Teldok

April 1987

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Management, Usage and Effects of Office Automation

Ronald E Rice, Ph D
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ISSN 0280-9583

Publications can be ordered from
TeleSvar, +46 8-23 00 00

Printed by: Televerket Materielavdelningen
Grafiska Sektionen
Stockholm 1987

Preface

TELDOK asked a group of knowledgeable US researchers and consultants to prepare a report covering and summarizing a number of recent findings on the management, use and consequences of Office Automation systems.

Thus, this TELDOK Reference Document was prepared by Ronald E Rice, Ph D; Douglas E Shook, (both Annenberg School of Commu-nicaions, University of Southern California, Los Angeles); and Ellen Sleeter, M S, (Santa Monica, California). Their report was later edited by Kelley Boan, Tele-K AB (International Operations Group) here in Stockholm, Sweden.

The final draft was telecommunicated from Kelley Boan and then processed with WriteNow, using Palatino fonts, and printed on a LaserWriter Plus.

We are sure you will find the Reference Document to be interesting, well-structured, and full of facts and insights.

Bertil Thorngren
Chairman, TELDOK Editorial Board

Contents

1 Introduction to Office Automation

This TELDOK report summarizes some of the basic trends from the research literature on the management, use and consequences of office automation. Throughout this report, we use the terms office automation (OA) and integrated office systems (IOS) interchangeably. Also, because of the rapidly increasing importance of end-user computing and information centers, we spend some time discussing research on the management and usage of these components of OA.

By **integrated** we mean multiple office applications that either comprise a single software package, or that are accessible by means of a common interface and network. By **office systems** we mean specifically computer-based technology and software to augment, assist or automate fundamental tasks performed by information workers in office settings. This concept includes features such as—

Input activities:

* **information retrieval from external databases:** using terminals to connect to commercial database brokers to search and retrieve numeric, textual and bibliographic information. In the United States, there are nearly 3000 databases available from nearly 300 vendors, providing information about financial trends, full-text journal articles, newspaper stories, patents, chemical formulae, indeed nearly any information that might be required for business, scientific, research, library, legal and consulting needs.

* **optical character recognition and digital scanning:** using optical input devices such as facsimile or video cameras to capture analog images, or using scanning devices to detect and interpret characters and numbers into digital form for later processing. Such capabilities not only reduce time and error in text or data entry, but also allow for the merging of text, data and graphics.

Processing activities:

* **decision-making support:** providing summary reports and figures upon which to base managerial or engineering information. Or, providing summaries of organizational surveys and opinions, perhaps in the form of quantitative analyses, to use in achieving consensus.

* **spreadsheet analyses and simulations:** using online balance sheets or models of complex systems, to compare alternative strategies, costs, timing, distribution. The most popular form of this is the personal computer-based spreadsheet used for "what-if" analyses as well as typical functional processing.

* **functional applications:** using mainframe and personal computer software to handle typical organizational functions such as invoicing, inventory management, accounting.

* **filing:** using computer-based systems to not only store digital and analog documents, but also to develop indexes and keywords for use in complex retrieval and management of those documents.

* **database management:** using computerized databases to maintain consistent organization-wide information, to update related files based upon separate transactions, and to allocate information resources in an efficient and integrated fashion.

* **calendars:** using personal computers for individual schedules, or mainframe-based calendars to schedule individual activities as well as joint activities such as meetings or room reservations.

* **project planning and scheduling**: using software to help guide the planning and implementation process, such as Gantt or Pert charts that identify how stages of a project inter-relate, how different schedules achieve different goals and require different combination of resources, and how current projects are progressing.

Internal communication and output activities:

* **electronic mail:** using internal, public or commercial services to deliver computer text to one, several or all members of a network. Typically, electronic messaging systems store the message in the file of each receiver. Telex, TWX, teletex, telegraph and facsimile may also be considered electronic messaging, but they typically do not allow the message to be further processed by the receiver.

* **computer conferencing:** in its simplest form, somewhat like electronic mail, but using shared files rather than individual files. This simplest of distinctions implies a host of additional capabilities, such as joint document preparation, private online bulletin boards and conferences, online voting and decision-making.

* **voice messaging:** using telephone systems and computers to provide store-and-forward digitized voice messages. This may involve just the playback of stored messages, but may also involve synthesizing of voice from textual input, and editing of the voice message by using the telephone keypad.

* **teleconferencing:** using audio and video systems to allow telephone conferences, slow-scan video images, full-channel video interaction, or some combination such as a broadcast video presentation with telephone response from the audience participants.

* **graphics and report-generation:** combining computers with color printers and plotters, or slide-making equipment, to portray and compare data in visual form. Internal publications may combine numeric and graphic material in customized or periodic reports.

* **word processing:** using any level of computing to input, process and output primarily text material. Word processing systems allow online editing, substitution of specific words, interactive formatting, spell-checking and alternate choices for words, and the use of standardized or repeated sections to reduce repetitive keystrokes. More innovative uses of word processing involve the development of inventories and catalogues, large-scale mailing lists and labels, continuous updating of complex technical reports, and rapid production of field notes.

* **and desktop publishing:** combining word processing, optical input devices, laser printers and even typesetting equipment to produce camera-ready or near-typeset quality documents for internal or external distribution of reports, newsletters and graphic documents.

These capabilities may be available on stand-alone dedicated word processors, interconnected distributed word processing systems, stand-alone personal computers, personal computers and word processing systems that can communicate with other systems, stand-alone mini- or mainframe computers with remote terminals, or a combination of word processing terminals, personal computers and remote terminals interconnected to organizational (internal) and external (commercial) mainframe computers.

These connections may involve local networks within the organization, public telephone lines, leased public switched circuits, or value-added computer networks that involve telephone, microwave, transatlantic cable or satellite transmission.

These capabilities may be delivered in organizations through decentralized or centralized word processing, through centralized control by Data Processing or Management Information Systems departments, through decentralized information centers and local consultants, or by commercial time-sharing vendors.

This report focuses primarily on word processing (WP), computer-mediated communication systems (CMCS), and end-user computing, capabilities of OA that represent fundamental aspects of organiza tions.

The first section provides case studies and short research results from studies of CMCS, information centers and end-user computing. The following sections then provide the theoretical and empirical foundations behind these examples, and behind general approaches to the implementation, management and study of office automation. A footnote at the end of each section provides references to the literature on which the discussions are based. The final section of the report is a bibliography along with a short annotated discussion of major books and information sources about office automation and information centers.

2 Example Results and Case Studies

2.1 Introduction to the Examples

The following example results and case studies reflect some of the main points made in this report. They are selected and summarized portions of several studies completed recently on expected and reported benefits from OA. Parallel to the implementation and management of OA, they analyze, in order,

(1) expectations of outcomes of office automation,
(2) the influence of access to systems on their use and effects,
(3) specific benefits from end-user computing and
(4) a qualitative case study of problems in managing information centers and end-user computing.

2.2 Expectations of Benefits from Office Automation

The first study reviewed here involved a small (N=60) federal office which answered questionnaires before and one year after implementing a networked integrated office system. Only the pre-implementation data are used here, in an attempt to understand what factors influenced the respondents' expectations of the outcomes of the system.

Dependent variables included 8 scales involving expectations: decreases in use of existing media, increases in structural relations (vertical communication, overall contacts, and frequency of communication), increases in information load (quantity and rate of work handled), quality of work, communication effectiveness, after-hours work, local travel and distant travel.

Independent variables included five sets of variables including percent of average day spent long report writing, letter and memo writing and phone use; task standardization; percent of day spent in cross-locational communication needs; organizational status (position and tenure; and number of times per business month the respondent communicated with the other office members as listed on a network roster.

Decreased current media use and decreased local travel were the expectations best explained by the independent variables, with between 40% and 50% of their variance explained.

Expectations of decreased uses of existing media were related to greater time spent on long-report writing, more standardized work, higher organizational position, and lower tenure in the organization. The major influence was tenure (27% of variance). Expected impacts on structural relations were significantly but slightly related only to tenure (9% of variance). Note that respondents who had been working the organization longer saw CMCS as a **complementary** medium because they expected greater overall use of media, while lower tenured respondents saw CMCS as a **substitute** communication medium because they expected lower use of print and phone media.

Respondents' expectations of changes in information load, quality of work and communication effectiveness were not influenced by any of the hypothesized sets of variables. Perhaps more extreme expectations of the innovation are less founded in current beliefs and situations.

Expectations of increases in after-hours work due to CMCS were more likely for those who spend less time in long report-writing (17% of variance), and have higher-level positions (7%). The implication here is that managers and supervisors expect an overall increase in after-hours work except when their work entails a significant amount of report-writing, where CMCS can help.

Increased local travel was expected by those with greater tenure in the organization (36% of variance explained). This effect does not, however, apply to expectations of long-distance travel increases, which were predicted by lower long-report writing (16% of variance) and less standardized tasks (8%). Some implications of this study are:

(1) Expectations of CMCS as a **complementary** medium, in this small sample, are related to greater tenure, position and less standardized tasks. That is, there seem to be two general classes of organizational members who will have two different sets of expectations. This means that the greater benefits of information technology are not expected by lower-level workers with standardized tasks. Such expectations, if not improved by training or implementation efforts, could limit the extent to which a CMCS can improve the nature of information work.

(2) Expectations of CMCS as a **substitute** medium are predicted by those who spend more time in long-report writing, as it can reduce shadow functions (telephone tag, searching for information, etc.) and media transformation (converting information from one media to another, such as re-keying a hand written report into a word processor, or sending information by facimile which must be converted to computer formats by the receiver). Thus, these workers are good can didates for early adoption and later models for demonstrating some benefits of CMCS.

Reference: Rice and Torobin, 1986.

2.3 Benefits from Electronic Messaging

Over 500 employees from another organization, a large, nonprofit R&D corporation, were asked to estimate the impact of electronic mail use on their on-the-job performance. The five-point scale went from "significantly reduced" to "significantly increased". Average reported values for changes in the use of a variety of communication channels are shown in the following table.

These data support a generally, but not overwhelmingly, favorable analysis of the impact of electronic mail as seen by the people who work there. The respondents saw CMCS as leading to slightly less paperwork and to slightly more communication with other employees. Both quality and quantity of work are slightly increased, but travel and after-hours work are seen as unchanged. The most dramatic impact is in the perceived ability of respondents to get messages or information to each other, which has somewhat increased. On the whole, these responses do not vary widely among organizational levels, with one exception. Executives and mid-to-top managers tended to report more extreme and positive CMCS impacts than did other respondents.

