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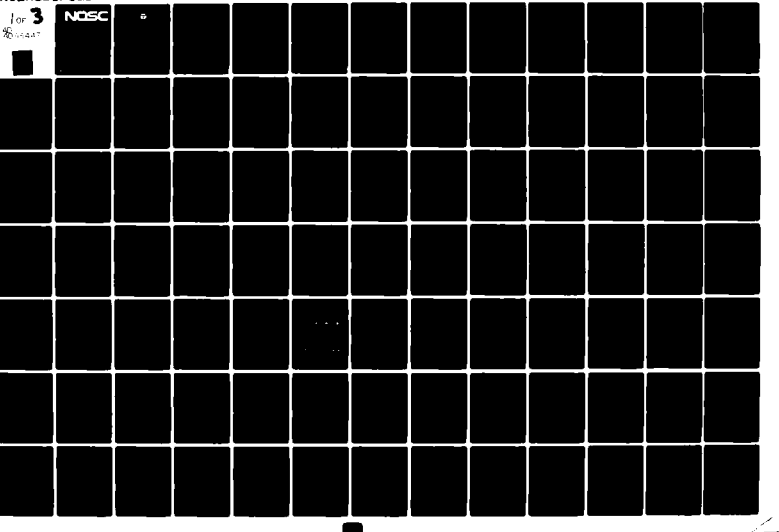

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Technical Report 618

TELECOMMUNICATIONS SERVICES REQUIRED BY DISTRIBUTED AND INTERCONNECTED OFFICE CENTERS

T.L. Comport
NOSC
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Systems Exploration, Inc.

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1981

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Work was performed under program element RDDA, subproject DCA, and NOSC Customer Order CM37 during 1980 and was sponsored by the Defense Communications Engineering Center (DCEC R720).

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This study addresses an analysis of trends in the development of information transfer systems of the future, such as electronic mail transfer, teleconferencing, communicating word processors, facsimile, micrographics, and other technological advances which allow the rapid exchange of multi-media information over communications networks to geographically separated locations. The importance of these technologies to DoD resides, among other things, in the continuing energy crisis and the necessity to reduce travel, cut information transfer costs associated with traditional delivery methods, and to reduce transfer delays of important and perishable information.

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EXECUTIVE SUMMARY

This study addresses an analysis of trends in the development of information transfer systems of the future, such as electronic mail transfer, teleconferencing, communicating word processors, facsimile, micrographics, and other technological advances which allow the rapid exchange of multi-media information over communications networks to geographically separated locations. The importance of these technologies to DoD resides, among other things, in the continuing energy crisis and the necessity to reduce travel, cut information transfer costs associated with traditional delivery methods, and to reduce transfer delays of important and perishable information.

The results of the present analysis indicate a significant proliferation over the next decade in the application and usage of these developing technologies. The communications medium appears to be the 9600 bit line capability offered by the common-carrier telephone networks.

The study concludes that the mainstream technologies of electronic mail transfer, communicating word processors, facsimile, micrographics and teleconferencing will have become well entrenched as common forms of information exchange between offices and Agencies of the DoD by the 1990's.

It is suspected that many offices in DoD, in addition to special systems which are already officially in place, now make use of most of the modern technologies unofficially as a matter of "convenience." Examples of DoD "convenience" communications would include the wide-spread use of individually leased facsimile machines and the employment of ARPA and other computer networks to exchange electronic mail, i.e., messages between individuals.

Teleconferencing techniques, particularly audio, narrow band video, and computer conferencing will continue to be employed by industry. Incorporation within DoD will greatly increase.

Computer graphics, a technique to present information to decision-makers in highly concentrated form, is considered to be the fastest growing technology examined in this report.

Computer output microfilm which may be digitally stored and transmitted electronically, will become more actively employed by DoD as the requirement increases to reduce or eliminate "paper" files.

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DoD INFORMATION TRANSFER SYSTEMS OF THE FUTURE: A TECHNOLOGICAL ANALYSIS

1. INTRODUCTION

1.1 Purpose. The purpose of this report is to present and synthesize the results of an analysis of available literature which projects the application of communications and computer technology to information handling and transfer systems of the future so as to aleviate the labor intensive, manual nature of such work.

Specifically, the report attempts to foresee trends in these technological areas which may impact on the automation capabilities incorporated into future DoD information centers and, hence, on the planning for communication networks that will have to be provided by the Defense Communication System (DCS) to interconnect them.

1.2 Scope. The Defense Communications Agency (DCA), in previous studies, has explored possible applications within DoD for facsimile and the various forms of teleconferencing [1] [2], which would appear to be necessary adjuncts to "automated information centers."

The current report expands on this information and examines other technologies which will have important roles to play in future information transfer applications. The technologies examined are: Electronic Mail, Teleconferencing, Facsimile, Word Processors, Intelligent Copiers, Electronic Funds Transfer, Computer Aided Instruction; Computer Output Microfilm, Computer Graphics, and Portable Communications/Radio Paging.

Other than the DCA studies cited earlier, there is not much data available relating specifically to how DoD might apply or adapt the new technologies to its own needs. Therefore, it has been necessary in this report to rely heavily on technology trends observed in the civilian sector and to attempt to extrapolate these in terms of DoD usage.

The primary sources of information used in the following trend analysis have been Technical Reports, articles appearing in the trade journals, and several popular books which foresee future trends in the networking of information such as The Wired Society [3] and The Network Nation [4].

Of special interest will be a brief discussion of preliminary field trials of computer teleconferencing currently being conducted by DCA which involve some fifty working group participants who are interconnected via a world-wide communications network and a centrally located computer dedicated to performing teleconferencing functions. This discussion is appended to a general section devoted to teleconferencing.

1.3 Assumptions. The (nominal) time-frame of this study is fifteen years into the future. Realistically, projections of technology are probably only valid out to five years. In other words, we know what exists now at the fore-front of the state-of-the-art. Our imagination can extend and refine this technology to applications which might take five years to develop (normal system time cycle). However, the history of communications and digital technology has been such that we also anticipate that there are bound to be qualitative changes in the way of doing things, followed by exponential growth in completely unanticipated directions.

It is probably realistic to envision that most of the civilian sector will have incorporated present state-of-the-art office automation technology by 1985. The DoD usually lags the civilian sector in terms of adapting new technologies into their administrative operations by at least five years. This brings us to 1990. The time-constant to respond to any qualitative break-through which might change the impact of technology on DoD administrative practices might be on the order of another five years, i.e., 1995.

Therefore, for DCA planning purposes, it would appear sufficient to examine present office automation technology projected out about five years. This is not to say that one should not look further ahead than that, if possible. But it is important to scope the study to a reasonably valid forecasting period. Also, given that the foregoing premises are correct, the time frame, of concern for projecting an increased steady-state traffic load on the DCS, due to DoD office automation, is 1990-1995. This is an informed prediction, which it is the intent of the study to further develop, and requires some explanation. The next ten years will represent a growth period wherein various DoD agencies will gradually automate their information handling functions and resort to DCS networks to transfer information between their offices. The growth in such traffic will increase until the demand stabilizes at some steady

state which reflects the extent of planning which can reasonably be implemented within the time involved. This limit, the steady state, then defines a network design goal for a definitive period. It is our judgment that this time frame is 1990-1995.

Efforts to automate offices are fairly commonplace these days in the continuing thrust toward reducing labor costs. But the concept of linking individuals, organization entities within offices, and remotely separated offices by means of communications networks aided by the computer, is an innovative development with enormous consequences for energy conservation and individual worker life-styles. The potential exists, both in office automation and communications technology, to alter our traditional ideas about the way information handling jobs used to be accomplished.

1.4 Summary. To summarize, the primary time of interest in this study will be to forecast the development of advances in office automation technology out into the future about five years, with particular emphasis on those techniques which will require telecommunications networks to support information exchange.

We will be especially interested in office automation technology which requires that automated offices and work centers exchange information over communication networks.

2. BACKGROUND.

The idea of automated information processing and transfer systems embodies the concept of combining electronic communications media in an integrated systems approach to solving the problems inherent in the paper based information processing and distribution system which exists today. Bringing together voice, facsimile, data processing, word processing, and computers in support of information processing and distribution functions will be a major step in the continuing evolution of communications.

Most office functions today are carried out very much in the same way they were fifty or a hundred years ago. Executives write out their correspondence in longhand or dictate it to a secretary, after which it is typed, revised, retyped and often re-revised and retyped again before being signed, put into an envelope, stamped, and consigned to the mail system for eventual delivery. Neither the importance of the communication nor its urgency generally do much to alter this process. The executive may resort to the telephone if he is in a hurry but that doesn't always speed the process as much as he would like because only one quarter of all telephone calls are completed to the intended person on the first try. There is always the telegram or military 'message' as a tried and true way to communicate but it has its own drawbacks. All of these media, letter, telephone and telegram/message, are labor intensive and have certain delays associated with each.

The terms 'office' and 'office worker' will be used many times throughout this report and it is important to understand that more is intended by these terms than might normally be expected. 'Office' also includes what might be described as a DoD 'work center' where any type of information handling and processing takes place. It is intended to imply that a work center and its 'office workers' perform more involved tasks than the minor clerical duties of typing, filing, and bookkeeping.

Paper, and paper work, impact on many offices in such volume that there is often little time left to perform creative work after dealing with the paper. The amount of information available far exceeds the motivation to use it or the ability to locate and acquire what is needed or desired even if the motivation exists. There is a dramatic need to increase white-collar productivity and decrease the cost of performing routine business functions. In

industry, office workers now comprise 22 percent of the entire U.S. work force and the numbers are growing. The office represents 50 percent of total operating expenses.

The ever increasing cost of labor and virtual explosion of information to be handled coupled with the steadily decreasing costs of computer based technology and communications make automation of office functions a necessity rather than merely a convenience. A great deal of the technology necessary for office automation is available now but hasn't been put into use for a variety of reasons. Many of the technologies have been developed as stand-alone systems and the economic impetus for their integration has not been present. Over the last ten year period capital investment per office worker has averaged between $2,500 and $3,000 and productivity has increased a mere 3 percent. During the same period capital investment per factory worker has averaged $25,000 and productivity has increased 85 percent. This is illustrated in Figure 1. It is apparent that for the office worker to become more productive a greater capital investment must be made in office equipment and systems, including changes in office techniques where necessary.

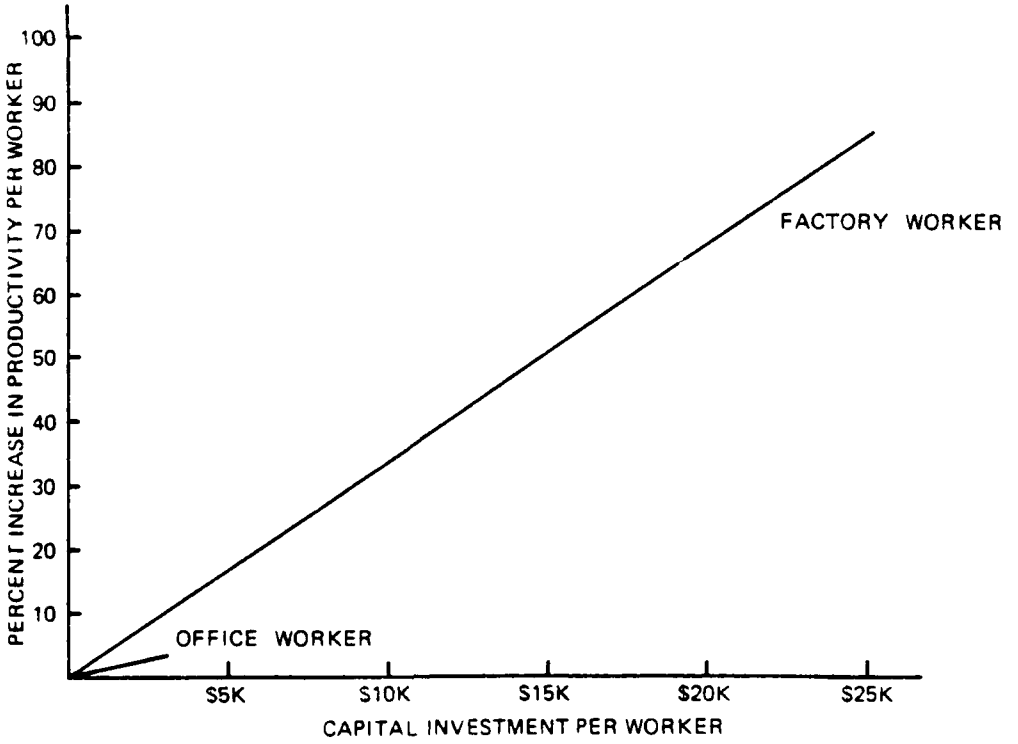


Figure 1. Capital Investment Versus Productivity Over 10 Year Period.

Automation of information processing and distribution in order to increase productivity is not a new idea. The introduction of telephones, typewriters, adding machines and calculators have all been steps in an evolutionary process which has been going on for quite a long time. More recent steps have included the convenience copier, desk-top facsimile machines, programmable calculators and word processors. The next step is based in microelectronics and the widespread availability of microwave and satellite communications systems. Microelectronics permits the blending of technologies and the expansion of capabilities for processing information and data while the communications systems provide the medium for real time processing and distribution.

Automation of the office and of information processing and distribution in general is underway and will accelerate as we move through the 1980s and into the 1990s.

Several terms have been coined in an attempt to describe the 'ideal' office which makes full use of the latest technologies and integrates them into a super efficient and cost effective whole. These terms include Office of the Future, Electronic Office, Integrated Electronic Office, Wired Office, Automated Office, *Office of Tomorrow*, *Paperless Office and* Peopleless Office. No matter what it is called the intended benefits are the same, to improve efficiency and cut costs. We will find a great deal of electronics technology in the automated office and we will also find paper and people - no matter how automated the office becomes.

