or conferencing system could be installed on one of the main systems as soon as the trunk network is in position. System evaluation should be a part of this phase so that mistakes could be corrected and avoided during the next project of the implementation phase.

Training of support staff and users would be a high intensity activity during this phase, but this training and upgrading of skills would be an ongoing effort with both new and continuing employees. This would require additional permanent training staff, possibly in an information centre support role.

Conversion activities result from setting up new databases or converting data structures to corporate-wide standards.

2.7 Post-Implementation

A project of this complexity and impact would require evaluation and refinement during implementation, to remedy errors as they occur. However, an overall evaluation after the implementation is complete can provide a comparison with the results versus what was to be attained. Measurements of actual versus expected productivity due to the integration should also be checked at this point. Finally, refinement of the integrated system so that it will be better able to serve user needs can also be proposed after users have been approached about their experience with the new system, since some of the changes in user behavior may be very difficult to predict in advance.

3. Relative Life Cycle Activity Levels

Because various functional activities may be carried out over several phases of the life cycle, it is inaccurate and inadequate to assume that a rigid life cycle framework could serve the needs of every integration project. For this reason, Table II (in accord with Ahituv, Hadass, and Neumann [1]) shows possible distributions of these activities during various life cycle phases. Note that these are representative of an "average" company, and actual experience could differ quite widely, depending upon various factors already discussed.

Table II

Activity Levels During A Project To Integrate Information Technologies

In An "Average Company"

PHASE	ACTIVITY					
	Org. Study	Communications Req. Analysis	Cost/Benefit	Technological Evaluation	Standards & Security	Training
Strategic Evaluation	H	L	M	H	M	L
Feasibility Study	H	H	H	H	M	L
Requirements Analysis	M	H	H	H	M	L
System Design	M	M	M	H	H	L
Development	L	M	L	M	H	H
Implementation	L	L	L	L	M	H
Post-Implementation	M	M	M	M	M	M

H = High, M = Medium, L = Low

4. Example Integration Life Cycle Scenarios

Because of the many possible differences among the companies which may be going through this life cycle, three representative corporate scenarios are outlined below and described in Table III in terms of the framework.

Company A : This is a medium-sized company which is geographically distributed, with a well-established and integrated information technology organization, a distributed data processing system, and several organizational islands of OA.

Company B : This is a medium-sized company with a highly centralized EDP and telecommunications organization, and a few small organizational islands of OA with no current association with the EDP organization.

Company C : This is a small company with little OA experience, a few isolated microcomputers, a small separate data processing facility, and very little technical sophistication in the data processing support group.

Table III

Probable Overall Relative Activity Levels
In Integration Life Cycle For Scenario Companies

	COMPANY		
ACTIVITIES	A	B	C
Organizational Study	M	H	M
Communications Requirements Analysis	H	H	H
Cost Benefit	M	H	H
Technological Evaluation	L	L	H
Standards and Security	H	M	L
Training	M	M	M

Comments on Table III

A. Company A already has the technical expertise and the distributed management philosophy which will help in working out requirements for OA communications. However, standards and security will likely be difficult to handle technically unless the various OA technologies have interfaces available for the installed EDP systems. The amount of technological evaluation is low because there will be few alternatives; the company will probably continue to extend systems which are already in place, but under the control of the integrated information information technology organization.

B. Company B has a highly centralized data processing and telecommunications organization, and the integration of this function with the small existing OA functions probably has only

one highly centralized alternative. The existing central mainframes will provide the common standards for the OA function, which will likely be networked directly to the mainframes. Geographically separate mainframes would be linked with high speed paths, to provide full integration.

C. Company C is too small to have the technical expertise to handle the communications problems arising from integration, and would probably rely on experienced consultants to do a majority of the project management and analysis [4]. Top managment would be directly involved in the study, and integration decisions would be centrally coordinated and controlled. This would ease the standards and security control problem. If it were possible to do so, an early enforcement of a standard microcomputer workstation, tied into a single vendor EDP system and communications network would avoid many of the interface problems faced by larger firms which are further down the office automation road before integration is attempted.

5. Conclusions

The life cycle for integrated information technologies will vary widely among the various companies where it may be applied. Every company with an information systems organization will have to consider the information technology integration process at some point. The advantage of using the framework developed in this paper is that it will assist in planning and controlling the integration process, thus improving the chances of a successful evolutionary change.

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