Table: Summary of Effects of Electronic Messaging

	Somewhat Decreased (-1) · No Change (0) · Somewhat Increased (1)
Number of phone calls you make:	I.X......I.........I*
Number of phone calls you receive:	I..X.....I.........I*
Number of memos you send:	I...X....I.........I*
Number of memos you receive:	I...X....I.........I*
Amount of other paper you produce:	I....X...I.........I*
Amount of other paper you receive:	I.....X..I.........I*
Amount of travel away from company:	I........X.........I
Amount of after-hours work:	I........X.........I
Quantity of your work:	I........I.X.......I*
Quality of your work:	I........I.X.......I*
Communication with other departments.:	I........I..X......I*
Number of contacts you initiate:	I........I...X.....I *
Rate at which you handle information:	I........I....X....I*
Number of contacts initiated with you:	I........I....X....I*
Ability to get message to others:	I........I.......X.I*

* = the average response to expected outcome was statistically significantly different from "no change". N = approximately 500

References: Rice and Love, 1986.

2.4 Influence of Access on Usage of Office Automation

In a study similar to the previous one, a subset of a sample of users (N=78) of an integrated office system were asked about their access to the system's terminals and the perceived benefits from using the system.

Access was measured by "How far away is the terminal you use?" The possible values were: at your desk, in your office, close to your office, on the same floor, and farther away than your floor. Usage was measured by the average number of minutes per business day that a person actually used the system. Media benefits were measured by the question, "To what extent has your initiation and receipt of (personal contacts, paper, telephone calls, letters and vertical communication) been significantly reduced?"

Physical access to a terminal was significantly correlated with system usage (r=.45). This relation supports the intuitive notion that access is an important influence on the extent to which OA will be used. Personal interviews indicated that the crucial difference in access was whether the user could see the terminal or not; if it was not on one's desk, but could be seen, then one could know when the terminal was free, whereas if it could not be seen, one was much less likely to make the effort only to find the terminal busy.

Computer-monitored system usage was significantly correlated with increases in contacts, with decreases in phone, letters and paper, but not with vertical communication (all correlations were between .23 and .36). These relations support the contention that actual use of OA leads to increased communication contacts but decreased usage of those communication media that involve media transformations, shadow costs, and temporal or geographic constraints on human communication.

2.5 Benefits from End-User Computing

The next table is a summary of the reported benefits from respondents in a large aerospace organization who used a terminal connected to a mainframe, or a personal computer either connected to a mainframe or in stand-alone mode. Means which were significantly different from "no change" are noted by an asterisk to the right.

The second table shows the mean responses from supervisors in the same department. They were asked to what extent did the use of PCs in stand-alone mode result in the following effects for their group. Again, means which were significantly different from "no change" are noted by an asterisk to the right.

Reference: Rice and Shook, 1986.

Tables: Reported Benefits from End-User Computing

From end-users:	Somewhat Decreased (-1) · No Change (0) · (1) · Significantly Increased (2)
Ability to make revisions quickly	I.........I.........I.......X.I*
Ability to detect/correct errors	I.........I.........I...X.....I*
Do whole task by myself	I.........I.........I..X......I*
Satisfaction with work product	I.........I.........I..X......I*
Use of graphics	I.........I.........I..X......I*
Ability to meet schedule	I.........I.........I.X.......I*
Ability to simulate alternatives	I.........I.........IX........I*
Performing data analyses	I.........I.........X.........I*
Speed of decision-making	I.........I.......X.I.........I*
Overtime hours	I.........I..X......I.........I*
Pressure from deadlines	I.........IX........I.........I

From supervisors:	Somewhat Decreased (-1) · No Change (0) · (1) · Significantly Increased (2)
Do new and creative tasks	I..X......I.........I.........I*
Amount of work in a given day	I...X.....I.........I.........I*
Do tasks that were too difficult to do before	I.....X...I.........I.........I
Find creative solutions	I.....X...I.........I.........I
Time spent explaining applications	I.......X.I.........I.........I
Time spent inputting information	I........XI.........I.........I
Time spent tracking down info & people	I.........I..X......I.........I*
Time spent analyzing data	I.........I...X.....I.........I*
Time spent distributing info	I.........I.....X...I.........I*
Time required to complete a task	I.........I.....X...I.........I*

* = the average response to expected outcome was statistically significantly different from "no change". N = 156 end-users and 22 supervisors.

2.6 Managing End-User Computing: A Case Study

2.6.1 The Organizational Context.

This section is a case study of one organization's attempts to manage a new Information Center in particular and end-user computing in general.

The organization was an international management consulting firm with Headquarters in the United States. In the U.S., the firm comprised 6 departments at Headquarters and 19 Field Offices in major cities. The Field Offices consisted primarily of consultants who sought out new clients and provided ongoing services to established clients, and support staff.

The organization's culture strongly rewarded entrepreneurial endeavor. This was largely due to the fact that although the firm was privately held, the Managing Partner founded and owned more than 50% of the firm. Also a strong influence in the culture was the large number of Ph.D. degrees in social science disciplines among the partners. Much of the business of the firm was rooted in social science research -- data gathering using standardized survey instruments, with subsequent data entry by "terminal operators" and statistical analysis on the mainframe computer at Headquarters. The firm had enjoyed a compound annual growth rate of greater than 23% over 10 years, attributable not to marketing ability but to reputation for excellent services.

Management traditionally embraced the notion of centralized data processing, with an IBM-compatible mainframe in Headquarters at the hub of a star network. IBM Personal Computers were used for local data entry, there was minimal distributed processing, and data was transmitted to Headquarters for processing on the mainframe.

Computing philosophy reflected the decidedly entrepreneurial, old-style academic culture, as evidenced by the following:

(1) there was little corporate enthusiasm for building a marketing database, and, once built, it was difficult to capture the consultants' imagination about the utility of the databases for their practice.

(2) a chargeback scheme for the Headquarters computer was eliminated, because too many consultants were reluctant to use the resource, knowing that their budget would be charged for usage.

(3) with the acquisition of IBM PC's and their local computing power, the entrepreneurial consultants saw an opportunity for even greater independence from Headquarters.

(4) the manager of the computer center was never titled the Director of MIS, but rather the Manager of DP; and he could never qualify for partnership.

Prior to the commercial availability of the IBM PC, the major Field Offices were equipped with mini-computers running local data entry and file transfer programs. The introduction of the IBM PC to those larger offices meant an immediate four-fold increase in computing power available to the Field Office.

All software for the minis and, later, for the IBM PC's, was developed centrally by the Field Office Staff at Headquarters. The Field Office Staff, in addition to developing microcomputer software for the Field Offices, also staffed a telephone hotline to support users of that software in the Field Offices. Because expertise with personal computers resided solely in the Field Office Staff, but a growing number of users needed help, an Information Center was created at Headquarters by the Field Office Staff. It was staffed initially with persons engaged in both software development and hotline support.

2.6.2 Staffing and Human Resource Issues

Of significant concern to the manager of the newly-created Information Center was the source and characteristics of its personnel. Should the staff come from the ranks of the traditional data processing department? Could a traditionally trained programmer/analyst develop the conceptual framework required to lead the end-user to the "tools" required to solve local and individual information problems?

Interactions between traditional DP staff and end-users were typically unsuccessful. As other studies have shown, even experienced systems analysts all too frequently had inadequate interpersonal communications skills to interact successfully with an unsophisticated user.

The Field Office staff was headed for difficulties even before the birth of the Information Center. The same staff who were developing software were drafted to supply the whole range of telephone support to relatively unskilled "terminal operators" in the Field Offices, as well as acquire and install PC hardware at those sites. The Field Office Staff manager vacillated between hiring:

(1) staff equipped to handle the technical requirements of the job (software and/or hardware) and,

(2) staff who had experience in training, good communication skills and sensitivity to anxieties of unskilled operators.

Finally, when several Field Office Staff personnel left for more challenging software development jobs, management recognized the need to turn support for the development of microcomputer software over to a separate unit that had hired personnel specifically to be software programmers.

Trouble arose for the Field Office Staff when junior members of the organization were bitten by the personal computing bug and when the Information Center was created. The Information Center was **not** implemented as a fully-supported entity, but rather was patched together from existing staff, hardware, and building space.

Not only was the number of Field Office Staff personnel insufficient to continue to develop software **and** to support the Information Center, but the available individuals were inappropriate. Only those programmer trainees who failed to make the transition to junior programmers were immediately available to work in the Information Center to support end-users in the Field Offices. The successful programmers were reserved for programming, a respectable and appropriate use of their skills in management's opinion.

The Information Center did not have a charge-back policy to charge end-users for services provided. Therefore it was unable to justify more staff positions. In spite of its limited and fixed budget the Information Center still had to respond to rapidly increasing demands for services from users. Luckily, "local experts" began to emerge, both to the advantage and disadvantage to the Information Center.

Who were the "local experts"? These were employees working in business units of the organization who tended to be

(1) recent graduates of universities or graduate schools with some, but not extensive, familiarity with computing,

(2) junior staff, frequently in research positions,

(3) wildly enthusiastic and visionary users of personal computers,

(4) individuals who were frequently overly optimistic about the size of the tasks that could be managed on a PC, and,

(5) fearless about solving problems.

They were able to conceptualize and realize creative ways to employ the personal computer as a tool to:

(1) reduce their reliance on the mainframe,

(2) reduce the percentage of their work day devoted to data entry and analysis, and

(3) expedite the graphic representation of that data analysis.

As is frequently the case with enthusiastic local experts, however, their rapid technical growth and increasingly familiarity with new developments in applications software and PC hardware became somewhat threatening to the Information Center personnel, who were barely managing to maintain essential services.

Not all the fallout from the rising level of end-user computing expertise among the workers was negative, however. In one case, enthusiasm for PC applications lured a local expert into a vacant position on the Information Center staff. In fact, the DP manager could have taken advantage of this latent resource by quietly recruiting local experts. Moreover, the organization could also have taken advantage of this resource by supporting the decentralized expertise of local experts in functional units.

The conclusions to be drawn from the experiences of this organization are that the management of personal computers and an Information Center within the organization was a good deal more difficult than initially expected. More generalized conclusion for others would be:

(1) A policy for the implementation and use of personal computers must be decided early in the introduction of them to an organization,

(2) Personnel to support the new users of personal computers must be able to deal with both technical and human relations question,

(3) Personnel within the organization who meet these two criteria should be identified and recruited to the Information Center, and,

(4) Management cannot take an ambivalent attitude towards the Information Center or end user computing and expect either to perform efficiently in the organization.