Nicholas Mokoff, Associate Editor of IEEE Spectrum, provides a useful understanding of office tasks which will serve as a base for defining office tasks and functions. Mokhoff cites a study of office technology done by Siemens A. G. of Munich, West Germany in which it was found that in analyses of the wide range of tasks performed in offices, one constant factor emerged: Office work serves to inform [5]. Data is constantly produced, shaped, and revised according to rigid and uniform procedures. In terms of functions performed by office equipment, the procedures can be broken down into handling information and processing information. Handling consists of oral exchanges as well as data, text, and graphics. Processing includes data collection, text production, graphics production, documentation and filing or storage. The handling and processing must be tied together with communications. Figure 2 illustrates these concepts. According to the Siemens study, before a network

of information channels can be automated, office tasks have to be formalized - described in terms of software instructions and algorithms. With knowledge of the time required to complete the task, certain formalized activities can be automated. Everything that can be formalized can't necessarily be automated and in some instances there is a large gap between formalization and automation. Things that can be formalized and automated lend themselves to integration in which one piece of office equipment serves many activities with office activities becoming more closely related than in the past. Figure 3 correlates technologies with the information processing and handling functions which each technology will support. This figure will be more meaningful if it is kept in mind that some pieces of office equipment will be, and are now being, adapted to perform functions previously performed by two or more pieces of equipment and others are being tied together into an integrated system through the use of an electronic switch, actually, a computer, to direct and monitor their activities. The key to such integration is the ability to digitize the output of the equipments tied to the switch so that there is a common language among all of the machines involved. In addition to machine outputs voice may also be digitized and handled in exactly the same manner. Figure 4 illustrates the digitized interface between machines/voice and the computer which serves as a switch and controller. Once the digital language is developed to the point where it is computer compatible it can also be communicated to other machines either locally or at a distance over data capable circuits as illustrated by Figure 5.

INFORMATION HANDLING		INFORMATION PROCESSING
ORAL EXCHANGES		DATA COLLECTION
DATA EXCHANGES	COMMUNICATIONS	TEXT PRODUCTION
TEXT EXCHANGES		GRAPHICS PRODUCTION
GRAPHICS EXCHANGES		DOCUMENTATION
		FILING (STORAGE)

Figure 2. Functions of Information Handling and Processing.

TECHNOLOGIES \ FUNCTIONS	INFORMATION HANDLING				INFORMATION PROCESSING				
	ORAL EXCHANGES	DATA EXCHANGES	TEXT EXCHANGES	GRAPHICS EXCHANGES	DATA COLLECTION	TEXT PRODUCTION	GRAPHICS PRODUCTION	DOCUMENTATION	FILING (STORAGE)
ELECTRONIC MAIL		●	●	●	●				●
TELECONFERENCING–AUDIO	●				●				
TELECONFERENCING–VIDEO	●			●					
TELECONFERENCING–COMPUTER		●	●	●	●	●	●	●	●
FACSIMILE		●	●	●		●	●		
WORD PROCESSORS		●	●	●		●	●	●	●
INTELLIGENT COPIERS		●	●	●		●	●	●	
ELECTRONIC FUNDS TRANSFER		●						●	
COMPUTER AIDED INSTRUCTION		●	●	●					
COMPUTER OUTPUT MICROFILM		●	●	●				●	●
COMPUTER GRAPHICS				●			●		
PORTABLE COMMUNICATIONS/RADIO PAGING		●	●	●	●				

Figure 3. Correlation of Technologies and Functions

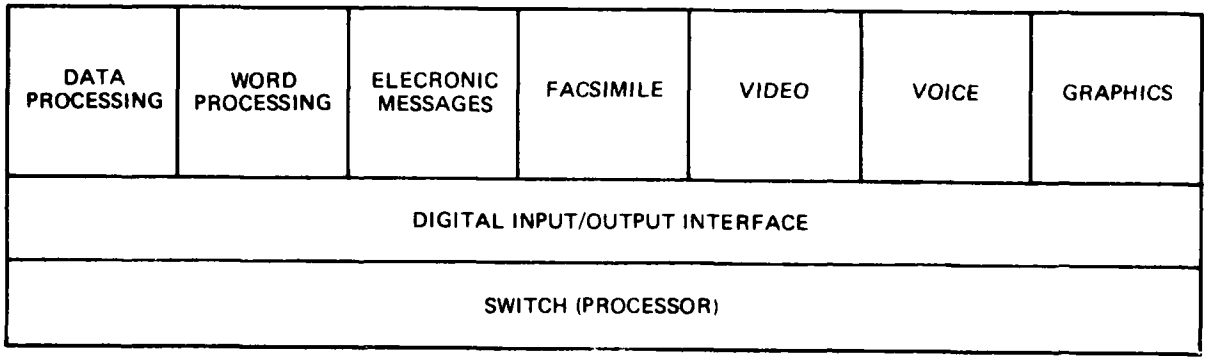


Figure 4. Digital Interconnections Between Office Equipments and a Controller

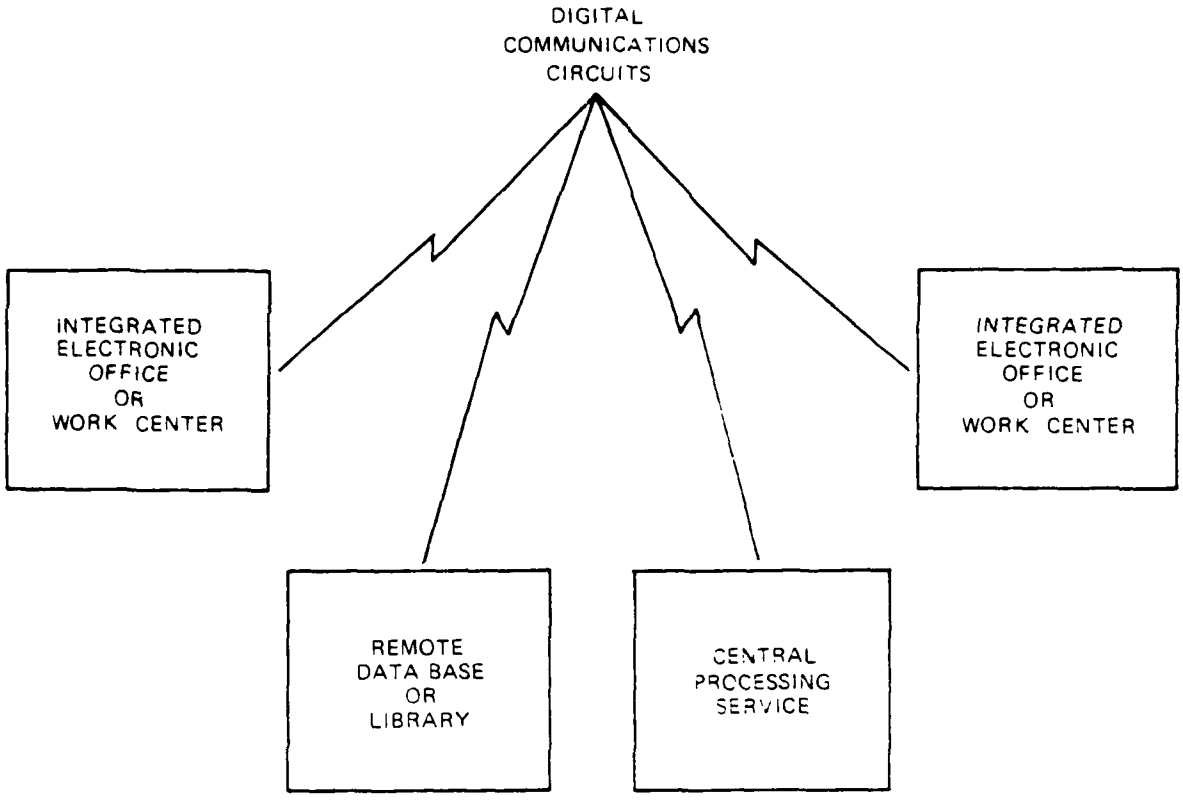


Figure 5. Dispersed or Distributed Office Functions
Connected by Digital Communications Circuits

So far we have talked about improving the efficiency and production of office workers. Also to be considered is improving productivity of managers and other professionals. The design of office systems and work centers that increase professional productivity will automatically achieve more efficient support of managers and executives as a by product. Presently, only about 30 percent of an executive's time is available for analysis or creative work. The remaining 70 percent is occupied in face-to-face meetings, telephone calls, looking at reports or traveling. Each of these areas offers good-to-excellent potential for productivity improvement with such automated office applications as electronic mail, teleconferencing and information retrieval designed to support the executive [6].

While the major impact on communications requirements will be as a result of automating those functions normally thought of as residing in or emanating

from offices it is necessary to keep in mind that offices per se are not the only candidates for automation. Many administrative or clerical functions which eventually result in communications requirements originate outside of normal office spaces, with the resultant generated paperwork being conveyed to an office for processing and further distribution or inclusion in a data base. Automating the collection of these functions by placing appropriate electronic devices at the point of origin will improve work flow while decreasing errors and requiring fewer personnel, or less training for personnel.

Our discussion of computer controllers and switches to manage the interfaces between the technologies in the automated office/work center has implied that the computer is located within the office complex. In many cases this will undoubtedly be true but the possibility for imbedding switching and control in the communication network does exist and offers considerable advantage in certain applications. We can cite as an example the computer controlled switching which the Bell System has introduced into local central offices. This has been the major switching innovation in the past decade and has utilized the Bell System's No. 1 ESS.

To the telephone subscriber, computer-controlled switching brings the introduction of pushbutton telephones, faster call connections, and the availability of new services. To the telephone carriers, computer-controlled switching means lower switching costs per line, more flexibility of service, and usage-sensitive pricing of local calls.

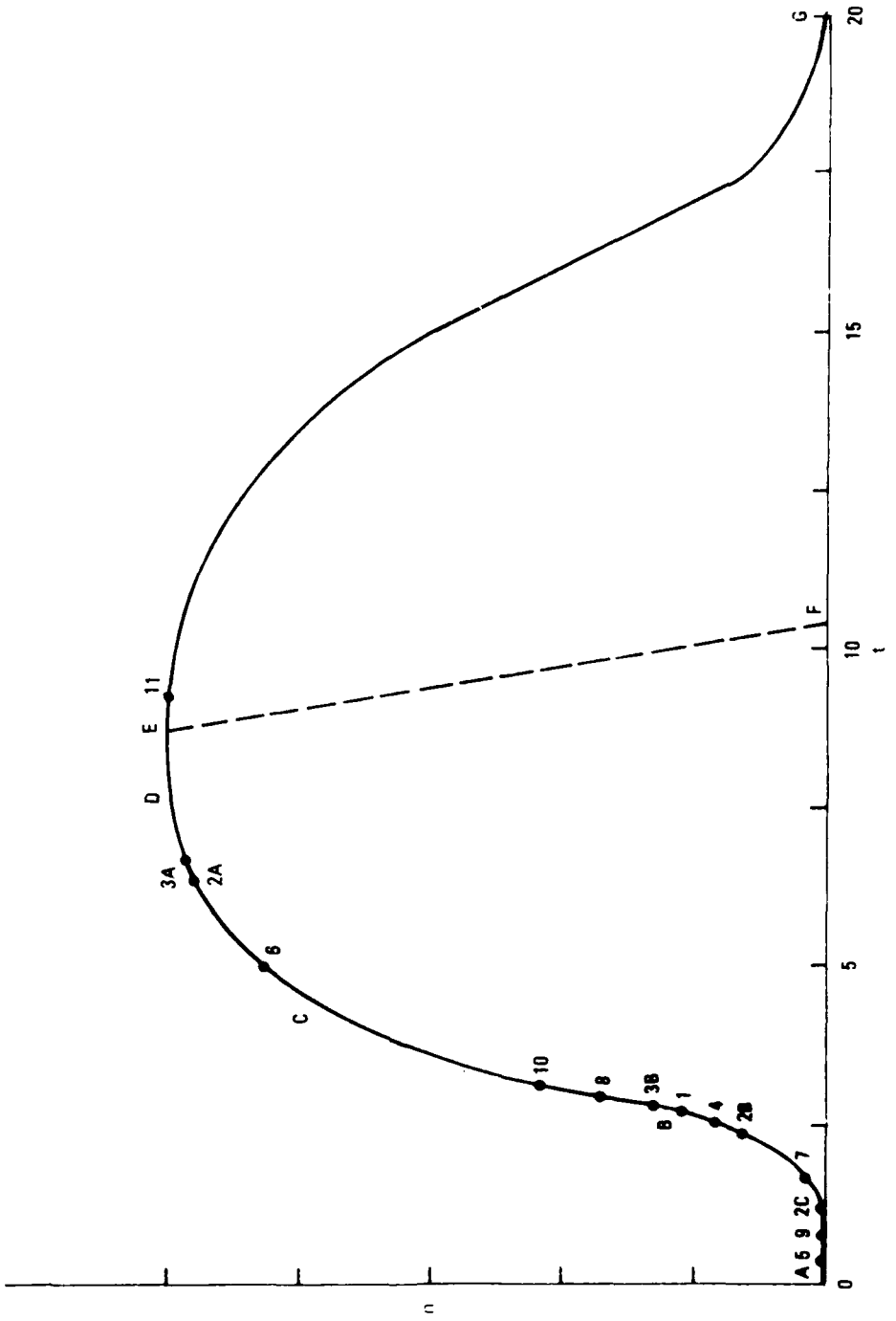
To give some indication of size and complexity, the Bell Telephone System now includes approximately 120 million telephones, 80 million local loops, 150,000 PABXs and key systems serving 30 million telephones and other terminals, 10,000 local central offices, and 1,000 toll switching offices connected by one million toll transmission trunks.

The conversion of some 20,000 telephone central offices from one switching technology to another is a formidable task. AT&T has programmed the introduction of computer-controlled switching over 40 years. As of early 1978, 13 years after the first No. 1 ESS switch was introduced, only about 25 percent of subscriber lines were connected to computer-controlled switches. It will be the mid-1980's before half of the Bell System's lines are served by computer-controlled switches, and well into the 21st century before the conversion is completed.

The introduction of computer-controlled switching to non-Bell telephone companies that serve predominantly small towns and rural areas has been even slower. Computer-controlled switching exhibits economics of scale, so that costs per subscriber are higher in small exchanges. This has led to the concept of a single computer-controlled switch handling several small exchanges via remote links. The Rural Electrification Administration and several independent companies are actively pursuing this approach. Still, the majority of non-Bell subscribers will probably not be served by computer-controlled switches during the 1980's.

Even as telephone central offices have begun converting to computer-controlled electromagnetic switches, a different approach to switching has been developed that more fully integrates computer technology and is more compatible with digital communications. Some of the newer computer-controlled PABXs employ digital switching. Digital switches (No. 4 ESS) are beginning to be installed in the toll telephone network. By 1990 the Bell System plans to route more than 75 percent of toll calls through digital switches. In 1977 the first commercial digital switches were introduced into a few independent telephone local exchange offices. However no plans have been announced to bring digital switches to AT&T local central offices.