(See Sections 6 and 7 for a full discussion of these issues.)

2.6.3 Data Administration Issues in the Company

2.6.3.1 Data and Database Administrators. Increasingly necessary in large organizations is the **database administrator**. The role of the database administrator is reasonably well understood in MIS departments as being responsible for maintaining the **container** of the organization's information.

Database administrators (DBAs) typically concern themselves with

(1) selection of the organization's database management software (assuming an environment of centralized database management).

(2) database definition and design, in conjunction with the user.

(3) monitoring and fine tuning the performance of the DBMS software.

(4) ensuring the integrity of the data by running frequent backups, and monitoring the output from database audit utility programs.

(5) managing the security module, implementing access privileges as determined by the user department or the data administrator.

(6) providing a means whereby the user can maintain data.

However, many organizations overlook the need for the data administrator, the executive who determines the **scope and content** of the organization's databases. The data administrator's realm is broader and extends to determining the rules for information generation, retention, and access privileges throughout the organization. The data administrator, as proposed by Martin (1976), reports directly to the MIS director and is a peer of the manager of application development. Typical concerns of the data administrator include:

(1) strategy for amassing corporate information and intelligence.

(2) policy for internal data collection and retention.

(3) management of the corporate data dictionary.

(4) policy for access and incorporation of remote, commercial information resources.

In some organizations, such titles as Chief Information Officer or Vice President for Information Resources are emerging; these organizations acknowledge the value of information as a resource comparable to investment capital, personnel, and raw material. By ascribing a dollar value to that resource known as information, the Chief Information Officer can set policy about the level of corporate investment in information: what types of information should be generated and stored in house, what information should be purchased from information brokers for one-time use, and what is the potential positive impact of any investment in information to the corporate balance sheet. The data administrator as well as the MIS director would report to the executive who manages information resources.

Data coordinators are the worker bees, carrying out the information/ data collection policies determined by the data administrator. Working closely with the end-user, the data coordinator monitors the end-user's database design to ensure that his use of field naming conventions, field characteristics, data retention practices, and field validation requirements are consistent with similar data usage practices across the organization. Indeed, the data coordinator makes vital the corporate data dictionary that describes all the information collected, stored, and used by the organization.

The traditionally-minded DP department in this organization had never accepted -- indeed, had energetically rejected -- responsibility for the scope and content of the user's data.

2.6.3.2 Data Redundancy and Proliferation. What is the urgency for coordination of databases in the end-user computing environment? Because now that personal computers facilitate the development of local and personal databases, and now that PC database software packages enable users to maintain small private databases easily, the problems associated with personal file-drawer paper files has been compounded. What was once a personal paper file kept in the desk drawer of an altogether innocent, well intentioned employee, has been transformed into a personal diskette file. This type of file is no more accessible to co-workers or to corporate intelligence gathering.

There are many risks to the organization in allowing the unmanaged proliferation of personal databases. In this organization, one that required centralized maintenance of databases, the consultants, when faced with a need to develop a small database of potential organizational clients, typically did not realize that many of the data elements (fields) that comprised the small database were in fact represented somewhere in the corporate database. Consultants became involved in the unnecessary task of reinventing (sometimes incorrect) data that had already been researched, verified and stored in the larger corporate databases. Pitfalls of data duplication have serious implications both for the end-user and the centralized corporate database:

(1) It is likely that the same data will be maintained in multiple forms and in multiple locations within the organization.

(2) In an environment that facilitated downloading from a central data store to a local microcomputer, the consultants tended to maintain (or correct) the data locally without reporting those corrections to the central database. Part of this lapse could be excused, since the development of software (and enthusiasm by the MIS department enthusiasm) to support one-step **uploading** back to the mainframe database lagged far behind the down-loading technology. Thus the multiple copies of theoretically duplicate data are, inevitably, not identical.

2.6.3.3 Data Security and Access. Large mainframe DBMSs support intricate levels of security (access) privileges, including the ability to mask certain files, fields, and even field values from specific classes of end-users. Microcomputer database software rarely provides that level of sophisticated database security. Further, the whole ethos of popular computing, i.e. computing "by the people", pushes in the opposite direction, in an effort to make **more** data available to **more** users.

Security privileges are generally devised by the data administrator, implemented through the database administrator. In this particular organization, any end-user applications were built without regard to or knowledge of corporate security considerations. In addition, an end-user who developed local files for expedient support of a local project typically underestimated the responsibilities for maintaining the database. Often, this short-sightedness could be explained by the user's lack of awareness of the usefulness of that database to other departments in the organization. So the user made no provisions for maintaining the data. Without careful coordination, and without an explicit corporate information policy, it is understandable that end-users overlooked issues of data security, integrity and access...

Under what circumstances might one department be restricted from using another department's data? Additionally, who owns the data in the corporate database? The Field Office culture that blessed departmental "ownership" of data reinforced the tendency of end-users to build local, incompatible databases and lock them in file drawers.

One of the departments in the organization had conducted many annual surveys of large corporations, amassed the survey instruments, paid for keypunching the data, executed data validation routines, and stored ever-growing databases for the duration of the survey year. The annual building and maintaining of these mainframe databases represented a substantial portion of its operating budget. The department head, a partner of the organization, felt that the departmental data should not be made available to other profit centers within the firm, since, after all, they had paid for it and thus owned it. As the technology evolved to allow consultants to download this survey data to microcomputers in the Field Offices for local analysis using spreadsheet and statistical software, this department began charging the Field Offices for downloading and using this data. Because there was no corporate information policy that mandated that the data be integrated with other client data, the departmental thesis of "ownership" prevailed.

An organizational philosophy that sanctions departmental ownership of data is also likely to promote data redundancy or under-utilization of valuable information within the organization. As with the proliferation of microcomputer hardware and software available to stock today's Information Center, integration of data is a key concern. After a workable combination of hardware and software is made available to end-users, as well as adequate training to support of their use, management must turn its attention to issues of data management in the end-user computing environment.

3 Influences on Adoption and Use of Office Automation

3.1 Overview of Influences

The remainder of this report focuses on theoretical, conceptual and empirical foundations for understanding the adoption, use, management and effects of office automation. There are, of course, many important aspects of each of these topics. This report emphasizes some at the expense of others, and in general emphasizes communication aspects.

This section looks briefly at four primary influences on the organizational adoption and individual use of office automation. These four influences include: the initial and primary organizational rationales for adopting systems, a variety of aspects of the accessibility of systems, the extent to which new systems can satisfy certain communication requirements of individuals' tasks, and the organizational position and individual demographics of potential users.

3.2 Innovation Rationales

Rationales for adopting organizational information systems have traditionally been based heavily on quantity and cost criteria. However, these initial rationales can strongly constrain the quality of information produced and subsequent innovative uses of the system, and generate symbolic and political conflicts. This is because they focus on traditional production criteria and on easily measurable outputs, rather than on the value that is added to organizational services and goals by means of information processes.

For example, adoption rationales identified in 200 organizations that had adopted word processing tended to focus on efficiency criteria such as reduced typing, cost avoidance, staff reduction. This emphasis prevented supervisors from being able to manage the unit's boundaries, scan their environment, encourage intra-unit innovation, or extend training into advanced functions, as those are all scarce input resources that do not provide immediate efficiency gains. The consequences were obsolete equipment, dissatisfied operators and limited organization-wide contributions to performance. Concepts of information quantity, quality and cost, and the relation of efficiency to performance, are discussed later in this report.

References: Johnson and Rice, 1984, 1987.

3.3 Access

The importance of accessibility to the use of information systems is intuitive. Yet the degree of its importance, and the form of its consequences, may be less intuitive.

Access may be the single most important criterion of information and an information system in the mind of a potential user. As early as 1967, researchers had concluded that, even for scientists and engineers, perceived accessibility was a stronger determinant of information use than was the perceived quality of the desired information.

One of the theoretical rationales for this apparent over-emphasis on access at the expense of information quality is due to the nature of information itself. Because the value of an information search is very difficult to determine (unless it is standardized, or is evaluated according to association such as brand names or highly credible sources), users who do not have slack resources cannot guarantee that an extended search will be cost-beneficial. Thus, reducing the time and effort involved in gaining access becomes a rational strategy for reducing uncertainty in information searches.

The rewards and costs for seeking certain kinds of information will also foster the use of some sources over others, such as trustworthy sources in conditions of ambiguity, and psychological costs and information-sharing norms in organizations. For example, because engineers typically have more extrinsic and outcome-related motivations for seeking information than do scientists, they typically place greater emphasis on access than on information quality.

Accessibility to computer-mediated communication systems has received increasing attention recently. Accessibility has been defined as the knowledge and effort required by users to gain access to the system, and provided empirical evidence for its positive relationship to system use and success.

Culnan (1985) expanded this concept by identifying four independent dimensions of accessibility:

(a) terminal accessibility,
(b) information accessibility
(c) system reliability, and
(d) ease of learning the control language.

Culnan also moved from the more traditional analysis of accessibility to management information systems, to the analysis of accessibility's impact on integrated office systems that primarily support communication activities.

Increased accessibility to a system's terminal is typically associated with increased expected and actual usage of the system. The effect of access is not purely perceptual; correlations between measures of access and both reported and computer-monitored CMCS usage in one study were around .4 (Rice and Shook, 1986). And access is more than the practical reason of simply being able to use a system; the same study found that the largest effect of access was not whether a user had a terminal on one's desk compared to elsewhere, but whether the potential user could see the terminal, and thus immediately evaluate the cost of leaving one's desk to use the system.

One of the primary values of the communication component of OA is access to other users, who then become the information or resource sought from use of the system; the need to communicate with geographically dispersed others has, along with other task needs, been shown to be associated with system usage. In this context, access becomes a primary value of the system, and not just a potential obstacle to retrieving specific data. For example, **sharing** of information in R&D environments is a greater predictor of productivity than the **sources** of that information. Thus, a CMCS can lead to an increased stock of ideas and exposure to research.

References: Allen, 1977; Allen and Cohen, 1969; Allen and Gerstberger, 1967; Dewhirst, 1982; Kerr and Hiltz, 1982; Hiltz, 1983; O'Reilly, 1982; Panko and Panko, 1981; Rice and Case, 1983; Rice and Borgman, 1983; Rosenberg, 1967; Steinfield, 1985; Svenning and Ruchinskas, 1983.