Mention has been made of the developing technologies and some discussion has been offered pertaining to the reasons for their just now being combined into an integrated system by industry. Development of mini- and micro-computers, digitization of machine outputs/inputs and the availability of adequate supporting communication networks were all cited as contributing to integration. Also to be considered is the fact that the technologies are not at the same point in their life cycle. Some of them are so new as to be still in the developmental phase while others are nearing maturity. In order to make any meaningful predictions about growth of the individual technologies or to project their use in automated offices and work centers of the DoD an understanding of relative life cycle positions is necessary. Such an understanding of the technologies as they now exist in the industrial world may be acquired through examination of Figure 6. As previously mentioned in paragraph 1.3, the technologies are expected to be assimilated by the DoD about five years after adaptation by the civilian sector, however, it is expected that they will maintain their relative positions on the life cycle curve. Also, it must be


G
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3B
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B
4
2B
7
2C
A 5 9
0
5
n

t - time in years (For industry application)

n - units

Line	Represents
A - B	Initial market entry. Some developmental work still going on. Slight user acceptance.
B - C	General acceptance by users and rapid acceleration of technology applications.
C - D	Market expansion continues, primarily because of decreasing prices due to vendor competition and technical advances.
D - E	Market constant, useage has reached maximum application.
E - F	Market declines because a new technology begins to take over the market.
F - G	Application of the technology continues. Equipment utilized to end of mechanical/electrical usefulness; may be sold by original purchaser in order to make room for a new technology then used by less demanding users.

Estimated positions of examined technologies in their life cycles as of 1980 is indicated by placement of the following numbers on the graph:

1 Electronic Mail
2A Teleconferencing - Audio
2B Teleconferencing - Video
2C Teleconferencing - Computer
3A Facsimile - Analog
3B Facsimile - Digital
4 Communicating Word Processors
5 Intelligent Copiers
6 Electronic Funds Transfer
7 Computer Aided Instruction
8 Computer Output Microfilm
9 Computer Graphics
10 Portable Communications/Radio Paging
11 Electric Typewriters (Shown for comparison purposes only)

Figure 6. Technology Life Cycle

remembered that technologies are being combined and blended at such a rate as to alter the nominal life cycle. Such innovations as bubble memories, very large scale integration (VLSI) and fiber optics and their incorporation into the technologies will further alter life cycles.

3. ELECTRONIC MAIL

3.1 Understanding electronic mail. The two words "electronic" and "mail" have been defined well enough for most people to have a definite opinion about what each of them means and for that opinion to be almost universal in nature. Unfortunately, when the words are combined into the term "Electronic Mail" there is no single definition which adequately describes what is meant and there is no universal opinion about much of anything having to do with the subject.

Managers and office personnel in the Department of Defense (DoD), because of the extensive and long time use of electrical and electronic communications media by that Department, are probably much more aware of and familar with electronic mail than are most of their civilian counterparts.

Within the DoD electronic mail is generally thought of as a "message" or "TWX" which is sent by typing information onto a form in a prescribed format and then handing it to a clerk in the message center who magically delivers it to its distant destination.

Recent efforts toward automating and modernizing DoD communications at the user, or customer, level have included employment of user operated facsimile machines and installation of message center remote input terminals in offices having a regular and continuing requirement for message handling. Electronic mail involves more than just adding some new equipment to the old office. New concepts in communicating are involved as are different processes for carrying on the business of the DoD.

Electronic mail dates back to the invention of the telegraph in 1840 but the marriage of electronic communications to data processing has caused a quantum leap in activity in this field over the past several years. Any kind of information - typed, handwritten or drawn - that would ordinarily be conveyed on paper can as easily be reduced to a multitude of electronic pulses identical to the data that is processed by digital computers. In fact, computers can manipulate, compress, store, switch and transmit those pulses the same way that they handle any other data [7]. The capability to digitize voice and process it in the same manner as other data allows a vocal version of electronic mail to parallel the more familar printed material.

3.1.1 Electronic mail defined. Quite a number of attempts have been made to define electronic mail, both as to what it is and what it is not. Two definitions which get at the heart of the matter and which are worthy of serious consideration are: (1) Electronic mail is the delivery of a document from one place to another by electronic means, and; (2) Electronic mail is a substitute for regular mail in which at least one of the transportation steps is via an electronic delivery.

If we expand the term electronic mail to "electronic mail and message system" then it is necessary to include consideration of voice transmitted messages which are stored and forwarded for later delivery in addition to text and graphics.

Electronic mail as a substitute for telephone calls offers certain advantages, both in convenience and in cost savings. It has been found that a majority of business phone calls are not completed on the first try. Either a busy line is encountered or the called party is not available. Repeated attempts to contact a certain individual in an office often results in a game of telephone-ping-pong in which A phones B, finds that B is not available and leaves a request for B to return the call when possible; B gets the message and calls A only to find that A isn't available. The game continues until someone gets lucky or gives up. The point is that sometimes several calls are made and must be paid for without the principals communicating. Additional costs over and above the cost of the phone call are also incurred. Loss of the caller's time as well as that of his secretary and the people who answer the phone in the called office must be considered. Once the principals do make contact there is generally a certain amount of social interaction which takes place in addition to conducting the business which prompted the call. A two or three minute business call is easily stretched into a fifteen minute visit between friends. If one of the participants must leave the phone in order to locate information or is interrupted by more pressing business the result may be an extended call or placement of an additional call (and perhaps another game of telephone-ping-pong). Use of electronic mail allows the sender to communicate one time when he is ready to do so and the receiver to communicate one time when he is ready to do so and has had time to gather any required information and formulate a "good" reply rather

than trying to respond without adequate preparation. The electronic mail message may be addressed to multiple receivers by a very simple process and their multiple replies collected just as simply.

Electronic mail is not the routine accessing of a central computer by remote terminals in adding to or utilizing a data base such as is done by the banking business or insurance adjusters. Batch processing of data from a remote site may not be considered as electronic mail while the frequent submission of certain reports might fall into the electronic mail category.

3.1.2 Evolutionary steps in electronic mail. Electronic mail is both a faster way of delivering mail and an entirely new way to communicate. Some examples to illustrate this last statement will help to understand electronic mail and its part in the office of the future.

3.1.2.1 Example one. Let us first consider the way in which preparation, dispatch and delivery of a letter takes place in the non-electronic office of today. The steps usually go something like this and are illustrated in Figure 7:

(a) Executive dictates letter to secretary or writes it out longhand.

(b) Secretary types a double-spaced "rough" and gives it to executive for review.

(c) Executive reviews letter, making any desired corrections with a pen or pencil.

(d) Secretary retypes letter in smooth form and gives it back to executive.

(e) Executive signs letter and returns it to secretary.

(f) Secretary types envelope, places letter in it, puts letter in "outgoing mail" basket.

(g) Letter is picked up and taken to mail room where postage is affixed and letter placed in outgoing mail bag.

(h) Letter is picked up by US Postal Service letter carrier on next visit or letter is delivered to Post Office or letter drop box by company courier on next scheduled trip.

(i) Letter is processed through USPS and delivered to addressee's mail room.

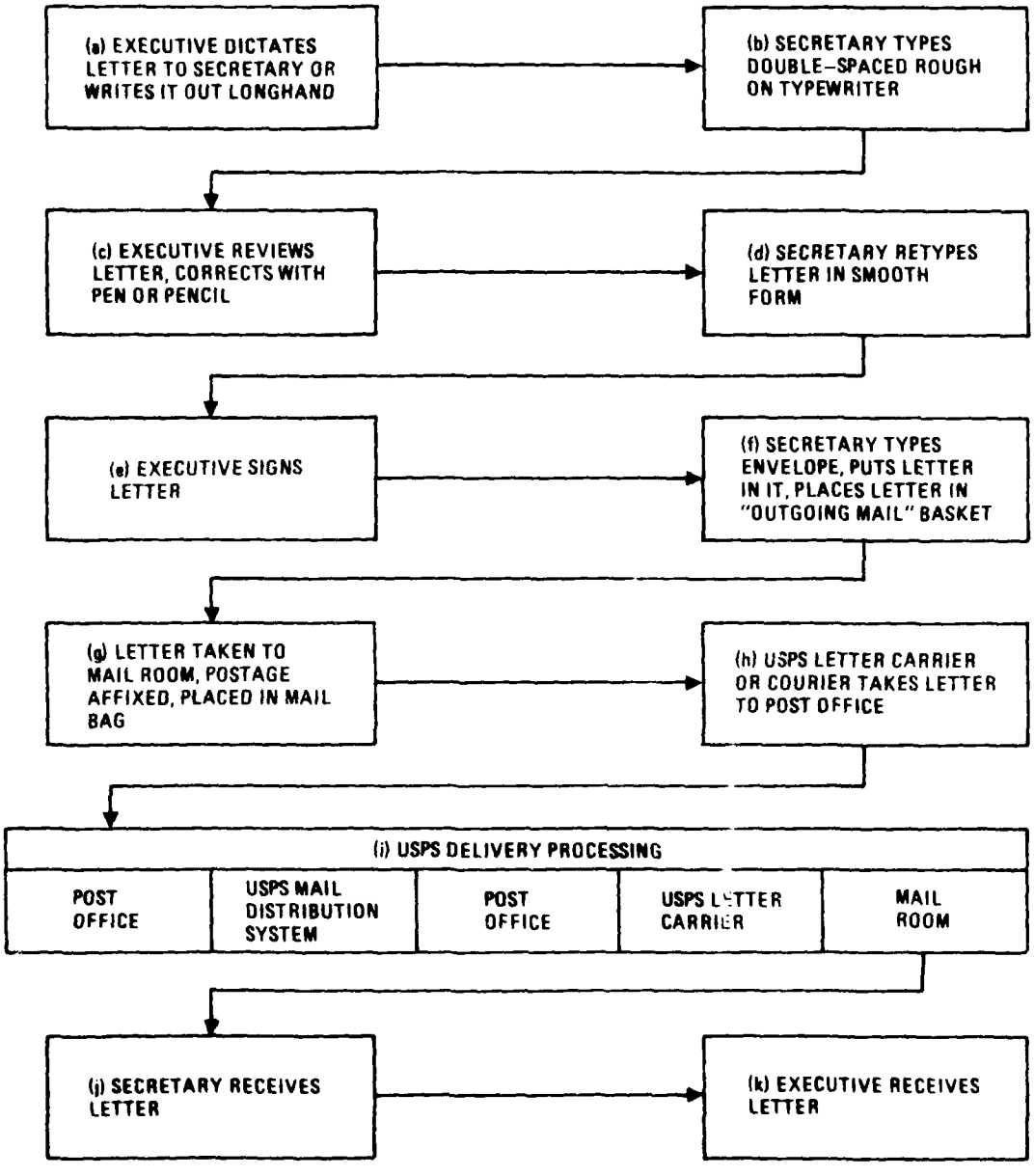

Figure 7. Mail Flow for Example One

(j) Mail room processes letter and delivers it to recipients secretary.

(k) Secretary delivers letter to executive.

As we are all aware, delays are introduced during each of these steps and are currently considered as part of the mail delivery routine. How much intra-company delay is introduced is a factor of management practices but the inter-company delay is attributable to the US Postal Service (USPS). It has been found that the USPS takes more than one day to deliver 91 percent of the mail [1]. Figure 8 illustrates the spread of mail delivery times by the USPS. In a great number of business and government situations time delays in excess of one day are considered prohibitive. Electronic mail is able to solve many of these delay problems, and in some instances all of them.

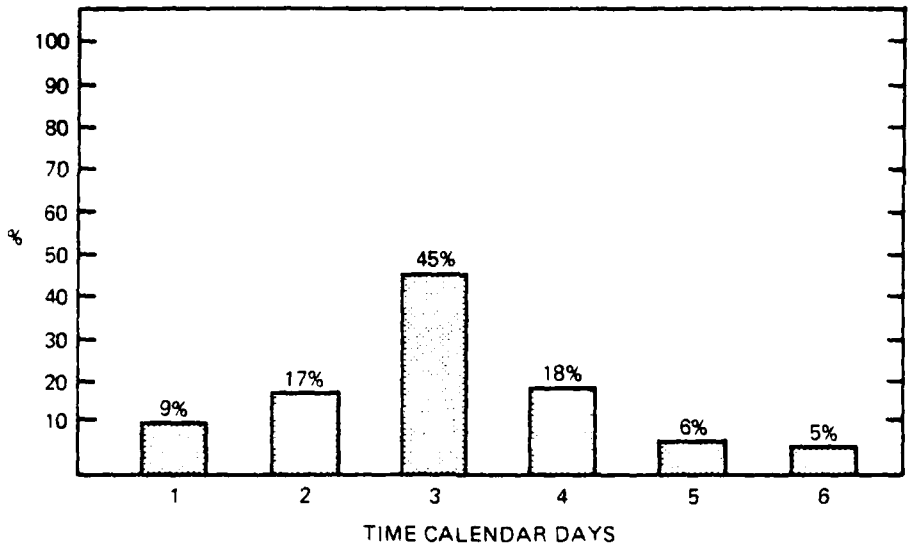

Figure 8. Mail Delivery Time Analysis

3.1.2.2 Example two. Lets now consider an example of electronic mail in which it serves as a faster way of delivering mail. We will use the same executive/secretary situation as previously. The steps now go something like this and are illustrated in Figure 9.