3.4 Task Requirements and Characteristics of a Medium

CMCS have apparently only moderate information-processing utility for managerial communication, due to the limited ability of text-based computer systems to transmit nonverbal and social information. However, this limitation interacts with the nature of the task that must be performed by using the system. Studies have shown a clear progression from more to less acceptable uses for CMCS as the tasks became less involved with the amount or certainty of information, and more involved with quality, equivocality and personal issues. Further, computer conferencing systems seem slightly more satisfactory than electronic messaging systems for more socio-emotional tasks, likely because of the increased capability for control, participation and interaction. The following table lists various information tasks in order of increasing appropriateness for handling by CMCS.

Table: Increasing Appropriateness of CMCS for Various Information Tasks

Less Appropriate	
	Getting to know someone
	Bargaining
	Persuading
	Resolving disagreements
	Solving problems
	Exchanging confidential information
	Making decisions
	Exchanging timely information
	Exchanging ideas
	Keeping in touch
	Exchanging opinions
	Asking for information
	Exchanging information
More Appropriate	

Studies have also shown that users with greater experience with such systems tend to find them generally more appropriate for socio-emotional communication than do users with little or no experience. That is, perceived appropriateness of CMCS is influenced by the specific medium, the specific task, and the user's prior experience with the medium.

References: Hiltz and Turoff, 1978; Hiltz and Turoff, 1981; Rice, 1984; Rice and Case, 1983; Rice and Case, 1983; Short, Williams and Christie, 1976; Steinfield, 1985.

3.5 Position and Level

Many studies have documented how information workers allocate their time to various channels (see Rice and Bair, 1984). Managers spend most of their time communicating (75-80%), about 60% of which is oral (phone or face-to-face). Higher-level managers spend more time communicating with subordinates than do lower managers; downward communication by senior managers is initiated more than is upward communication; lower levels engage in more peer communication; only a small amount of managerial time is actually spent making decisions; managers communicate more in situations of innovation and uncertainty; and written communication has fewer opportunities to capture the attention of managers because of their fragmented, interrupted schedule.

These patterns have been used as the basis by many authors to identify potential opportunities for organizational information systems. Typically, they focus on possible time savings -- for example, in secretarial text handling. However, because different levels of workers require different levels of organizational resources (pay, benefits, equipment), analyses of cost savings show quite different opportunities -- for example, managerial interpersonal interactions may take up less total time than clerical typing, but will cost the organizations considerably more.

An organization may be further differentiated according to the extent to which its members are professionals or secretaries, as their aggregate allocations are fairly different. For example, the information task involving the most time in high-secretarial organizations is document creation (48%), consisting primarily of typing (66%). However, the task involving the most cost in extreme professional organizations is interpersonal communication (42%), consisting primarily of meetings (53%). These figures represent moderate leverage by position and major leverage by medium. Depending on the type of organization, level of the user, and the evaluation criterion, OA may have very different benefits.

As higher-level organizational jobs require more interpersonal communication and increased handling of non-routine and intuitive tasks, CMCS are less likely to be appropriate, as discussed in the preceding section; executive norms against using terminals may also hinder usage. Clericals may spend less total time communicating, but a greater proportion in mediated communication or routine information processing. For example, organizational level was the strongest predictor of the perceived overall appropriateness of a university CMCS in one study. Thus, position, level, tenure and current media habits all influence the adoption and acceptance of CMCS.

References: Doswell, 1983; Rice and Case, 1983.

4 Outcomes of Office Automation and Word Processing

4.1 Information and Performance: Quantity, Quality, Cost

While the anecdotal and research literature, represented in very brief form in prior sections, indicates that improvements in efficiency, effectiveness, productivity and performance are possible from the adoption of OA, we should point out some more conceptual aspects of productivity in information work.

There are three general measures used in assessing the value of organizational information: quantity, quality and cost.

(1) **Quantity**. In its most common interpretation, information is any event which reduces uncertainty. Information, then, can inform (change the probabilities of outcomes), instruct (provide a basis of choice among outcomes) and motivate (alter the value of the outcomes). The definition also implies, however, that more "data" is not necessarily more information -- more facts about a question that has been satisfactorily answered is not, theoretically, more information. Indeed, information overload can decrease performance.

(2) **Cost**. Efficiency is typically measured as an increase in the output/input ratio, through increased outputs and/or decreased inputs. One form of efficiency comes from cost avoidance; for example, fewer telephone circuits, clerical workers or business trips are used after system adoption than would have been necessary under conditions of manual information processing. Cost avoidance seems to have been the primary reason so far that organizational computing has had any overall effect on productivity -- which has been very little because of overall problems in the economy, unproductive information processing demands from government, poor management and organizational learning costs.

(3) **Quality**. The scarcest organizational resource is not information, but managerial attention; that is, the time and capacity to analyze and decide. Thus, communication structures and systems should serve to reduce the quantity and increase the quality of

information that organizational subsystems provide as input to other subsystems. Outputs of from organizational tasks should be, then, decisions, evaluations and necessary inputs for other tasks; that is, the extent to which information is usefully summarized, modified, routed or delayed is a measure of the value added to the original information. This approach emphasizes the quality of information: a small amount of the right information used by the right person at the appropriate time is far more valuable than large amounts of tangential information broadcast immediately. It also suggests that qualitative, intuitive information can be more valuable than quantitative, objective information.

There are at least three significant economic problems associated with an over-emphasis on narrow conceptions of efficiency in information work.

(1) The value of the material medium is an approximate or arbitrary indicator of the value of the content: the truth behind "Don't judge a book by its cover" is that the physical appearance and cost of many media have little relation to the value of their content. A more pervasive effect is that many significant costs go undetected altogether. For example, Strassman (1985) estimates that less than 20% of the total first-year cost for an end-user workstation is attributable to equipment depreciation. Other costs include training, supplies, overhead, telecommunications, software, support staff, furniture. Indeed, he argues that "organizational learning" about uses, implementation and behavior related to information systems is the single most expensive, and long-term, cost. Thus cost benefits can only be realized in the long-run. But organizations use short-run efficiency criteria.

(2) Benefits of information are ambiguous so information is often underinvested and undervalued. Indeed, econometric studies have shown, based upon analyses of inputs and outputs of 50 industries in 1967 and 51 in 1972, that the economy underinvests in information. Investment in organizational learning will reduce innovations' payback period, but training and experimentation are undervalued.

(3) Increased efficiency may be sending a misleading signal to the organization about the effectiveness or relevance of the information work itself, leading to "rigidity and unresponsiveness to change".

These are some of the reasons that conceptualizations of innovation and office automation have turned to effectiveness and value-added as more appropriate indicators of performance.

The value of an output can be higher or lower than the opportunity cost of the inputs, and can be higher or lower than the actual cost of the inputs. These comparisons lead to four conditions:

1. the "best" solution,
2. a solution which is not profitable but than which there is nothing more profitable,
3. a solution which is worthwhile but not as profitable as other solutions,
4. and an unprofitable and unworthwhile solution.

These measures emphasize the distinction between potential, planned and actual output value, and the importance of opportunity cost as a way of avoiding narrow or misleading notions of efficiency. While cost-oriented managers may avoid effectiveness as an evaluation criterion because it involves subjective judgements, they overlook the fact that most efficiency measures also embed subjective choices and assumptions in their calculations.

Economic, technical, structural, political, perceptual and cultural dimensions should all be taken into account when evaluating the value of new information systems. Over-emphasis on efficiency criteria may not only degrade performance in other organizational units, but also stifle innovation and learning in the users' unit.

References: Arrow, 1974; Bowen, 1986; Doswell, 1983; Hayes and Erickson, 1982; Strassman, 1985; Simon 1973; Strassman, 1976; The Economist, 1986.

4.2 Information Processing and Communication

4.2.1 Primary Functional Capabilities of OA

Characteristics of computer-mediated communication systems that have implications for organizational communication include the following:

(1) **Asynchroneity:** users do not have to be on the system simultaneously in order to send or receive messages. This removes the constraint of temporality inherent in face-to-face or telephone communication.

(2) **Feedback:** users may interact as quickly as they wish, to clarify points or request further information. This removes the time lags inherent in memos and letters.

(3) **Electronic transmission and storage of information:** messages can be accessed wherever the user has access to a terminal. This removes the constraint of geographic proximity inherent in face-to-face communication, but also the constraint of point-to-point communication inherent in letters and memos. Additionally, this removes the constraint of limited access to physical records of communications.

(4) **Structuring of communication:** users may use the capabilities of the computer to help structure their communication. This removes the constraint of having to send separate letters or make separate phone calls to transmit the same message to many people. This also increases users' abilities to structure, edit, index and retrieve communications, similar to the processing of numeric data.

(5) **Connectivity:** users can typically contact other users on the system without having to know them in advance, or, by using keywords for interest areas or distribution lists, necessarily even knowing the person exists. This also increases the potential value of interaction: because users become sources of information value themselves, the value of the communication component rises exponentially with the number of other users.

(6) **Integration:** users have access to multiple applications and technologies without having to learn different interfaces, or transform information from one medium to another. This removes the constraints, errors and costs that most organizational media impose on the sequential transmission or formatting of communications.

Information systems in general have been shown to improve the following information processing functions:

(1) **Control:** requiring less information to perform a task; understanding better the consequences of specific information; anticipating environmental changes, structuring communication activities to conform to organizational needs and goals, improving accountability for resources used for and benefits obtained from information, developing alternative ways to process information or arrive at a decision, improving quality of work.

(2) **Timing:** reducing information float, response time, time spent in decision-making or initiating action, and increasing flexibility in work schedule.

(3) **Automation:** augmenting information work processes, transferring routine and programmed work to the computer system, providing units with pre-formatted files for vertical reporting.

(4) **Media transformation:** reducing time, energy and errors in transferring information from one medium to another as the physical medium moves from one subsystem to another, from one set of processing norms to another.

(5) **Shadow functions:** reducing unforeseen, unpredictable, time-consuming activities that are associated with accomplishing tasks, but that do not contribute to achieving goals and outcomes (such as telephone tag, business travel, waiting for group members).

Because of these and other characteristics, computer-mediated communication systems have been shown to reduce delays in information exchange, improve maintenance of records and information received, increase coordination of geographically dispersed groups, and improve users' ability to process large amounts of information.