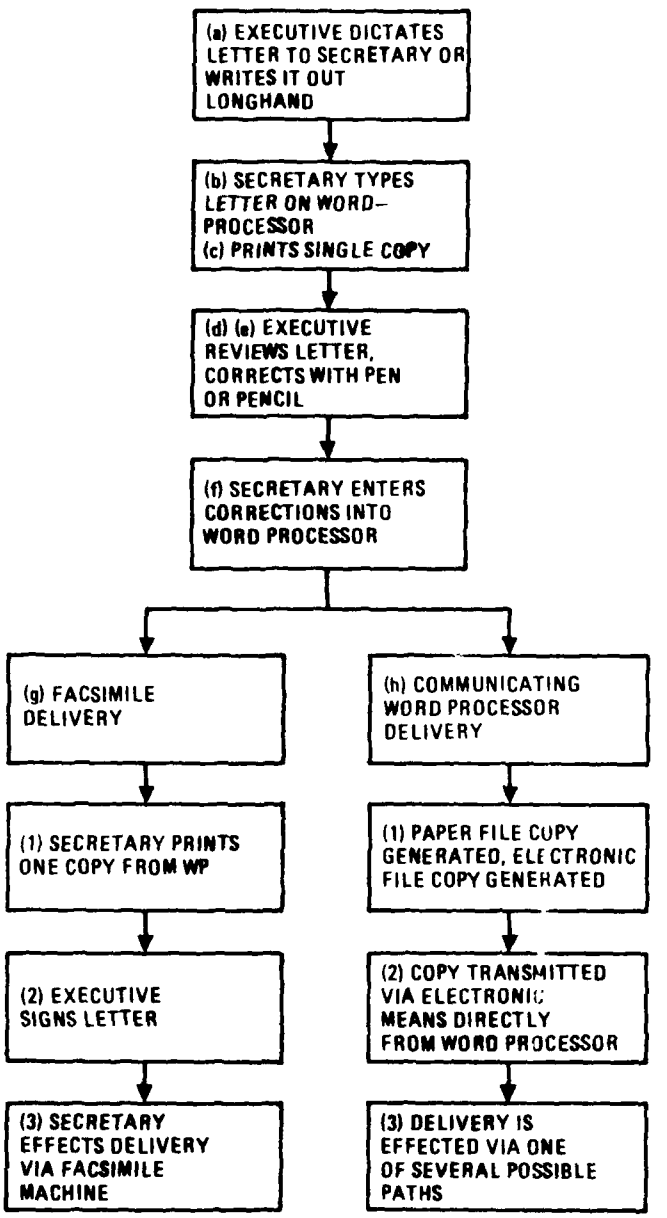

Figure 9. Mail Flow for Example Two

(a) Executive dictates letter to secretary or writes it out longhand.

(b) Secreatry types letter on a word processor terminal which has a cathode ray tube for composition and correction of the letter before it is printed. The word processor formats the letter, supplies the usual salutation and close and any "standard" paragraphs from its memory as directed by secretary.

(c) Single copy of letter printed by secretary pressing "print" key.

(d) Secretary gives copy to executive for review.

(e) Executive reviews letter, making any desired corrections with a pen or pencil.

(f) Secretary enters corrections into word processor using cathode ray tube visual presentation of original letter. Word processor reformats letter automatically.

At this point delivery might be effected in any one of several ways. We will consider two possiblitities:

(g) Facsimile delivery:

(1) Secretary obtains copy from word processor and gives it to executive for signature.

(2) Executive signs letter and returns it to secretary.

(3) Letter is transmitted via facsimile machine to destination. Delivery time varies between almost immediately and overnight depending on transmission system in use.

(h) Communicating word processor delivery:

(1) Secretary obtains copy from word processor and places it in her office file cabinet. A copy of the letter is retained in an electronic memory and may serve as the "file" copy instead of the hard copy on paper.

(2) Secretary presses "mail" key on word processor and letter is routed to its destination automatically via the company's central processor which acts as a switch for all communications.

(3) Letter is delivered to destination via US Postal Service, value added common carrier system or dedicated communications network, depending upon system employed. Delivery time varies from a few minutes to two days.

3.1.2.3 Example three. Lets now consider an example of electronic mail in which it serves as a new way to communicate. We will use the same executive/secretary situation as previously but now the steps go something like this and are illustrated in Figure 10.

(a) Executive perceives a need to communicate with several subordinates located at remote sites and to have their reply within the same day. He overcomes urge to telephone each of them individually. Dictates message to secretary or writes it out longhand.

(b) Secretary types message into her computer based message system (CBMS) terminal, enters a "list number" to indicate required delivery destinations and "mails" the memo via the CBMS by pressing a single key.

(c) Copy of message is placed in executive's electronic in tray - which he may read via a CBMS terminal in his office.

(d) Addressees receive messages in their electronic in trays and initiate replies.

(e) Executive receives replies in his electronic in tray. Secretary may or may not receive copies in her electronic in tray, depending upon privacy key appended to the message. Delivery and reply times are dependent upon systems in use and availab lity of addressees and the required information. A minimum dela' time of fifteen minutes is not unreasonable.

A variation on this scenario would be for the executive to type the memo directly onto his own CBMS terminal, bypassing the secretary entirely. Some executives are willing to do this, some are not.

3.1.3 Electronic mail media. The media for processing electronic mail include facsimile machines, communicating word processors (including intelligent typewriters), computers and their computer based message systems (CBMS), micrographics and digitized voice. Reference should be made to the appropriate sections of this report in order to gain a more in-depth understanding of each of these media and the part they play in electronic mail systems. Digitized

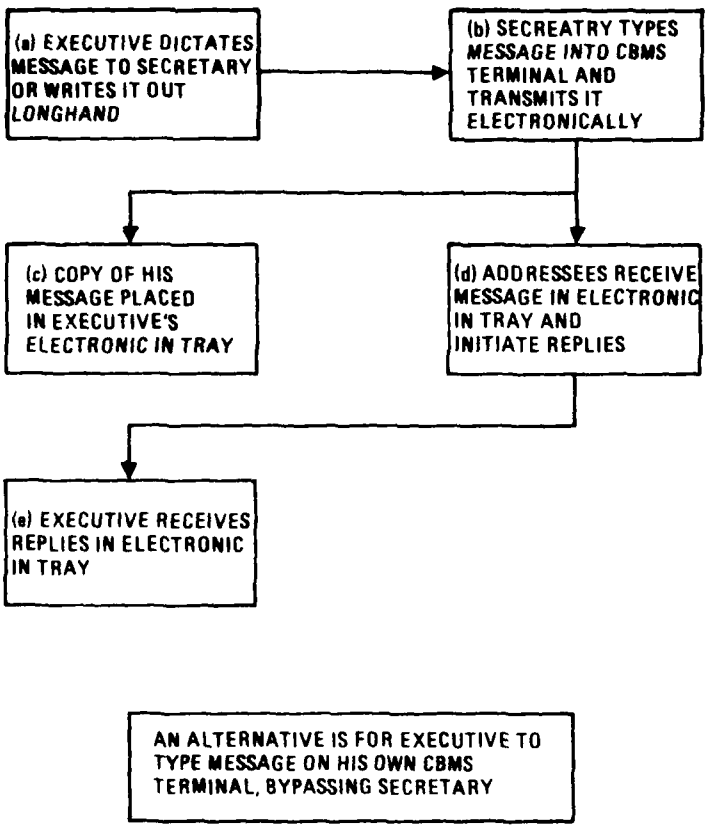

Figure 10. Mail Flow for Example Three

voice is a new and developing technology with little information available. The subject is not pursued in this report.

3.1.4 Electronic mail systems. Electronic mail systems may be divided into three general categories, each of which may be further subdivided. The general categories are facsimile, word processor, and computer based. Each of these systems will be examined in this section and some examples given for the systems in order to convey an understanding of their makeup and capabilities. The communication networks which support these systems are:

(a) U.S. Postal Service Electronic Mail Service
(b) Common Carrier/Value Added Services and Networks
(c) Corporate/Private/Government Networks

The total electronic mail requirements of any given office may be satisfied by any single combination of a system and a network or by any multiple combination of these.

3.2 US Postal service electronic mail service.

3.2.1 Background. Electronic mail is a matter of grave importance to the US Postal Service. It is an issue, the outcome of which will determine, for the long range, whether or not the USPS continues as a viable, nationwide mail service or becomes a small federal entity serving those areas private industry cannot make a profit serving [8]. As this report is written the USPS and private industry are debating their respective postions in the federal courts and regulatory agencies which control the Postal Service and the communications industries. The outcome is not likely to please everyone nor will it be achieved quickly. Descriptions of USPS services in the field of electronic mail as given in this report reflect the Postal Service desires and the expected outcome of the ongoing controversy, at least from the viewpoint available in the press and industry related periodicals.

The Postal Service has lost large and lucrative chunks of business mail to electronic communications. The biggest mail diversion in recent years has been to electronic-funds-transfer (EFT) systems that enable banks, credit-card companies, retail stores, and even private individuals to conduct financial transactions by wire. Part of this loss in business has been as a result of other government agencies attempting to cut their own operating costs. Deposit in banks of Social Security payments and government civilian and military

retirement payments via electronic fund transfer is an example of such cost cutting efforts which also represent an improvement in service. Payments are credited to accounts on the date they are due and the frustration of having checks delayed, lost or stolen in transit is avoided. Also avoided is a trip to the bank by the recipient of the payment.

Letters are the single most important part of the USPS business, contributing nearly 80 percent of operating revenues - more than $10 billion in 1978. This was derived from a volume of 97 billion pieces of mail. Reorganization and automation between 1971 and 1978 allowed the USPS to increase its volume by 12 billion pieces, decrease employees by 80,000, increase productivity by 22 percent and reduce dependency on Congressional appropriations from 24 percent to 9 percent. In spite of these gains everyone still isn't happy with the Postal Service.

The USPS pursues the belief that the only way they can continue to operate as a universal postal service in such a responsible manner is to continue to keep the volume high and the cost per piece as low as possible; goals which will be difficult to achieve unless the USPS participates in electronic message communications.

(a) Improve means of moving the mail.
(b) Help reduce costs of handling mail.
(c) Help reduce costs for customers in preparing mail.
(d) Achieve postage rate stability.
(e) Speed and improve service.
(f) Preserve a viable Postal Service.

3.2.2 USPS electronic mail. In order to examine these objectives the USPS has initiated three proposed new service tests: (1) ECOM, or Electronic Computer Originated Mail, service; (2) Intelpost, an international electronic message service; and (3) an Electronic Message Service System (EMSS).

3.2.2.1 Electronic computer originated mail (ECOM). ECOM, as a sub-class of First-Class Main will enable companies with the message volume and computer capability to tie into receivers in 25 major post offices around the country. The messages then would be delivered anywhere in the country within two days -and the Postal Service confidently expects to deliver 95 percent of the volume in one day after it leaves the sender. It has been estimated that 30 percent

of the present First-Class Mail, including such items as bills and statements, is prepared from a computer-based system. The volume projection for the first 12 months of operation has been predicted as more than 12 million messages with most of the messages consisting of bills originated by utilities, credit card service, and large retailers. ECOM service would be similar to mailgram, which Western Union currently offers in conjunction with the USPS mail delivery service with a major difference being in the delivery standard and rates. Whereas Mailgram provides next-day delivery service ECOM service would nominally require two days. But, because of savings made possible by volume and concentration of certain message processing functions with ECOM service the proposed rate ranges from 30 to 55 cents per one page message, compared with the rate of $1.15 for a similar Mailgram message. The final difference is that Western Union would operate as a contractor for electronic transmission in connection with a service provided by the Postal Service, rather than as the originator of the service. Users will access the WU InfoMaster switch via MTS or WATS lines leased at their own expense.

ECOM will provide USPS selected customers that meet volume requirements (at least 2,000 messages a month, not less than 200 messages per batch) and have the necessary computer capability, a highly reliable nationwide service. The USPS proposes to provide ECOM to its selected customers by using s single contractor who will supply the communications switching and transmission segment of the service. ECOM messages in non-hard copy form (magnetic tape or disk, intelligent terminals, word processors, etc.) will be accepted by the contractor from USPS customers for transmission via the contractor's communications network to the 25 serving post offices (SPO). The 25 SPSs have been selected on the basis of postal mail processing ability to service the ZIP code areas within two postal delivery days of receipt by the SPO. Upon receipt at the SPO terminals, the messages will be printed and enveloped, processed through the normal mailstream, and delivered by a postal employee to postal customers. The network will extend across the contiguous US with delivery provided in all fifty states.

The growth and expansion of electronic mail service within the USPS may be viewed as developing in succeeding generations as portrayed in Figure 11. In Generation I all input to and output from the SPOs is of tangible material, capable of being hand carried. There is electronic transmission only between

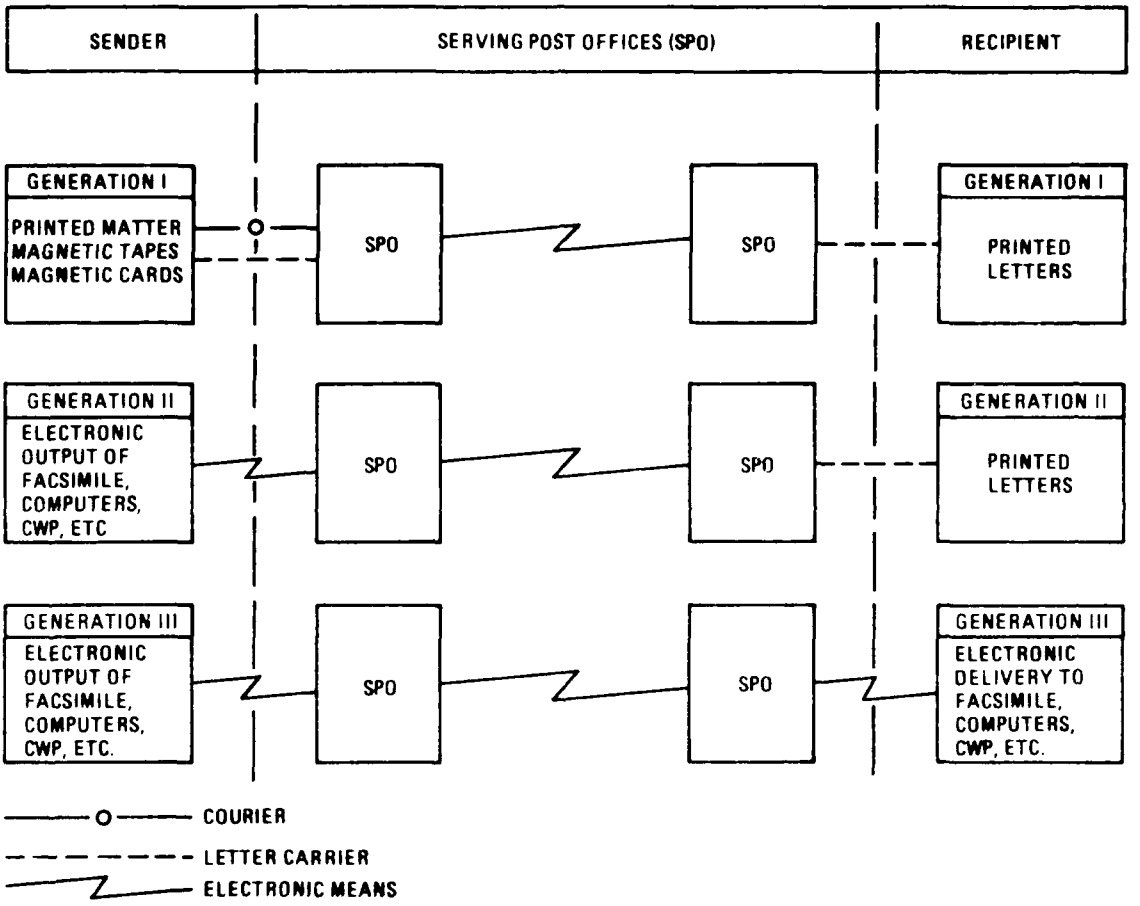

Figure 11. Generations of Electronic Mail Systems Within the U.S. Postal Service

SPSs. In Generation II, input is electronic in nature but the output is still printed matter and delivered by a letter carrier employed by the Postal Service. Generation III provides for both electronic input and electronic output between SPOs and their customers - but the USPS has avowed that it has no intention of developing Generation III and will leave this type of service to common carriers.