Reference: Rice and Associates, 1984.

4.2.2 Substitutability and Complementarity

CMCS can provide increased quantities of accurate, timely informa-tion for tasks that do not require highly intuitive or personal information. That is, CMCS can **substitute** for some extant organiza-tional media. CMCS also can increase communication among units, within organizations and across boundaries that previously did not occur. That is, it can **complement** or **augment** extant organizational media and information processing.

At both the organizational and individual levels, CMCS studies have shown reported subsequent increases in overall direction, amount and diversity of communication linkages; both horizontal and vertical linkages have been expanded.

At the organizational level, CMCS can increase the amount and diversity of organizational information processing by, in essence, extending organization boundaries along their "value chains" which

> "*...transform the nature of products, processes, companies, industries and competition itself*" (Porter and Millar, 1985: 149).

For example, specialized terminals can be placed in customers' offices so that they can provide inputs directly to the organization, without delay, routing or modification problems, to reduce the inter-dependencies that increase environmental uncertainty. These same systems then can provide control over outputs, such as inventory levels, feedback services and timed distribution.

CMCS systems can facilitate the diffusion of organizational information products, both directly through inter-organizational networks (electronic journals), and indirectly through internal composition, layout and production of technical documents (desktop publishing). Large-scale CMC systems, especially those that cross organizational boundaries, are already providing such structures, some in the form of true invisible colleges. R&D researchers use these networks to keep informed, solicit evaluations, collaborate on research, and exchange sources for funding and job opportunities. Thus, some physical, temporal and financial constraints can be removed from the creation, distribution and utilization of scientific and technical information.

Insufficient diffusion of technical resources, and symbolic and cultural reward systems (such as academic performance evaluations based upon print-based refereed journal articles), are some of the more obvious reasons why such applications have not progressed very far.

At the individual level, because CMCS have similar as well as additional attributes of traditional organizational media, they may lead to decreases in some of those media, although time and cost savings would be differentially allocated by position and level, as discussed above. Studies of CMCS usage have found post-implementation decreases in written, telephone, travel and some face-to-face communication.

A narrow emphasis on the ability of CMCS to increase the amount of information overlooks the possibility of subsequent information overload. Conditions of overload not only constrain and distort human and organizational information processing systems, but tend to exhaust the scarce resource of attention, as discussed above. However, because of the ability of CMCS users to structure their communication, there are considerable opportunities to not only avoid overload but profit from it as well.

References: Hiltz, 1983; Hiltz and Turoff, 1985; Rice and Associates, 1984; Rice and Bair, 1984; Strassman, 1985.

4.3 Decision-Making

Some of the generally accepted characteristics of interpersonal group decision-making are not necessarily beneficial to performance. For example, leaders of new groups tend to be chosen on the basis of how much they talk, but this personality characteristic has no strong relation to expertise in solving the group's problems. Yet, early opinions and decisions by group leaders are significantly correlated with final group decision. Further, while agreement among the group's members may be highly valued, results from controlled experiments show that such agreement is not correlated with the quality or accuracy of the decision. Thus, while rational, objective decisions may not be the most beneficial goal in many organizational processes, there are aspects of traditional interpersonal group decision-making that are clearly conducive to biased results.

Because socio-economic status, physical attributes, gender, age, physical surroundings, ability of certain speakers to dominate the group, network structure and communication cues (such as interruptions) are not conveyed by CMCS, participants are freed from some of the communication constraints in typical group exchanges. More users can discuss matters more equally, without nonverbal influence, and are less influenced by group leaders than in face-to-face groups.

For these and related reasons, group decision processes performed using CMCS tend to compare to interpersonal processes as follows: greater accuracy, fewer total words, slightly slower time to decision (although this decreases as users gain experience with the keyboard), slightly less consensus, less leadership emergence, greater equality of participation, greater quality and quantity of ideas from more participants, more innovative outputs and greater variance of opinion. However, because individuals and groups in most organizations have ongoing traditions, social and hierarchical relations, and decision-making needs that are only partially "objective", the role of CMCS for decision-making will likely remain quite limited.

Reference: Rice, 1984.

4.4 The Nature of Work

4.4.1 Job Design

Some of the earliest scholarly writings about computerized word processing (WP) concerned its effects on clerical workers. Sociologists Glenn and Feldberg (1977) synthesized some literature on clerical work and compared it with their own investigations of WP installations. They took as the "standard modernized office" one which conformed closely to that advocated by IBM and others in the early history of WP; that is, information work designed according to the industrial model of hierarchical control and task specialization.

Glenn and Feldberg examined, through informal interviews, five WP installations; two which closely fit the IBM model (called WP/AS "Word processing/administrative support"), one which had "all-around clerical and secretarial arrangements with finely graded steps for upward mobility," and two others which were "somewhere in between." They found in the WP/AS organizations many personnel problems noted in other studies of fragmented jobs --alienation, lack of motivation, and "work to rule" attitudes. Administrative support people complained about "loss of typing skills" because they were denied typewriters. The WP personnel complained of dull jobs with no advancement potential.

The diversity of possible job outcomes is typified by a sample of studies of clerical video display terminal (VDT) operators and office automation (OA) users.

(1) Over half of the managers of 55 office automation sites reported that task activities generally involved greater satisfaction, skill levels and task variety, while around a quarter reported increases in pace fluctuation and stress (Gutek, Bikson and Mankin, 1985).

(2) Buchanan and Boddy (1982) found that 23 operators and authors became **less** skilled in some ways (less fear of error, less concern for spacing and format, less need to know technical terms related to layout, less understanding of authors' special needs) but **more** skilled in others (constant relearning of formatting and editing codes, greater concentration, handling lost or erase files). Although pay, promotion opportunities, and control over the quality of typing increased, there was reduced "task variety, meaning and contribution, control over work scheduling and boundary tasks, feedback of results, involvement in preparation and auxiliary tasks, and communication with authors" (1982:1).

(3) Kalimo and Leppanen (1985) found that physiological stress levels did not, essentially, vary by job type, but VDT operators reported greater job satisfaction, and, with photocompositors, greater competency and activity levels, than did proofreaders. Their general conclusion -- "on the whole the use of computer technology seems to influence the process of text preparation favorably" (p.58) -- is explained by the increased task variety, feedback and output control that the computer allowed the first two job categories.

(4) Analyzing Department of Labor Statistics for the insurance industry, Attewell and Rule (1984) found evidence for both skill upgrading **and** downgrading in 13 job categories. In the overall economy, they found little change in job categorizations, except perhaps a narrowing of skill differences. Concerning effects on employment, the authors reported that most European government studies, especially case studies, predicted or showed quite large reductions in employment in certain job categories, yet also emphasized the worse consequences of not implementing office automation. The opponents of these government studies argue that automation generates more economic benefits over the long run, cuts the costs of goods and services, and occurs in industries with labor shortages and latent consumer demand.

There are two general points indicated by this literature on VDT impacts. The first is that the consequences of introducing computers to clerical work may range from good to bad; there is no necessary predetermined nature of clerical office automation due solely to the implementation of technology in an organization. Most reviews of the impacts of computerization in the workplace conclude that the typical overall result is moderate, not revolutionary, improvements in work and productivity, and no change or some reinforcement of the status quo, in the location of decision-making control. The second is that organizational policies about the way jobs are structured and managed will significantly influence these outcomes.

4.4.2 Ergonomics

There has been a considerable outpouring of empirical studies of office equipment design, use and impacts; proposals for establishment of standards for equipment use; and regulatory and union policies defining the contexts and limitations of office equipment.

For example, the National Institute of Occupational Safety and Health (NIOSH) studied clerical and professional workers at five California office facilities: 250 users of video display terminals (VDTs), and 150 non-users. The NIOSH and some European studies have reported that one-third of operators using VDT's for most of the day complain almost daily; more time spent using a VDT was associated with more fatigue; there were more eye-related complaints in situations of poor lighting, poor VDT quality and poor furniture; and the type of work, along with fear of automation, unemployment and new technologies, all influenced negative attitudes toward VDTs. Overall, numerous health complaints were more frequent among clerical VDT users than among non-users.

The national women workers' organization conducted a large-scale survey on work and stress (9-to-5, 1984). Of about 2000 respondents who used video terminals, nearly two-thirds of clerical workers and three-quarters of both managerial and professional workers reported that using OA equipment made their job more interesting; half overall said that work was less stressful and easier. If their work was monitored by the system itself, however, workers reported significantly more headaches, nausea, dizziness, exhaustion, fatigue, anxiety, anger, depression and medical problems.

Another large-scale survey interviewed over 500 end-users of office automation technology. 60 to 70% of intensive VDT users reported bad effects; less than 10% of the 110 organizations had most of their VDT's in "satisfactory" condition -- as classified by the responding managers. This study's conclusions also found that bad health effects were worse in jobs with higher control and pressure.

Reviewing most of the ergonomic studies of VDT work, Smith concluded that "job demands, both physical and psychological, influence the type, severity and frequency of VDT operators' health complaints" (1984: 209). The **amount** of VDT use is not nearly as strong a predictor as the **type** of VDT work (Sauter et al, 1985, found **no** direct effect of amount of use); jobs with insufficient participation, inadequate training, poor technology design and physical surroundings, job insecurity, high stress, greater role ambiguity, performance monitoring and close supervision were strongly associated with health problems. Thus, as with the structuring of WP work, the primary determinants of the ergonomic effects of WP work are determined by managerial policies and job design through their influence on operators' stress and lack of control in their work.

References: Attewell and Rule, 1984; Cohen, 1983; Grandjean, 1983; Gruning, 1985; Jarrett, 1982; Kling, 1980; Rice, 1980; Turner, 1984; Wagenaar, 1985; Westin et al., 1985.

4.5 Participation, Communication and Innovation

This brief review of job design and ergonomic aspects of OA indicates that how OA work is managed, designed and structured has a great influence on the degree to which such work is unsatisfying, de-skilling and unhealthy. That is, while OA technology clearly places constraints on how it can be structured and applied in organizations, the technology itself does not solely determine the outcomes of its use. Managers must make conscious choices in job design when implementing technology in order to prevent the potentially bleak consequences that are not only possible, but all too prevalent.

One approach to the management of implementation is called the socio-technical systems (STS) perspective. The socio-technical systems perspective argues that implementation of organizational change in general, and information systems in particular, should consider relations among tasks, technology, individuals and the organization.