The Private Express Statutes grant the government a monopoly in the transmission and delivery of First-Class Mail and the Postal Service intends to stand on its right to be the sole delivery agent for such mail when delivery is in hard-copy form.

3.2.2.2 Intelpost. Intelpost, launched in July 1979 between the US and the United Kingdom, eventually will send facsimile messages between the US and seven foreign countries by way of satellite. The Communications Satellite Corporation - Comsat - is providing technical support under contract on the project. The proposed service would enable customers to transmit and receive facsimile copies of original messages, documents, graphics, and other correspondence. Among the potential large-scale users are people in banking, manufacturing, news and information services, multi-national organizations, and federal government agencies. The possibility exists to expand this service into more than 100 countries.

3.2.2.3 Electronic Message Service System (EMSS). EMSS is a long range program being proposed for a national basis. Much of the exploration work relative to possibility and feasibility of such a system has been conducted by RCA through contract. Conclusions reached are that:

(a) Tying such a system into the existing postal network is technically feasible.

(b) The establishment of such a system would involve a prudent investment risk.

(c) Such a system could provide 95 percent next-day delivery service and do so at rates possibly below today's rates.

(d) The system would use the services of existing telecommunications common carriers.

(e) Target operational date is 1985.

Three different types of distribution are expected: between addressees served by a single Post Office, between addressees using different Post Offices in the same city, and between addressees using different Post Offices in different cities [9].

The concept of operation is that an "electronic mailbox" will be installed in Post Office lobbies, and possibly in shopping centers, for hardcopy intput. The electronic mailbox will also collect the postage and convert the hardcopy via OCR/facsimile to a binary format (e.g., magnetic tape). This input will be collected, perhaps "polled" by the USPS central computer periodically.

A great many of the details pertaining to EMSS remain to be resolved.

There are a number of important points concerning what the USPS does not intend to do concerning electronic mail systems and they are set forth here:

(a) Revenues from other classes of mail will not be used to subsidize.

(b) Congressional subsidies will not be sought.

(c) Application of the Private Express Statutes will be avoided as regards electronic mail systems but the right to deliver hard copy letters when a third party is required for that purpose will be maintained.

(d) USPS will not own or operate electronic transmission systems.

(e) Point-to-point - sender directly to recipient - electronic message service will not be provided. Final delivery will be by hand.

3.3 Facsimile based electronic mail systems. As mentioned above in paragraph 3.1.4 facsimile electronic mail systems may be supported by several different communication networks. An example of a facsimile electronic mail system supported by a dedicated network is given as is an example of a system supported by a value-added common carrier network. Reference should be made to paragraph 5 of this report for a more in depth discussion of facsimile technology.

3.3.1 Dedicated communication network. An example of a facsimile based electronic mail using its own communication network is that of International Paper Company (IP) which operates a company-wide system utilizing 135 facsimile communicators [10]. IP transmits 12,000 pages per month between 80 locations

on 45 automatic and 90 manual facsimile machines. The system serves IP's national, regional, and local offices, lumber, plywood and paper mills, woodlands offices, and packaging plants throughout the United States and Canada. The facsimile network enables IP's regional and national headquarters to receive daily inventory reports from mills, packaging plants and other company locations, many of which are located in remote areas. Payroll information, month end close information, banking transactions, press releases and urgent letters and memos are among the many kinds of documents carried by the facsimile network. Many of the company's operations are located so far from population centers that reliance on frequent mail pickup and delivery or messenger service to handle routine and priority correspondence proved to be totally impractical. Advantages which the company has realized from installation of the system include:

(a) Personnel are not required to stop performance of their regular duties in order to answer an incoming facsimile message.

(b) Many message pages can be loaded in the equipment's document feeder for unattended transmission.

(c) Anyone can use the equipment without special training.

(d) Charts, graphs, drawings and signatures can be transmitted as well as typewritten or printed text.

(e) No re-keying or re-formatting has to be done to transmit a document.

(f) Labor costs associated with electronic mail are kept to a minimum and errors due to retranscription are eliminated.

(g) Existing standard forms and reporting formats were retained.

(h) Material received at the corporate headquarters from field activities may be directly incorporated into executive reports without being subjected to additional processing.

(i) Portable facsimile equipment associated with the system serves as a link between company headquarters and top corporate officers attending the annual meeting, management conferences, and other important conferences. During such meetings there may be as much as three hours per day of facsimile support involved.

The IP communications network includes not only facsimile machines but also data processing terminals, teletypewriters, and other communications and processing equipment.

3.3.2 Value added network. An example of a value added fascimile carrier system capable of providing electronic mail service for those users not requiring their own dedicated network may be found in ITT FAXPAK [11]. FAXPAK is a nationwide facsimile transmission service that combines a computerized store and forward capability and employs packet switching technology. It provides service at a very reasonable rate with nighttime transmission from a one minute facsimile machine in New York to a one minute facsimile machine in Los Angeles-with two hour delivery priority - costing less than a first class postage stamp. FAXPAK offers two delivery priorities - 15 minute and 2 hour - so that the cost of transmission is controlled by the urgency of the document. An overnight delivery feature allows documents to be sent when the receiving office is closed and stored for delivery at the beginning of the next delivery day. This feature also allows taking advantage of nighttime rates and avoidance of peak traffic hours. The system incorporates a patented front end processor which performs the speed, code and protocal translation necessary to let any facsimile machine talk to any other facsimile machine and accepts input from 300 baud ASCII terminals. FAXPAK is capable of handling 'broadcast' transmissions in which a single transmission from a terminal is delivered to any number of recipients. The FAXPAK computer can pre-store individual recipients or entire 'mailing lists' and then call them out with an abbreviated code sent from the transmitting station. Documents directed to a busy receiving machine are held until the receiving terminal is free then delivered. Delivery is made automatically to machines capable of unattended reception and the system persists in attempts to deliver to machines which require operator attendance until an operator is present. The system provides billing which contains a detailed summary of charges by calling or called terminal. The format of the bill is detailed enough to allow allocation of charges to department or customer accounts. Usage charges are detailed below:

Per minute terminal connection charges:

	15 minute delivery	2 hour delivery
Business hours (8am-6pm)	16¢	10¢
All other times	10¢	6¢

INPUT TIME + OUTPUT TIME X RATE = USAGE CHARGE

For a transmission during business hours and utilizing the 15 minute delivery priority in which the input machine was a one minute machine and the output machine was a three minute machine the charge would be:

1 + 3 X 16¢ = 64¢

For a transmission outside of business hours and utilizing the 2 hour delivery priority in which the input machine was a one minute machine and the output machine was a three minute machine the charge would be:

1 + 3 X 16¢ = 24¢

And as mentioned above, a transmission outside of business hours and utilizing the 2 hour delivery priority in which both the input machine and the output machine were 1 minute machines the charge would be:

1 + 1 X 6¢ = 12¢

For remote offices outside of major service areas, there is an additonal 5¢ a minute charge for entering documents on ITT's INWATS lines. High volume users can opt for unlimited use via their own dedicated line for a flat monthly fee of $675. If no message is delivered, there is no charge.

3.4 Word processor based electronic mail system. Word processors range from relatively simple electronic typewriters with a memory to elaborate terminals incorporating extensive operator aid and storage facilities. Some word processors have communications capabilities built in when they are manufactured and others are capable of being adapted for communications, either in the field or in the manufacturer's service facilities. Most manufacturers now offer some communications facility on their latest machines, either as an option or as a

part of the system. Some communicating word processors (CWP) are highly advanced and flexible and can also communicate with compatible mainframe computers, terminals, telexes, TWXs, photocompositors, and other CWPs. Protocol translators, available either as part of the software in a given CWP or as part of the communications network, permit word processors to overcome protocol and code differences when talking with each other and with other devices. Some models of CWPs offer unattended reception with stack paper feeders. A few sophisticated shared-logic systems also offer store-and-forward 'electronic mail'. A number of display-type WPs offer CRT-to-CRT communications so no paper is required. Other can communicate one document while the operator is working on another (called 'background mode' or 'background communications'). There is no question that CWPs will be one of the major office links in future information networks [12]. As of the end of 1978 only about a quarter of the 400,000 word processors in the U.S. were communications capable and less than a quarter of those were using the communications mode, as shown in Figure 10. CWPs tramsmit data over phone lines, microwave links or via satellite at rates that vary - depending on machines - from 60 bps to 9,600 bps. Modems are required at each end unless a digital line is used. CWPs can also be used to enter material into a photocompositor, and in the near future, they will be able to send to and receive from centralized micrographic sites.

Examination of Figure 12 might lead to the conclusion that there is some foot-dragging going on as relates to making use of the communications capabilities now existing or available to word processor users. This reluctance to get involved stems from several sources. There has been considerable difficulty about protocol, codes, and standards, - which are now being overcome. Lack of knowledge and understanding of advantages to be gained by going 'on-line' on the part of users has also been a contributing factor. Many of the most successful communications with word processors is now taking place in systems that were originally conceived of as data entry and intelligent terminals networks, supporting the primarily arithmetic-oriented data processing, rather than the word oriented text editing tasks [13]. The development of communications networks, provided by third parties and available as time-sharing on-demand, or full-time basis allows WP users to go on-line even if their volume does not warrent acquisition of dedicated full-time circuits to support their communications needs.

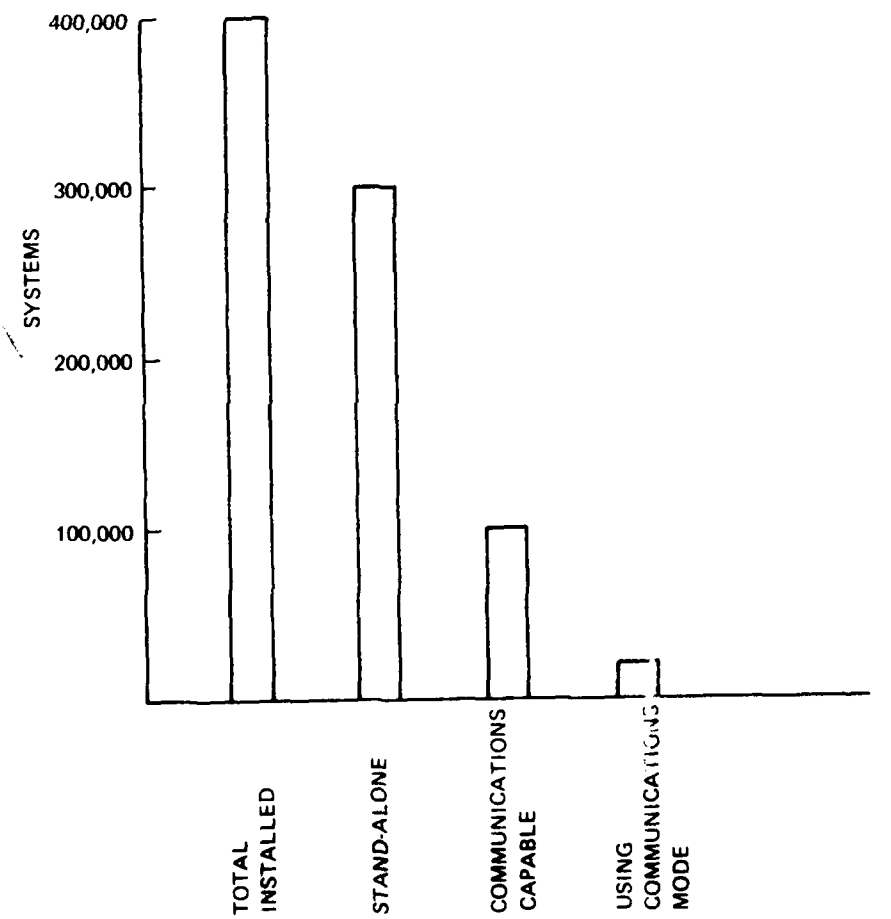

Figure 12. Word Processors as of End-1978

For a more in-depth understanding of word processors and their capabilities reference should be made to paragraph 6 of this report. It should be noted that all CWPs utilized in a network do not have to be of the same manufacturer or model and that their capabilities and capacities may be chosen and employed to fit the requirement existing at a particular work station.

The communications network which supports the CWPs can also be tailored to fit user requirements, a small user may get along quite well with a word processing typewriter which communicates via a dial-up voice grade telephone line to another similar device while the large scale user may require a dedicated full-time data conditioned line in a satellite network.

3.4.1 Example of large CWP system. An example of the way CWPs have been put to work on a rather large scale is that of the First National Bank of Chicago (FNB) [14]. FNB is the nation's tenth largest bank with $25 billion in total assets. They occupy three facilities in downtown Chicago, and operate the largest savings floor in the world. Some 7,600 employees are connected with the bank throughout the U.S. and another 1,500 work in its international network of 71 installations in 36 countries. The bank first installed WP in its legal department jut to do text editing and correspondence. These applications are the same ones initially adopted by most WP users because they are easiest to cost justify. As management realized that those functions weren't the only ones that could be used in different areas of the bank they organized a team of in-house consultants to study expansion of WP to other parts of their operation. As of the end of 1979 twelve divisions were using WP systems, six more divisions were awaiting equipment delivery and twenty other divisions were under study as potential WP users. Figure 13 illustrates a variety of systems architectures adapted to specific needs.

The personnel department uses six CRTs and three character printers cable connected to a CPU to accomplish open-job posting, to store boilerplate material concerning job descriptions, and to answer letters.

Commercial banking and worldwide banking use the system to transfer messages and other documents electronically, some of which were previously created on punched paper tape from Telex machines, in their lending operations with regional offices of the home bank across the country. Commercial banking is

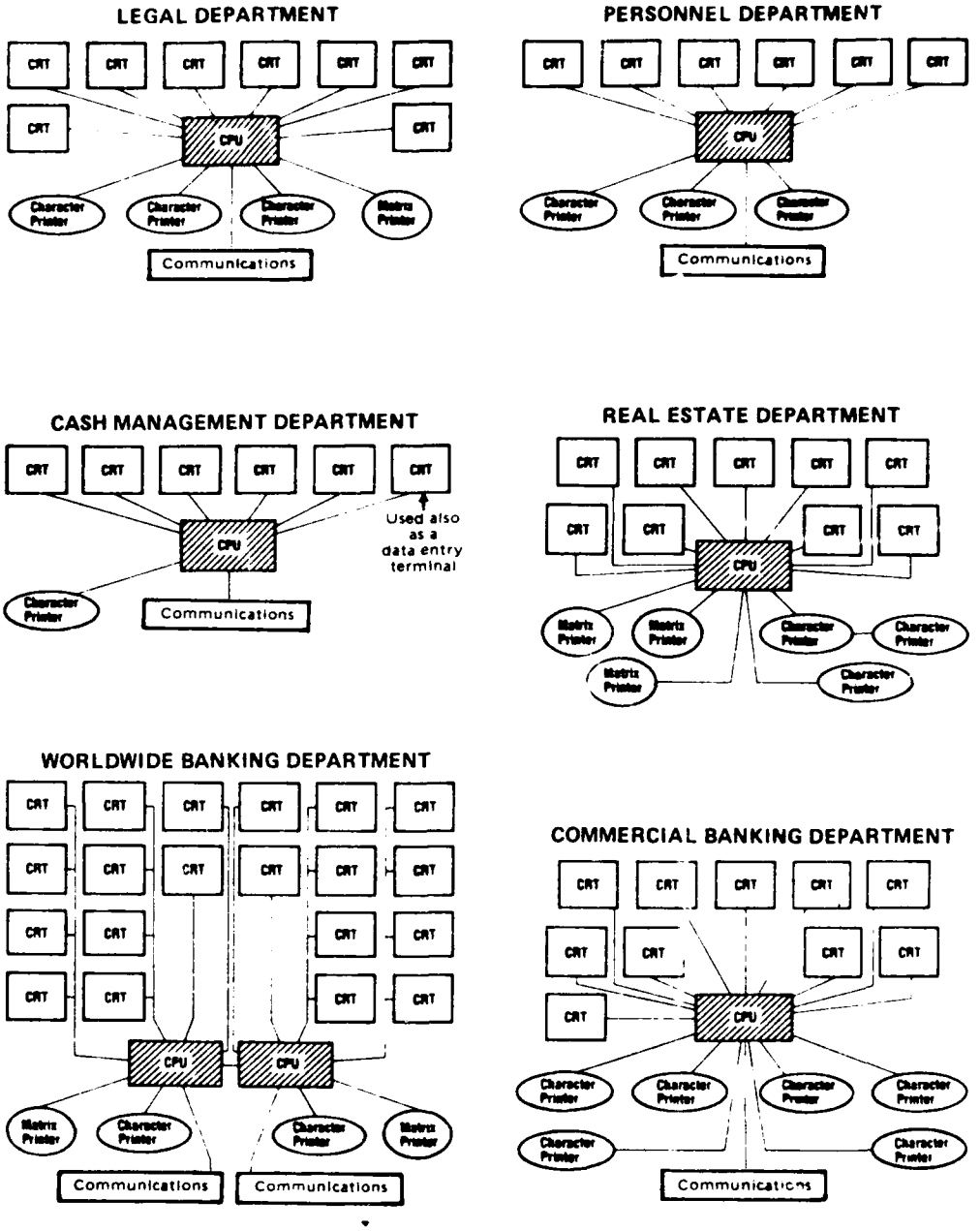

Figure 13. Examples of WP System Architectures.

using 10 work stations and six character printers connected to a CPU. World-wide banking has 20 CRTs and two matrix and two character printers connected to two CPUs.

The real-estate department uses the system to edit documents, create credit commitments, legal documents of all kinds, and both internal and external letters and memos that will need to be revised in the future. To accomplish these tasks, the department operates nine CRTs and three matrix and character printers connected to its CPU.

The legal department, the original user of WP in the bank, uses eight CRTs, one high-speed matrix printer, and three character printers connected to a CPU.

Cash Management performs cash-management studies for several large bank customers, and their system has the ability to call up and display data so that the operator can, in effect, manipulate the data to answer a battery of questions about the cash positions of these companies. Each work station in the system can also be used as a data-entry terminal so that a customer's cashflow information can be put on the bank's main computer system or on an on-line time-sharing system. The cash-management-department system includes six CRTs and one character printer.

FNB has found that they have gained advantages in streamlined work flow, increased output and significant savings in salaries and purchased services. The bank is using word processing in all nine domestic regional offices and also in several of its overseas installations. The bank anticipates the establishment of an electronic mail network in at least the Chicago facilities.

3.5 Computer based electronic mail systems. The concept of computer based electronic mail systems includes a work station, a computer, a communications network, and storage facilities (on-line and off-line). This truly represents more than just electronic mail. It is really a comprehensive management communications system which includes as an integral part electronic mail, document filing and retrieval and administrative functions.

3.5.1 Work station. The work station in many ways resembles a communicating word processor with extensive additional capabilities for interacting with the user, the computer, storage facilities and the communications network. All work stations within a network need not be identical but may be tailored

to the needs of the user at each specific location. A relatively small operation conducted at a remote location would incorporate only those capabilities required in order to meet its requirements while a very large operation supporting a central headquarters might incorporate most or all of the capabilities into a single work station or part of the total capabilities into each of several work stations until all capabilities were utilized.

3.5.1.1 Computer. The computer at a given work station may be scaled to fit the user requirements, being a large capacity central processing unit (CPU), a mini-computer (mini), or a combination of CPU's and mini's interconnected as required.

3.5.1.2 Communications network. The communications network can also be tailored to fit user requirements, ranging from a dial-up voice grade telephone line for local use to a wide-band data conditioned full-time satellite channel employing packet switching techniques.

3.5.1.3 Storage. Storage facilities may range from a disk or diskette located at a simple work station to a large on-line library, "electronic filing cabinet", or data base located at a central site and accessible by many users on a time sharing basis.

3.5.2 System capabilities. We will describe a hypothetical work station and system which incorporates all the capabilities available in the several electronic mail systems and communications management systems which are on the market. It is expected that these systems and the capabilities they offer will be available and intact throughout the period of time under examination and that the changes to them will consist of refinements and some moderate expansion of capabilities while achieving cost reductions [15].

The work station consists of a video display (CRT) and a typewriter-like keyboard with function keys and a numeric keypad for data entry. The video display may be a standard 80 character, 24 line format or may be capable of displaying either one page or a double page of text at the users choice. Either display can scroll horizontally and vertically, forward and backward.

3.5.2.1 Detailed capabilities. A detailed listing of system capabilities is contained in Table 1.

Table 1. Computer Based Mail System Workstation Capabilities

Information processing functions:
Sort
Arithmetic calculations
Shared logic processing
Data processing:
Data input by direct communications or magnetic tape terminal
Reception of data reports from local or remote data sources
Operator aids:
Query language
Fill-in menus
Tab setting at any point in the text
Automatic decimal alignment
Control of reserve space at top and bottom of page
Automatic word wrap
Abbreviation index - typing short abbreviation causes system to automatically print the full text from the abbreviation index
Document reformatting and right margin control
Document indexing
Automatic hyphenation
Automatic underlining of:
Words
Phrases
Sentences
Text proof-reading and indexing
Automatic text insertion from another document
Footnote insertion - footnote automatically appears on the page where referenced regardless of subsequent editing performed, or optionally, at the end of the document

Table 1. Computer Based Mail System Workstation Capabilities (Contd)

Glossary of:

- Formats
- Words
- Phrases
- Paragraphs
- Whole pages

Automatic numbering of:

- Footnotes
- Paragraphs
- Pages

Document file and retrieval: Redundant filing is eliminated and only one copy of a document resides in the data base. The system creates an index record for the originator and each recipient. Users may then file 'their' copy of the document in up to four different filing categories. One user may have an unlimited number of filing categories. At any time, the user can retrieve the document according to any one or more of these categories, as well as by a selection of date, author, or title. In purging document files, each user can designate 'their' copy to be deleted or archived. When a document is archived, it is removed from on-line disk storage and copied to magnetic tape while its' index record(s) remain on disk. When the user wishes to view any document that has been archived, a request is entered via the user's terminal. Upon restoration, a "Document Restored" message is automatically sent to the user's 'intray' when the document has been returned to the disk files.

General file: One user code is reserved to function as a general or central file which is accessible to any user of the system. The originator of a document determines if it is placed in the General File.

Table 1. Computer Based Mail System Workstation Capabilities (Contd)

Security and confidentiality: Extensive security and password control features are contained in the system. No one, other than an originator or a recipient, can access a document on the system. Only the individual users can access their own diaries and notes. Material in a file may be segregated by security classification or 'Need to know'.

Distribution: Messages, documents, or data may be distributed via several channels simultaneously and processing may be carried on at the work station while distribution is taking place (background mode of operation). Messages may be distributed generally, i.e., to one of the user maintained lists in the system, or it can be distributed selectively, i.e., each recipient's ID may be entered separately. The originator can set confidentiality flags which will prevent a recipient from either printing it or redistributing it (forwarding the document to another user). Distribution may be to users on the same central processing unit (CPU), or to users connected to other CPU's in the network, or to non-users via certain private or public communication networks. The user may choose to have the message sent as a printed letter, a telex or TWX, or as a CRT screen display which may be printed later at the recipients discretion. Material distributed through the system does not necessarily have to be a letter or a document but may, with a simple interface program, be data processing reports from other systems or the remote batch entry of data or programs. Distribution within the network may be accomplished by any of several means according to work station requirements and network capabilities. A message may be directly transmitted or placed into an 'electronic mailbox' and distributed by a central controller which polls the network periodically, delivering and picking up messages at the various connected work stations. Polling may be controlled to provide pickup and delivery to and from selected work

Table 1. Computer Based Mail System Workstation Capabilities (Contd)

stations depending upon volume or priority messages, as determined by the user, may be stored in the system and delivered during low usage or low circuit cost times.
Intray: An 'electronic intray' is maintained for each user to receive and store (until some action is taken) administrative notes, messages, telexes, documents, and appointment requests sent to the user by other users of the system. The items in the intray may be read, filed, annotated, forwarded to others, or processed in any logical combination of these activities.
Associated user: Two users may be linked for common document access purposes. This would normally be used for managers and their secretaries. Even in this case, however, there is an "Eyes Only" code which invalidates this link for any given document.
User schedule and diary: Provides a time grid in fifteen minute increments for the current and following months. If desired the system will generate the 'next available' meeting time and date for a selected group of users.
Maintenance of calendar/holidays: Maintains a full calendar file for users of the system to automatically identify significant (user designated) holidays for up to ten countries.
Multiple CPU network: The work station will operate on one central processing unit or incrementally to 35 CPU's in a network. When using a network, the data base on each system is accessible (under password control) by any other user of the system.
Shared logic: Software for the work station can operate and co-reside with any other data processing system on the same hardware configuration.

Table 1. Computer Based Mail System Workstation Capabilities (Contd)

Multiple language capability: Several languages and extensive dictionaries (up to 60,000 words) for each can reside in the system simultaneously with the capability for additional languages being provided through substitution of disk packs.

Printers: A choice of printers is available to satisfy various requirements such as:

- Daisy wheel
- Wide carriage
- Draft
- Image (fiber optic)
- Ink jet

Storage station: The storage station supporing the work station may be:

- Magnetic disk
- Magnetic diskette
- Magnetic tape
- Main memory in the computer

Mail log: Keeps track of mail sent and information pertinent to it:

- Senders name and location
- Document title
- Destination
- Dates sent and received
- Date reply required
- Date reply received

Interface to other equipments: The work station may be interfaced with:

- Word processors
- Photocomposition devices
- Optical character readers (OCR)

Table 1. Computer Based Mail System Workstation Capabilities (Contd)

- Computer output microfilm (COM)
- Audio input and response
- Telex and TWX message switching

Work monitoring and reporting:

- Tickler file
- Record of information flow - usable for:
  - Chargeback
  - Budget control
  - Activity analysis
  - Terminal activity
- Session data includes:
  - User ID
  - Access location
  - Session date/time
  - Number of messages sent/received
  - Number of characters sent/received
  - Total connect minutes
- Message data includes:
  - Sending-user ID
  - Message recipients
  - Time/Date sent
- Phone line usage data including:
  - Traffic
  - Number of calls
  - Duration of calls

Message accounting procedures:

- Pericdic recap report indicating acceptance or rejection of message by communications network and reason for rejection
- Unique system number assigned to accepted messages

Table 1. Computer Based Mail System Workstation Capabilities (Contd)

Messages delivered to a terminal are assigned a sequential number
Delivery report made to sending terminal after all copies delivered to prescribed destination
Time/date appended to messages

3.6 Third party electronic mail systems. Certain requirements for electronic mail may be satisfied by services such as those provided by Western Union [16] and Graphic Scanning Corporation [17].