By focussing on the identification of performance gaps and obstacles to information flow surrounding the work unit, the STS perspective argues that uncertainty within work units can best be reduced by greater autonomy and experimentation at the unit level and by minimization of constraints on unit structure and job design.

Supervisory support for group communication about work and experimentation, feedback about the unit's performance and ongoing learning are crucial tactics in achieving performance and developing work-unit innovations. In this way, work unit members can focus attention on necessary changes, implement them and understand their part-whole relationships, by means of the managed exchange of information. The major conclusion of a critical review of worker participation in management was that most participatory interventions fail because workers do not gain enough information about their tasks and organizational functioning.

In the word processing study already mentioned in this report, communicating and learning about word processing hardware and operations were not associated with increased levels of innovation in WP work units; however, regular meetings and unit communication about how the technology could be used in work and about advanced features, were significantly associated with increased innovation in the WP work unit.

Involvement and participation is a mechanism for increasing access to information by workers. Increased obstacles or costs to access will significantly reduce the use of information potentially available to work units. This concept helps us understand otherwise counter-intuitive results such as the significant correlation between centralized word processing centers and increased implementation success and reinvention. Word processing centers can, if managed appropriately, foster an "information hothouse" effect, where new ideas about how to use the technology receive encouragement, feedback and adoption. Such support for innovation leads to customized and continuous adaptation, which in turn leads to greater overall benefits from OA.

Part of this adaptive capability is influenced by training policies. The few studies that compare modes of training for office automation systems indicate that peers are the preferred means of learning a new system, especially for advanced functions and applications. While vendor manuals and introductory seminars are useful for learning the basics of a system, they do not provide insights into either a conceptual understanding of the system, or the contextual and potential uses of the system.

References: Cummings and Srivastva, 1977; Dachler and Wilpert, 1978; Gregory and Nussbaum, 1982; Johnson and Rice, 1984; Johnson and Rice, 1987; Rice and Rogers, 1980.

5 End-User Computing

5.1 Foundations

5.1.1 End-User Computing versus Data Processing

End-user computing may be defined generally as a movement toward an organizational environment where the actual "consumer" of computer services is also the "provider" of those services.

This organizational arrangement stands in stark contrast to traditional organizational approaches where a large organizational subunit (data processing or DP) is responsible for, and in control of, all organizational computing needs, decisions, and services. This more traditional arrangement of highly centralized organizational computing clearly has roots in several contributing factors: characteristics of prevailing hardware technology; the levels of sophistication, flexibility, and power exhibited by most software and programming languages; and the relative cost ratios of human labor and computing power. The following sections consider each of these roots in more detail.

5.1.2 Hardware

For well over twenty years, the backbone of most organizational computing has been mini-computers or large mainframes. The actual physical size and environmental demands of these computers require that the computing technology must be placed in a "machine room" usually away from other organizational activities. These rooms are usually characterized by raised removable floors to accommodate massive wiring systems, special filtered power supplies, and climate control to compensate for the relatively narrow thermal operating ranges of most computing equipment.

Mainframes also are very complex and brand-specific machines or systems. They need a respectable amount of attention by technicians trained in operating specific technologies. Walking into a machine room housing a large mainframe computer, even the most skilled user of microcomputers would probably be unable to turn on the computer.

The physical dimensions of the mainframe and its numerous peripherals (printers, disk drives, tape drives, monitors, supplies, cables, etc.), environmental operating demands, and technical support necessary for operating mainframe computers has contributed substantially to their isolation from the ultimate consumers of their products. These factors also have contributed to the centralization of organizational computing.

5.1.3 Software and Programming

By the 1980's, computer operating systems and applications languages had evolved into what is loosely known as "third generation" languages. Although these languages are much more understandable and readable than previous languages, they fall considerably short of normal conversation. Simply stated, it requires a reasonable commitment of time to acquire sufficient expertise with a third generation language to solve common problems in a given computer application. Most organizational members lacked this level of expertise and relied upon the DP staff to supply them with the needed computer services. A combination of more "machine oriented" languages, and a generally low level of computer expertise by organizational members contributed to the centralization of organizational computing.

5.1.4 Human versus Computing Costs

The costs of computing have declined drastically in comparison to the costs of the associated human labor. In the 1960's, and even throughout much of the 1970's, people were relatively cheaper than computing power. Mainframe computers cost millions of dollars and were weaklings in comparison to most mini-computers today (e.g., even some of today's faster microcomputers could embarrass a 1960's mainframe).

Simple economics forced organizations to purchase only one or two computers which were guarded jealously. Even with access to the mainframe by remote terminals, central processing (CPU) time was a valuable commodity which was not delegated lightly. The very limited and costly nature of this resource prohibited potential "end-users" from logging into the system and experimenting with writing and debugging programs.

The combination of hardware, software, and relative costs set organizational computing on a path destined for central operations by a select few. It should be kept in mind that although this move toward centralization may in many cases have been an intentional part of an organization's strategy, centralization was established in a vastly different computing environment than what is arising today.

As mentioned previously, the term "end-user computing" can mean many things. Much of this confusion is simply an artifact of attempting to label a trend or process with static descriptions. For this portion of the paper, end-user computing simply refers to a process where organizational computing generally moves from the traditional centralized condition described previously to that of a more decentralized environment where the provider of computing services and the consumer of those services is one and the same.

5.1.5 Potential

Although it is not entirely clear how much of all organizational computing can or will be conducted by end-users, the potential appears to be considerable. Depending upon the study, growth of end-user computing in organizations averages between 50 and 90 percent per year in comparison with an average growth rate of 5 to 20 percent per year for traditional DP.

One expert in the field estimates that 70 percent of all user computer needs can be met with simple query languages and report generators. Other experts have estimated that by 1990, 75 percent of all organizational computing resources will be absorbed by end-users. Studies and numbers abound, but generally it is proposed that within a decade, fully two-thirds to three-quarters of all organizational computing will have moved to the control of the end-user. Most of the remaining 25 to 33 percent of computing would consist of DP applications such as payroll operations and other organizational-wide functions that are typically performed in batch operations on a mainframe.

This transition from traditional DP oriented computing toward a more end-user oriented environment is a drastic change for organizational computing practices. Although it appears to be need driven and promises a multitude of organizational benefits, the transition is not without its dangers and problems.

References: Benjamin, 1982; Martin, 1982; Rockart and Flannery, 1983; Sumner, 1986.

5.2 Motivations

A composite of both survey and interview-based research on end-user computing suggests that the following factors have been the major motivations toward end-user computing:

(1) a new generation of organizational members who are familiar with computing from university experience.

(2) better (more comprehensive, more flexible, and easier to use) operating systems and languages (fourth generation languages, query languages, report generators, etc.).

(3) a wider awareness of the available hardware and software as well as the perceived potential of computing created by vendors, trade journals and the media.

(4) decreasing costs for hardware, leading to perceptions that computer-based solutions are more "feasible".

(5) increasing availability of relevant databases within the organization and from external commercial database providers.

(6) more complex and volatile business conditions (higher demands for information, less stability).

(7) the feeling of many users that traditional DP solutions and approaches do not serve all their (the users') needs.

(8) long turn-around times for requests for services from DP, due to six month to two year backlogs typical in most DP departments.

Clearly there are potentially hundreds of reasons for the exponential growth of end-user computing, but these factors were the most prominent and recurring given in a majority of the studies.

5.3 Profiles of End-Users

Several studies have attempted to create typologies or profiles of the "typical" end-user of organizational computing. Although some studies found six categories while others found only four, the major differences stem from whether or not to include persons whose jobs are primarily centered around computing tasks (e.g., information center support personnel). Regardless of the inclusiveness of the list, there does appear to be a range of organizational end-users falling into the following classifications:

(1) **non-programming users** - end-users who only access computer stored data through software provided by others (access is through menu-driven computer interfaces, etc.).

(2) **command-level users** - end-users who generally perform simple inquiries or calculations and generate their own unique reports -- they are willing to learn enough to perform their tasks.

(3) **end-user programmer** - end-users who use both command and procedural languages and write their own applications, some of which may be used by other end-users.

(4) **functional support personnel** - sophisticated end-users who spend much of their time supporting other end-users in a given functional area. By virtue of their expertise, these users have become centers of information for systems design and programming support. They do not, however, view themselves as programmers per se.

(5) **end-user support personnel** - information center employees, etc., whose primary responsibilities involve providing training, development and information for other end-users.

(6) **DP programmers** - similar to traditional Cobol shop programmers except they are familiar with end-user languages.

The following table lists the percentages of personnel comprising each category of end-user:

Category of end-user	*Range of Percent*
non-programming end-users	4- 9%
command-level end-users	16-25%
end-user programmer	30-41%
functional support personnel	30-53%
end-user support personnel	5%
DP programmers	15%

A key finding in most of these studies is that end-users are extremely diverse in their sophistication, applications, needs, etc. This diversity indicates that widely differentiated education, support, training, and control exist in different departments and organizations. Many levels of software need to be supported (for the vastly varying levels of expertise), as do a wide range of software applications (word processing to advanced statistical packages and programming languages). Also, because of their ability to support other users, and because of their abilities to individually direct functional area computing directions, functional support personnel deserve a great deal of attention (this group of end-users will be discussed more thoroughly in the following section on information centers).

5.4 Applications

In a recent study end-users reported that they had developed over 271 applications. The applications ranged from very simple operational paperwork processing to complex analytical applications:

Type of Application	*Percent Reporting*
operational systems	9%
report generation	14%
inquiry/simple analysis	21%
complex analysis	50%
miscellaneous	6%

The researchers also determined the scope of the applications (whether it was for personal use, departmental, or for multi-departmental usage), and clearly end-users are creating many applications which have a departmental or greater scope of function:

Scope of Applications	*Percent Reporting*
multi-departmental	17%
single-departmental	52%
personal use	31%

Interestingly, however, there appears to be a gap between the amount and type of data needed by end-users for their particular applications, and their abilities to find or extract that data from existing data bases. Rockart and Flannery (1983) termed this the "data extraction gap". The reverse problem occurs when users are **not** aware of what data are being collected and made available.

Sources for end-user data include:

Sources of Data	*Percent Reporting*
extracted from production files	36%
keyed in from reports	34%
generated by user and keyed in	17%
data collected by control processes	10%
extracted from other end-user sources	3%
entered from purchased databases	2%

References: Brancheau,Vogel and Wetherbe, 1985; Rockart and Flannery, 1983.

5.5 Advantages and Disadvantages

There are numerous advantages to end-user computing. Assuming James Martin's cited statistic that 70% of all users' needs could be met with query languages and report generators, and considering the normal two-year backlog for the development of many DP applications (others have cited that the actual, but "invisible" backlog is close to

800% greater than the known backlog), end-user applications development would seem to be a very natural solution to a long-term problem.

An even greater potential advantage, however, may exist in the fact that DP development personnel have difficult tasks in front of them in attempting to design a system for a specific functional application. DP personnel may have very limited understanding of the actual departmental practices, and users are notoriously unable to articulate needs in technical terms for a very technically minded DP'er.

Although prototyping has been seen as a tool for DP staff to work with the potential user to determine actual need, the ability for the user to create his or her own application could obviate many of the problems and iterations involved in needs assessment and system design. Additionally, end-user computing can facilitate applications developments which are personal in nature, offer very specific functions, or simply are too small for normal DP development.

There are, of course, a variety of disadvantages to end-user computing as well. Most end-users lack the computing sophistication needed to assess possible alternative approaches. They also tend to work from short-term and stand-alone perspectives. Common problems cropping up with end-user applications include (from Sumner, 1986):

(1) users are not trained in requirements definition, design methodologies, or technical support.
(2) applications may be developed on personal computers but are far better suited for mainframes.
(3) many applications are not cost or time effective.
(4) a general lack of data integrity, audit trails, testing, and adequate documentation.
(5) in general, a prominent concern is the lack of control over application development.

A myriad of horror stories tell of end-users relying upon defective algorithms or data, program destruction with no backups, system designers leaving the organization without documenting their work, etc. The following table summarizes some of the benefits and problems of both traditional mainframe computing and end-user computing.

Table: Advantages, Disadvantages by Computing Type

	Traditional DP <---------->	*End-user computing*
Benefits	• data integrity • standardization • ease of organizational control of computing • high technical expertise	• reduction of "invisible" backlog • better functional "fit" of application design to actual task • greater "local" control of computing
Problems	• long delays • DP not familiar with functional area needs/practices • not appropriate for small/ specific applications	• lack of documentation • lack of audit trails • low organizational control • lower technical expertise • questions about investment return • worse technical "fit" of application design to actual task

5.6 Management Strategies

A variety of researchers, information managers, and MIS personnel have called for some controls over and planning for end-user computing. Sumner (1986) summarized many of these ideas:

(1) **planning for application development** - Planning should be conducted in order to determine what applications merit development and set priorities for development.

2) **requirements analysis** - This involves an iterative process through which a systems designer and end-user work together to identify and refine system needs.

(3) **policy and guidelines for end-user computing** -Successful end-user computing requires guidelines for hardware acquisition, data management, and application development. Incentives must be provided to end-users by offering support and training for particular hardware protocols to ensure compatibility (such as providing in-house short courses on disk operating systems, or offering peripheral support such as laser printers for specific hardware standards, etc.).

(4) **proactive management policies** - Information management and functional area management need to work together to create an environment which leads the end-users toward desired goals and avoids forcing management simply to respond to crises as they arise.

(5) **data administration standards** - Data collection, structuring, accessibility and updating should be managed as explicitly as any other major organizational resource. Accurate databases with built-in audit trails and clear references to their associated databases will help to avoid redundant, contradictory, obsolete and incomplete data. In critical applications, formal auditing of end-user systems is recommended. Also, design reviews by information system specialists; documentation guidelines; explicit procedures for backup, recovery, and data validation; specification of the justification and purpose of applications; and processing controls are recommended. In particular, a single, comprehensive data dictionary for all databases simplifies the administration of data.

(6) **data management standards** - Policies must be established concerning work with new and updatable data, downloading data from corporate databases, etc. These critical policies are standard fare for traditional mainframe-based systems and must be incorporated for end-user applications to maintain data integrity. Standards for data security also should be developed for departmental and personal systems.

(7) **training** - Deliberate efforts must be aimed at supplying end-user training professionals. A heavy emphasis on training is mandatory as deferring training costs creates untrained end-users who certainly become a much greater instrumental cost to the organization down the road.

Sumner (1986) also calls for specific attention to be paid to the development of functional support personnel who will shoulder much of the development. These individuals have relatively high technical expertise, but are, for example, accountants or marketing analysts by trade. They possess the functional area knowledge so critical to good applications development in highly differentiated organizations, but also possess adequate technical expertise either to develop the application or to know when it is time to turn it over to DP.

Ultimately, the number of user-developed systems will grow and begin to share data and resources across departments. Clearly long before this occurs, a coherent plan and strategy must be present to organize this rapidly growing force in organizational computing.

Despite the frequent and widely-shared recommendations concerning the necessity of managing end-user computing, Rockart and Flannery's (1983) study of 200 end-users in 50 organizations is more telling for what the study did **not** find:

(1) **strategies for end-user computing** - Although all the organizations had well documented, strategic, long-range plans for "normal DP," only one of the organizations had any form of strategic, long-range plan for end-user computing.

(2) **development of end-user priorities** - Although most of the organizations were reasonably "proactive" in developing priorities for their "paper-processing applications," end-user computing basically was a reactive response to demands by users.

(3) **policy recommendations for top management** - Although there was a general recognition that policies for DP procedures were not applicable to end-user computing, there was only one example of an organization which had attempted to recommend a new policy designed specifically for end-user computing.

(4) **control methods** - It was generally recognized that the information system department could not control the use of end-user computing resources, but the problem had been largely ignored.

The authors summarized this basically "hands off" relationship between management and end-user computing as:

> "*We'll give them the hardware, some software tools and perhaps some centralized support and let them do their own thing*".

The authors also call for a four-pronged approach to providing support for end-user computing:

(1) **distributed organizational support** - the authors call the information center (a form of centralized support) only the "first stage" of end-user support. Though only the "lightest matrix" approach, information systems (IS) could combine with functional support persons to provide distributed support to end-users. This arrangement combines the technical expertise of the IS staff with a departmental knowledge of the functional area.

(2) **provision of a wide spectrum of products** - this is an answer to the vast diversity found in the world of end users. Failure to provide the appropriate software or hardware tools for the particular application clearly leads to high instrumental costs later.

(3) **the development of education programs** - again, in response to the wide variety of end-user expertise and needs, a comprehensive educational program is required.

(4) **data migration** - many end-users complained about an inability to locate where data was stored, or to have it transferred to them (e.g., the earlier reference to "re-keying" existing data). This is clearly a waste of time and an open invitation for error.

Rockart and Flannery also examine areas of control over end-user computing. Control entails many functions such as:

(1) flagging "critical" end-user applications for heavier support from DP and information systems personnel.
(2) a need to control primarily through line management, not information system personnel (only functional managers can keep track of functional needs and strategies).
(3) a need for involvement of information system personnel.
(4) "environmental control" through incentives (e.g., offering support only for compatible products, etc.).

6 Information Centers

6.1 Foundations and Characteristics

IBM in Canada is generally credited with establishing, in 1974, the first center for supporting end-users of computing and information systems. They called it an "information center". From four analysts and one manager at that time, it grew to 11 analysts serving over 800 users by 1981. It is estimated that there are now over 6,000 information centers in American businesses, and that 80% of America's largest businesses have information centers. Some organizations have up to four or five separate information centers.

Information centers range from "a booth with one person answering questions on a phone" to large operations supplying access to databases, applications development, debugging and troubleshooting, R&D on new hardware and software, computer stores, training on software, provision of computer and peripheral access, and "hotlines" for an assortment of computer questions and problems.

Although one of the most salient original motivations for creating information centers was a reduction of DP backlog, a recent study of over 1,000 information centers nationwide found that this is now perceived to be of little importance. Managing the proliferation of personal computers used in American organizations is now considered a key task for the information center. Although most research has failed to demonstrate the ability of information centers to reduce the nearly universal six-month to two-year DP applications backlog (only 15% to 30% of the centers surveyed by CRWTH [1985] indicated that DP backlog was reduced), some researchers have pointed toward information centers' abilities to foster a reduction in the "invisible backlog" or jobs which users have not submitted due to the expected long delays. The founding information center at IBM Canada did, however, report a decrease in the amount of time DP spent in maintaining software from 70% in 1974 to 32% in 1981.

Although as mentioned, information centers vary widely from organization to organization, it is helpful to examine composite statistics drawn from numerous studies in an effort to characterize a "typical" organizational information center in America. The table at the end of this section summarizes some of these characteristics, based upon several recent surveys.

A series of studies on organizational information centers was conducted over a three year span by researchers at the University of Minnesota. The items listed in each of the following topic areas are ordered in decreasing frequency of mention by managers of information centers:

(1) **dominant services offered:** Consulting, training, trouble-shooting, research, development, data extraction, and newsletter.

(2) **reasons for using IC's rather than traditional DP:** Faster turn-around, more end-user control, services not provided by DP, DP not appropriate for smaller projects, a better image of being concerned, interest by users in learning, more flexibility.

(3) **reasons for using IC rather than "doing it alone":** Need for IC expertise, lack of confidence, policies and procedures, desire for IC services, less expensive, availability of personal computers.

(4) **important IC successes:** Increased user computer literacy, increased job productivity, increased accessibility and use of corporate data, success of specific applications, high demand for IC services, successful introduction of personal computers, availability of competent staff, accessibility of corporate data, large number of applications, improvement in image of DP, IC services successfully promoted, training of users.

(5) **major obstacles and problems:** Demands for services exceed capacity of staff and resources, insufficient user training, lack of application development by users, inadequate controls for development, unrealistic user expectations, lack of top management support, difficult software procurement, resistance by DP, development of inappropriate applications.

(6) **critical success factors:** Provision of needed services in a timely way, development of a competent staff, selection of "right" software, effective end-user training, monitoring and coordinating end-user development, top management support, quick response to development requests, promotion of IC services, services, good communication with other departments, cost effective solutions.

These surveys also list the importance of information center characteristics according to end-users:

(1) **overall importance of the Information Center:**
critical- 31%
very important- 35%
somewhat important- 25%
slightly important- 6%
not important- 4%

(2) **importance of services:** troubleshooting, consulting, training, database extraction, research, development, newsletter, word processing. Users depend heavily upon informal networks and vendors to supplement IC support, and seek help based upon where they think they will get it fastest.

(3) **critical success factors:** competent staff (technical skills, business understanding, service orientation, and communication skills), availability/responsiveness of services, adequate training, appropriate soft/hardware, research, and support by management.