3.6.1 Western Union. The Western Union Telegram is familiar to everyone and, to the older generation at least, evokes a vision of a boy with a peaked cap, riding a bicycle and rushing to deliver a most urgent message - often containing bad news. The Western Union Mailgram has evolved quite a long way from the boy on a bicycle method of handling electronic mail, and it is from this same simple telegram that all electronic mail has evolved. WU still delivers telegrams by hand in some instances but the more usual method is by telephone. What we are considering here is the InfoMaster controlled network which represents a much more complex and comprehensive service [18]. WU Mailgram service has grown through several steps. Mailgram messages initially were sent only from Telex machines. Telephone-dictated Mailgram service was added, followed by computer-originated Mailgram messages, and direct-access via intelligent terminals such as CWPs. Value-added services such as Business Reply Mailgram, Certified Mailgram, and stored text and address services were incorporated into the system. Figure 14 illustrates a service similar to Mailgram. The heart of the system is the InfoMaster Computer which serves as storage and an interface between the various input media shown and the U.S. Postal Service which provides final delivery. From the viewpoint of the potential electronic mail user, InfoMaster provides, for example:

Peak volume (multiple messaage service)
Busy station (re-dialing service)
Same text to many (multiple address - stored list optional - service)
Off-net (speed and code conversion)
Many texts (stored text service)

Table 1. Computer Based Mail System Workstation Capabilities (Contd)

- Computer output microfilm (COM)
- Audio input and response
- Telex and TWX message switching

Work monitoring and reporting:

- Tickler file
- Record of information flow - usable for:
  - Chargeback
  - Budget control
  - Activity analysis
  - Terminal activity
- Session data includes:
  - User ID
  - Access location
  - Session date/time
  - Number of messages sent/received
  - Number of characters sent/received
  - Total connect minutes
- Message data includes:
  - Sending-user ID
  - Message recipients
  - Time/Date sent
- Phone line usage data including:
  - Traffic
  - Number of calls
  - Duration of calls

Message accounting procedures:

- Periodic recap report indicating acceptance or rejection of message by communications network and reason for rejection
- Unique system number assigned to accepted messages

Table 1. Computer Based Mail System Workstation Capabilities (Contd)

Messages delivered to a terminal are assigned a sequential number
Delivery report made to sending terminal after all copies delivered to prescribed destination
Time/date appended to messages

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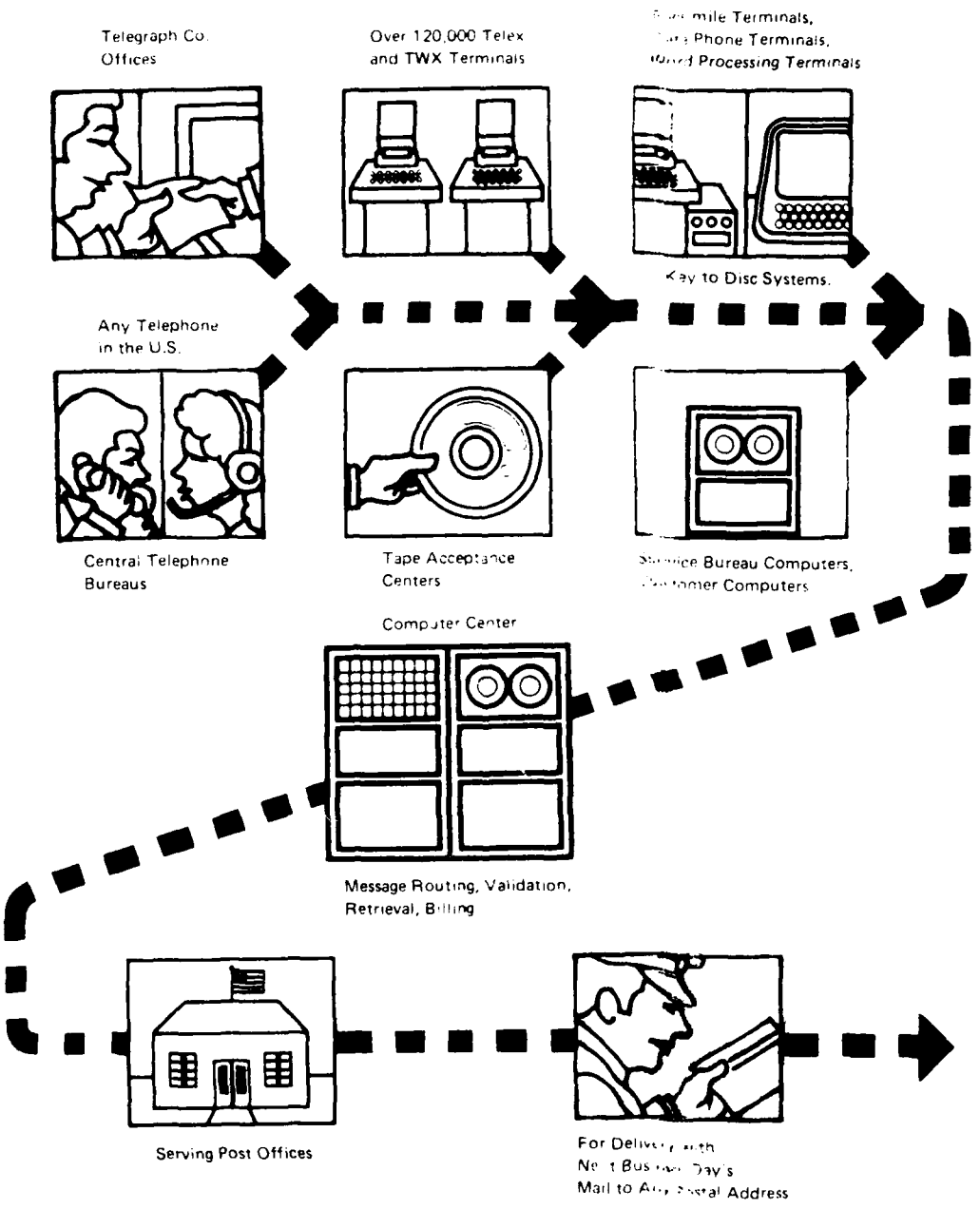


Figure 14. Flow Chart for Messages Handled by a Ma[illegible]gram-like Service [16].

Electronic funds transfer (commercial Money Order and Charge Card Money Order service)

Confirm delivery (certified Mailgram service)

Unequipped correspondents (from telephone to Telex/TWX/Datagram)

Information (FYI News service, including market, weather, news, finance, commodities and so on plus News Alert service, offering automatic (UPI) news bulletins to Telex and TWX users)

Required reply (business reply Mailgram).

Most Telex and TWX messages are transmitted electronically from one machine and delivered electronically to another. Many are originated on customers' computers, which are connected directly into the Telex and TWX network. Other customers have direct connections to the Western Union Info-Master computer complex through which they send many forms of electronic mail messages, and through which many added-value services facilitate the movement of electronic mail messages. Other messages, called Datagrams, are dictated on the telephone to an operator who transmits them to a Telex or TWX machine. Table 2 gives an idea of the electronic mail volume existing in the InfoMaster system.

Table 2. InfoMaster EM Volume [16]

User Message	Typical Weekly Message Volume
Telex	140,000
TWX	110,000
Telegram	340,000
Mailgram	720,000
InfoCom	145,000
Cablegram	70,000

3.6.2 Graphnet. Graphnet and the Graphnet Fax Gram are in direct competition with Western Union and the Mailgram/Telegram. Graphnet is the nation's only computerized digital input store-and-forward-facsimile communications service and offers a wide list of service options to pick from. Graphnet accepts electronic mail from word processors, CRT terminals, Data

Phone, Telex/TWX, or directly from the customer's computer and delivers to all kinds of devices, including facsimile. Services offered include:

Multiple addressing (One message in, many out. Will send the same text with many addresses)

Variable inserts (Messages may be personalized through insertion of different names, dollar figures and other variable information)

Storage (Users may store frequently used forms, letters and lists and effect their transmission through entry of a simple code number)

Information Retrieval (Messages sent via Graphnet may be recalled at any time)

Alternate routing (Messages may be automatically delivered to an alternate device if the addressed terminal is out of service)

Terminal compatibility (Communications is transparent to the terminal devices and assures compatibility)

Management reports (provides message numbers, addressee data, time of acceptance and delivery, users reference data)

Departmental billing (Automatically sorts user charges by department)

Least cost routing (System determines least cost routing automatically).

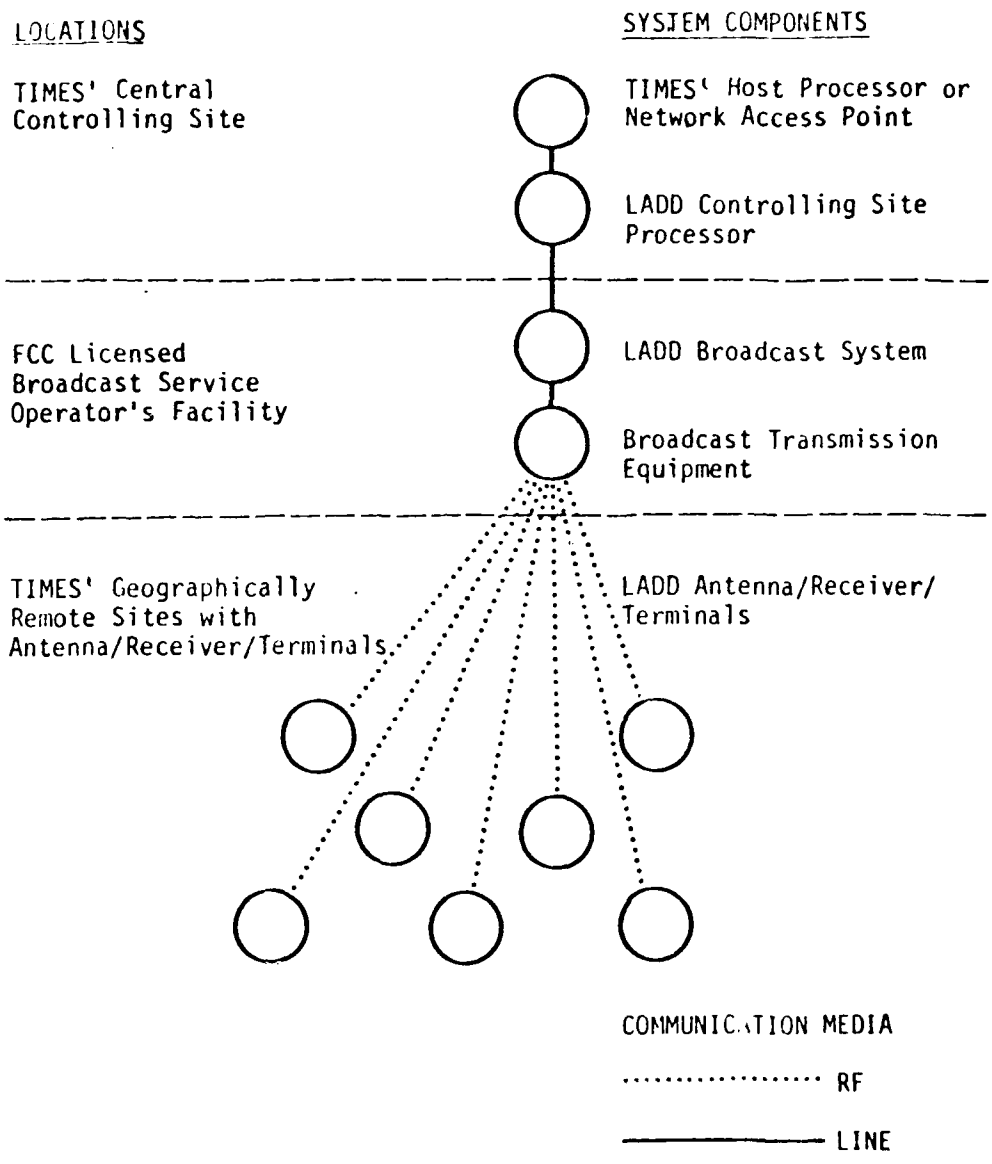
Fax Grams are delivered by hand, phone or mail as well as to the terminal devices previously named.

3.7 Radio network electronic mail systems. A spin-off of electronic mail is the distribution of information via radio networks. An example of this type of electronic mail will be given here but not pursued in other parts of the report. The Los Angeles Times has linked their computerized subscriber service to circulation agents utilizing a low-cost, one-way data communications system operating in voice-grade to wideband channel widths in either the broadcast or point-to-point mode. The system, called Local Area Data Distribution System (LADD) (TM) is interfaced directly into the subscriber service center's central computer, where messages are stored by individual agent identification codes [19]. Polling the computer periodically, the LADD system automatically transmits not only customer complaints and other time-sensitive messages, but also an increasing number of important, non-priority communiques. The LADD system is capable of operating in all three broadcasting modes licensed for data by the FCC -- radio common carrier, FM radio subcarrier frequencies, and Industrial Radio Services. When messages are sent, they travel from computer

storage or direct from the LADD System controlling terminal over leased lines to the transmitter location. There, information is stored as necessary, encoded for broadcast, assigned priority and processed for radio frequency transmission. Special antenna/receivers at each reception point pick their specific signals out of the air; the 120 character per second radio printers process and format the data for printout. The Computerized Home Delivery System hardware which supplies information for transmission of the LADD network consists of a battery of intelligent CRT terminals tied into a host computer dedicated to subscriber service activities. There are more than one million subscriber records in the data base. Terminal operators receive customer calls by telephone, format their messages on the CRT terminals, and input the information to the host computer, which can be polled automatically or given 'send' instructions. With messages coming automatically, agents simply check their terminals periodically, and carry out the instructons they receive. Figure 15 depicts the described system which serves the southern California distribution area of the Times.

3.8 Economic factors. Well documented cost figures relative to electronic mail are difficult to find, due in large part to the newness of the concept and in part to the lack of truly large scale systems.

One company in civilian industry which does have considerable experience in electronic mail and which has made some cost comparisons concerning the subject is Johns-Manville (J-M). J-M has worldwide mining and manufacturing operations in the building, wood, and paper industries, and incorporates seven major businesses: fiber-glass products, non-fiber-glass insulation, pipe products and systems, roofing products, asbestos fiber, industrial products and services, paper and wood products. Corporate headquarters is at Ken-Caryl Ranch near Denver, Colorado [20]. J-M is recognized as a pioneer in the corporate communications field and operated the first company-owned, totally computer-controlled, private line network. In 1978 the company interfaced a shared-logic word processing system into their worldwide network of factories, warehouses and regional sales offices. The word processing system has been in operation since 1975. During the five year transition from typewriters to shared logic, output from the system has doubled, staffing has decreased slightly (temporary help was dispensed with) and the cost per work station has



PRINTER TERMINAL COMMUNICATIONS CORPORATION
LOCAL AREA DATA DISTRIBUTION SYSTEM

LOS ANGELES TIMES

Figure 15. LA Time LADD System

decreased from $900 per station to $300 per station. These points are illustrated in Figure 16. As a part of the move to electronic mail J-M performed an analysis of the various modes of electronic mail available and costs associated with each. The results, demonstrating totals, are contained in Figure 17. The bottom line entry in the table, CWP-MSGSW-CWP, represents the J-M system as it now exists. The company projects a cost decrease from $1.63 to $1.43 per letter with the savings being derived from decreased network connection (14¢) and transmission (6¢) costs. These figures are made more meaningful if viewed in comjunction with an understanding of the size of the J-M system. The J-M system is served by 85 remote terminals linked in a message-switching system controlled by computers. The network and its satellite earth stations are organized in six nodes, each capable of communication with the other. There are 8 computers, 41 terminals, and 19 printers linked in the J-M network that supports the 85 remote terminals. The word processors and the terminals they support are polled, as are the other teletypewriter terminals in the network. Word processors are located in United States, Canada, Paris and Beirut.