(4) **future needs of end-users:** more reliance on IC, more training, remaining current, more advanced support, decentralized services, easier access to data, improved micro/mainframe links. 64% of end-users said they will depend on the IC for these needs, 20% said they would use IC and other sources, 17% said they would use only other sources of support.

References: Brancheau, Vogel, and Wetherbe, 1985; CRWTH, 1985; Ewing, 1986; Garcia, 1986; Information Center, 1986; Leitheuser and Wetherbe, 1984; Sprague and McNurlin, 1986; Sumner, 1986; Vogel, 1986; Wilk, 1986.

Table: Components of Typical Information Centers

Hardware Used and Supported

- 77% of IC's support both mainframe and microcomputer users
  17% of IC's support only mainframe users
  6% of IC's support only microcomputers
- both an IBM 308x and an IBM 4300 series machine are used
- MVS is the primary operating system
- 130 microcomputers are served
- 380 3270-type terminals are served

Staffing

7 personnel, 1 trainer

Software Supported

Mainframe	Microcomputer
all support	the majority support
database management system	spreadsheets
about half support	word processing
graphics systems	half or less support
info. retrieval systems	database programs
statistical analysis	integrated software
fourth-generation language	
program generator	

Services Performed by Information Centers

- 86% training end-users
- 74% supporting personal computer use
- 67% selecting end-user products
- 59% providing computer graphics
- 58% supplying database access
- 49% centralize equipment procurement
- 43% providing networks or mainframe connection

Users of Information Centers

70% of ICs over three years old support over 200 users

- 33% business analysts
- 27% clerical and administrative
- 16% supervisory personnel
- 24% miscellaneous

This summary table is based upon statistics compiled from a variety of research including: CRWTH, 1985; Ewing, 1986; Garcia, 1986; Information Center, 1986; Information Week, 1986; Wilk, 1986. Percentages are the proportion of information centers reporting the software, services or user type.

6.2 Cost of End-User Computing and Information Centers

Personal computers are relatively inexpensive, but it is not a clear-cut proposition to determine the return on investment from such information processing equipment.

Opposing the argument that personal computers must be kept busy 24 hours a day to justify their costs, Holmes (1985) computes a very simple, and perhaps conservative, equation to determine the return on investment. For an employee with a range of pay from approximately $30,000 to $60,000 per year, it works out that if the PC saves the $30,000-per-year employee about 1.5 hours per week, it is "breaking even". For the $60,000-per-year employee, less than 45 minutes per week is all that is required to break even.

The relationship is surely more complex than this little formula would indicate (i.e., what do the employees do with their saved time, what about all the "hidden" costs of PC support, etc.), but the exercise does indicate how inexpensive hardware and software have become in relation to the costs of human labor.

Perhaps this also accents the questionable strategy of initiating OA at the lowest end of the pay scale (i.e., clerical) where it actually may be much more difficult to cost-justify. It also brings up the concept of efficiency versus effectiveness. Mechanizing a clerical job is probably more efficient than using manual labor, but the return on investment may not be nearly as high as putting a professional in an environment where he or she can perform a task more effectively.

Other researchers, however, do not offer such a clear-cut and simplistic picture (Keen and Woodman, 1984). Citing other studies, the authors state that in most cases, the use of personal computers results in a 10 to 20% increase in personal productivity. In addition, they claim that it is worth investing almost 60% of a person's salary in computer support to achieve a 10% productivity increase. This comes out to $20,000 of computing support for a person with a $35,000 salary. According to the price schedules computed, the total cost of supporting one person with personal computing should total about $20,000 for the first year (i.e., this figure includes initial purchase prices, software, connections to mainframes and other "LAN type" equipment, support, peripherals, etc.).

An implicit caveat should be extended, however. The calculations of the ratio of "obvious" costs to "hidden" costs vary dramatically between traditional mainframe systems and microcomputer-based systems. Personal computing's ratio of "total cost" to "obvious cost" is nearly 4 to 1. The equivalent ratio for mainframe computing is about 1.3 to 1.

Clearly "hidden costs" are a far more significant component of personal computing applications than they are for mainframe applications. The $3,000 price tag for a PC can quickly climb to well over $11,000 dollars even for the most basic set-up. Indeed, Strassman (1985) found that only 20% of the first-year costs actually related to a personal computer and appropriate software are allocatable to the equipment and software. The rest is allocatable to informal and unstructured "organizational learning", including time and energy spent by the user, the user's sources of help, the work group and the organization as a whole. Strassman concludes that organizations severely under-invest in training and learning, because in fact those activities would significantly **reduce** the **total** first-year costs (i.e., confusion, errors, deferred costs, and delays due to lack of training, as well as traditional hardware and software costs). Information systems personnel accustomed to mainframe-based costs estimates should be cautious when planning for costs of microcomputer-based systems.

A major thrust of the Keen and Woodman argument focuses upon the need to plan a strategy for the implementation of personal computers. For example, one organization with a $25 million-per-year DP budget was surprised to discover that over $14 million had been spent in independent actions to acquire personal computing with relatively no guidance or standardization.

Even less sanguine about and more complex in discussing organizational computing costs, Nayle and Scacchi (1985) break costs into four categories. Costs are defined as the:

> *... expenditure or binding commitment of organizational resources during the organizational life cycle of a PC system. A cost may entail the consumption of resources such as money (or budget), time, skills/expertise, beliefs, or attention within the sovereignty of an individual, informal work group, or an organizational unit. Accordingly, a cost may take on a social or political character in addition to an economic one.*

Four types of costs are singled out for analysis:

(1) **direct costs** - price paid to purchase hardware, software, operating supplies, to pay salaries of computing support personnel, and fixed administrative (overhead) charges.

(2) **indirect costs** - costs that arise from the need to perform additional, non-routine tasks that facilitate and maintain the usefulness of a PC to its users (called articulation work). This work may come about from system failure, resource bottleneck, or circumstantial negotiations with others to complete a person's primary work task.

(3) **deferred costs** - sometimes tasks may be deferred (possibly to transfer the task to another organizational unit or because actors may not agree with the apparent priority of the activity). Nayle and Scacchi found that some deferred tasks may lead to very substantial additional costs when borne at a later time.

(4) **governance costs** - differential organizational arrangements needed to structure primary work routines (e.g., writing "in-house" software to agree with existing work patterns may require hiring programmers or contracting consultants while using "off the shelf" software may require changes in organizational practices to accommodate the capabilities of the purchased software.

It should be clear that evaluating costs may not be entirely straight-forward. Simplistic cost savings such as utilizing marginal training for end-users or purchasing less than "ideal" hardware or software at a considerable price reduction become deferred costs resulting in even greater future costs. For example, daily work becomes more inefficient because of inadequate knowledge of systems functions or from the inability of the system to perform necessary tasks.

6.3 Future Trends and Management Strategies

A general consensus from all the studies reviewed highlights the trend for greater "interconnectivity" between stand-alone personal computers and mainframes. Also, many researchers believe that as expertise grows in the various functional areas, these functional areas will eventually begin to share data and application programs generated by end-users. This would imply that the current centrality of the information center for end-user computing may eventually decline as support and expertise move into the functional areas. Much of this decentralization depends on key users called functional support end-users.

Functional support end-users (see description in the section on end-user computing) are a key to the future transitions of informations centers. Authors in this area call for increased support for applications development (in contrast to the more basic software training programs supported by the majority of information centers) directed at these functional support personnel. This type of support will enable the functional areas, through their own "resident" or "local" experts, to develop applications without the intrusion of an IS person who typically is not familiar with the details of the functional area operations.

Considering the growth of end-user computing in general and information centers in particular, several "stage" models of examining technological growth in organizations have been proposed, including one by Zeisman:

(1) **initiation** - Word processing is substituted for typing and centralized word processing operations are organized. Even though word processing has been centralized, corporate DP remains uninvolved.

(2) **expansion** - At this stage, tools are provided for professional task environments as well as clerical (e.g., electronic mail, database, electronic calendars, etc.). DP staff and management usually begin to take notice of OA as a major applications area at this stage, and may attempt to recommend or enforce standards to control the proliferation of incompatible devices.

(3) **formalization** - A key change here is a transition from simple mechanization of separate tasks to that of automating organizational processes. Arguably, this stage can be characterized by a "blurring" of traditional status lines as clerical persons are freed from more routine tasks and are able to assume more responsible tasks "off-loading" from professionals and management.

(4) **stabilization** - This stage is characterized by an greater integration as processes with even less structure or predictability become automated. OA simply blends in with business and social processes.

This stage model, if applied to information centers, depicts organizations moving along a path as shown in the following figure.

Figure: Applying a Stage Model to End-User Computing and Information Centers

Stage	early	current	future
Control	decentralized technology	centralizing control	decentralizing support & control
	>---------------------	>--------------------	>
Location	end-user implementation	MIS & IC intervention	IC support moves into functional areas

This model depicts technological change as initiated by end- users across the organization. The introduction of, say personal computers, does not attract much DP attention at first. As end-user activities increase, however, DP becomes concerned about incompatible systems, data integrity, and all the other potential problems associated with end-user computing outlined earlier. IS or DP "moves in" to standardize matters somewhat through the introduction of information centers, initiating policies, and through providing incentives though selective access to high-speed printers, main frame capabilities, and training and support for specific hardware and software.

Once policies and standards are established, the information center should attempt to move "higher level" support for applications development into various organizational subunits by focusing on the functional support personnel in each area. At this stage, end-user computing will once again decentralize and be fueled by functional area need and expertise. It will be managed by IS personnel (for standards), but more importantly, end-user computing will be managed by traditional management in each functional area, which knows far better their functional needs than an information systems staff can.

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Atre, S. **The Information Center: Strategies and Case Studies.** Boston, MA: Weingarten Publications, 1986. Action-oriented solutions to problems of information centers and recommendations to MIS managers responsible for end-user computing. Considers start-up activities, budgeting, training, database management, organizational politics, and case studies.

CRWTH provides consulting services and a newsletter on computer-based training and information centers. Their address is 613 Wilshire Boulevard, Santa Monica, California, 90401.

Bennett, J.; Case, D.; Sandelin, J. and Smith, M. (Eds.) **Visual Display Terminals: Usability Issues and Health Concerns**. Englewood Cliffs, NJ: Prentice-Hall, 1984. Chapters consider adoption, design, use, effects and management of video terminal work.

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