3.9 Summary. The possibilities for achieving truly automated information processing and distribution are all contained in the existing computer based electronic mail systems. Application of all of these capabilities will probably never occur in every office within the Department of Defense. Some of them have been incorporated into various offices already. Adoption by additional offices will depend upon the need envisioned by potential users and their ability to develop cost-effective plans to support their needs. The subject of computer based message systems is not addressed in any other section of this report.

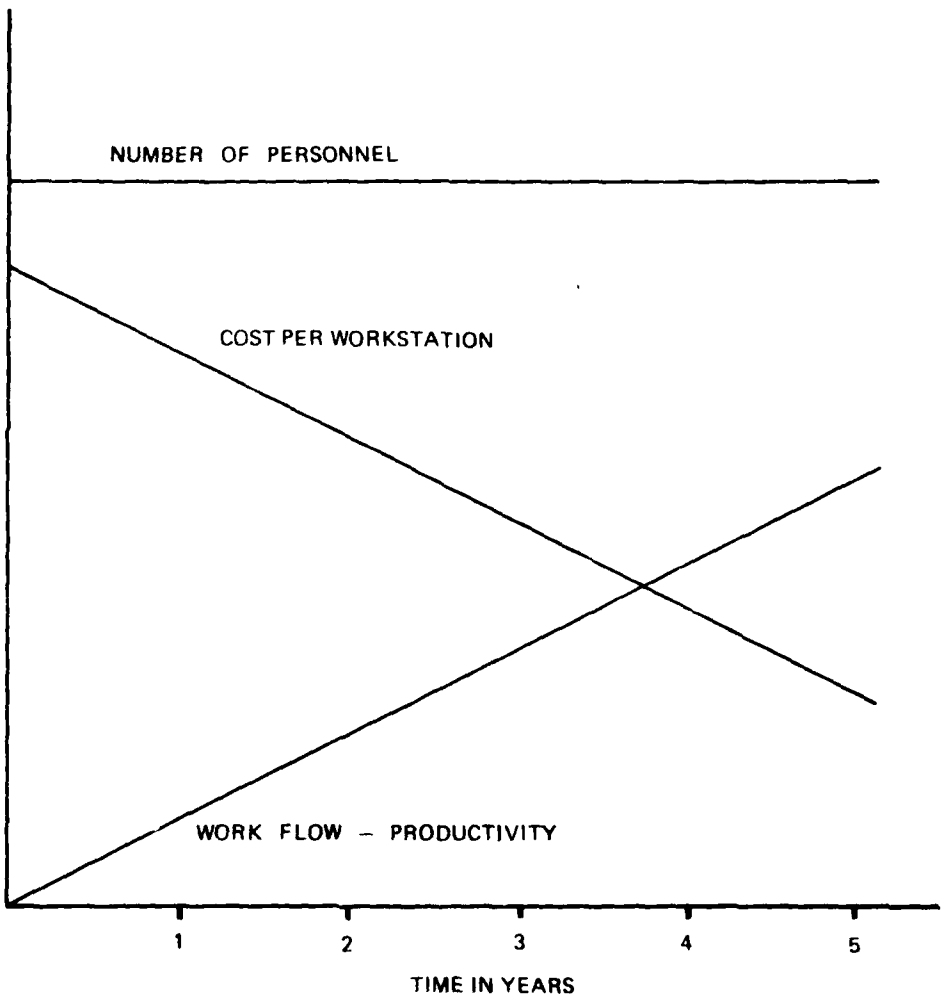


Figure 16. Transition From Typewriter to Shared Logic System

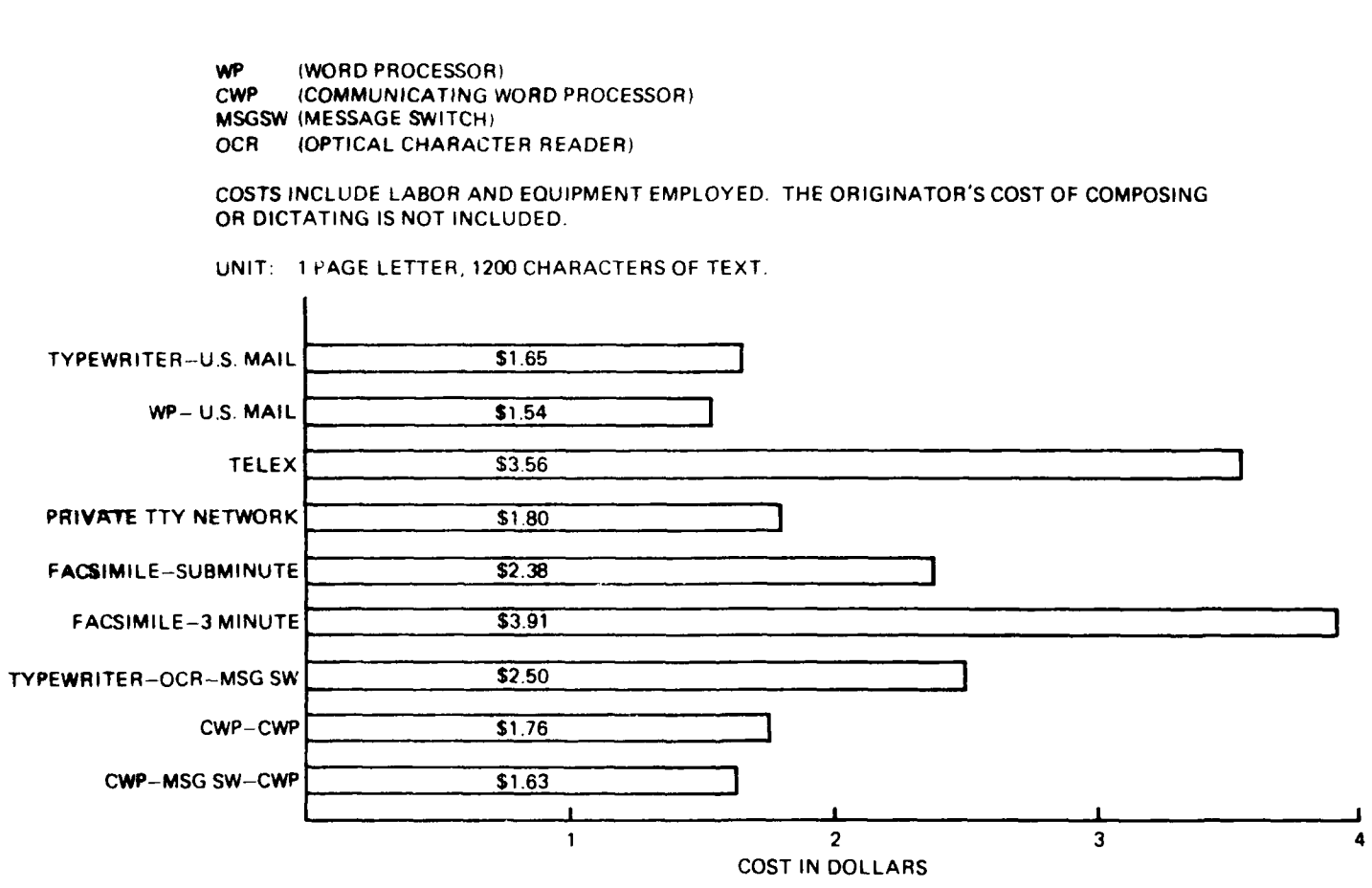


Figure 17. Comparative Costs of Various Modes of Electronic Mail - 1979

4. TELECONFERENCING

4.1 Introduction. The concept of teleconferencing as an adjunct to or a substitute for face to face meetings between individuals has been investigated thoroughly for almost two decades, and in many cases, has been operationally implemented by both Government and private industry.

The primary impetus for these activities has been the desire to accommodate to the realities of organizational decentralization, i.e., the physical remoteness of key individuals within an organization and the travel costs involved were they assembled to confer on important organizational or personal topics.

Teleconferencing is a much more broad and pervasive mode of communications than appears on the surface. Telephone conversations between persons is a restricted form of teleconferencing. Conference telephone calls represent an expanded basic form of teleconferencing. Exchanges of record message traffic are another form, although constrained in terms of spontaneity.

Teleconferencing can be defined as a 'face to face' contact between two or more individuals who are geographically separated and/or separated in time because of schedules, using available telecommunications networks, appropriate terminal equipment and intermediate switching devices (which may possess store and forward memory).

There are several key aspects of the definition which require attention. Conference contact ranges from an exchange of correspondence over distance to physical presence at a meeting. There is also the implication that telecommunications is a substitute for the most desirable communication of all, actual face to face contact (which may or may not be a valid assumption). The dynamics involved in individuals working toward a common goal is a complex issue involving communication in general but not necessarily telecommunications in an engineering sense. Geographic and real-time separation among conferees may or may not be a primary issue. Individuals working on similar problems have been known to occupy adjacent offices without ever communicating. Finally, it should be observed that teleconferencing, since this technology involves communication networks, terminals, and switching equipment, adds a dimension of control and constraint upon interpersonal communications which may or may not be advantageous.

The real value imbedded in this technology may be how to use it to advantage in individual or group interactions rather than as a cost-saving substitute for travel. This is not to say that energy/cost savings might not be enormous if effective telecommunications techniques were developed to further decentralize information processing and exchange, as the office of the future proponents predict. But it must be remembered that teleconferencing per se is another tool which might augment this technology.

The following section will accomplish these purposes:

(a) The state-of-the-art in teleconferencing will be reviewed briefly as a means of providing an over view of the topic. This material is based on several published reports which represent a viewpoint circa 1977. [2], [21], [22]. The material will be organized according to the commonly recognized categories of teleconferencing, i.e.:

(1) Audio teleconferencing
(2) Video teleconferencing
(3) Computer teleconferencing

(b) Since a number of popular articles and books have appeared since that time, on the topic of teleconferencing, recent developments in technology and application will be extracted and presented.

(c) Viewing the topic of teleconferencing in general, comments will be offered regarding the possibilities and limitations of this mode for future DoD application. The discussion will be augmented by observations made of recent DoD field trials of one of the principle teleconferencing methods: computer conferencing.

4.2 Teleconferencing background. Teleconferencing is a generic term covering a variety of communication modes linking two or more conference participants at a distance. Three principal modes have been identified and studied, audio, video, and computer teleconferencing. Linking of conferees between locations, which may be world-wide, is by means of conventional telecommunications channels and equipment.

These modes may be a hybrid combination of methods. For example, audio conferencing may incorporate facsimile to exchange explanatory graphics, video conferencing almost always involves an accompanying audio link, and in some cases a provision to transmit graphics which are beyond the resolution capabilities of TV cameras. Computer conferencing may have to be augmented by side telephone conversations among participants. In practice, the various conference modes tend to be multimedia in nature.

The intent behind employing teleconferencing between remote locations has been to conduct organizational operations without recourse to frequent face-to-face meetings, to reduce the inconvenience of travel, to cut costs, and to improve productivity.

Teleconferencing, as a mode of communications, has been intensively investigated over the last two decades by common-carriers such as AT&T, Bell of Canada, British Post Office, large companies with dispersed operations such as Dow Chemical, General Electric, decentralized banks such as Bankers Trust of New York, Bank of America, and several Government agencies such as General Services Administration, and NASA. Most of these organizations have implemented either test or operational systems.

The DoD has lagged behind the civilian sector in the application of teleconferencing to facilitate its normal administrative business. However, attempts have been made to apply the concept of teleconferencing to command and control, most notably within the National Military Command Authority structure and within Army, Navy, and Air Force organizational units committed to possible combat roles.

It must be recognized that segments of the DoD differ in their criteria as to the requirements and usefulness of such systems. Time lag, utility, and availability would outweigh cost in command and control situations. Cost versus utility would be a primary issue in the conduct of most DoD administrative business.

One of the most successful teleconferencing systems to date has been that used by NASA in connection with the Apollo space program. Initially, eleven remote sites, with a capacity of twenty five or so participants per site, were linked together in a NASA voice network which also had the capability for graphics transmission by facsimile. The network has since been expanded.

Results have been satisfactory and substantial savings in travel costs are claimed. The NASA system is basically an audio-only teleconferencing network whose operation is characterized by extensive preconference coordination and strict observance of meeting protocol.

On the other hand, the attempts by common carriers to market teleconferencing capabilities to users in the public sector has not been notably successful to date, although the attractiveness of such a service (particularly when it offers the advantage of video imagery) seemed obvious at the time of conception. It became apparent fairly early to those concerned with the commercial possibilities of teleconferencing that the human factors involved in multimedia communications rather than hardware or electronic problems would have a significant impact on systems utility and acceptance. The common carriers of the U.S., the British Commonwealth, and Japan have initiated or stimulated considerable research into the behavioral and attitudinal aspects of teleconferencing. The results of this work have only been marginally satisfactory in terms of identifying, for example, the most appropriate teleconferencing modes to use with which conferencing situations, how to optimize the man/machine interface, and predicting user acceptance once systems are implemented.

From our own observations, the most meaningful generalization that can be made at this time concerning attempts to design and implement teleconferencing systems is that the successful ones seem to have stemmed from very pressing and specific intra-organizational communications needs that, because of situational circumstances, couldn't be solved in any other way. The least successful ones appear to have evolved from the notion that teleconference would be an acceptable alternative to the public for face-to-face contact and thus result in savings in travel cost and executive convenience. Both orientations are valid. But in terms of user acceptance and ultimate utility, these orientations in design may be worlds apart and need to be considered in formulating a system for DoD.

4.3 Audio teleconferencing. Audio teleconferencing has been employed since the invention of the telephone in the sense that individuals have been able to confer at a distance. In more recent times, it has been possible to connect more than two persons in a conference by prearrangement with the telephone company. With the advent of Private Automatic Branch Exchanges (PABX) individuals can arrange their own conference calls.

4.3.1 Examples of audio conferencing. Several large civilian and Government organizations have attempted to apply audio conferencing technology to meet their specific needs.

4.3.1.1 Example of civilian effort. An example of a civilian effort to use audio teleconferencing is that of the Bank of America whose key offices are in San Francisco and Los Angeles. To reduce the travel expenses for executives to travel back and forth in order to confer on organizational issues, an elaborate audio conferencing system was set up which could be used on a daily basis between these headquarters. The executives involved were well known to each other (and presumably their vocal mannerisms) so it was deemed an important requirement that the "conference room" atmosphere between the two locations be preserved. This requirement demanded the ultimate in sound fidelity. In fact the audio conference rooms were designed to be acoustically independent of the building structures.

4.3.1.2 Example of Governmental effort. An example of a Governmental effort to employ audio teleconferencing is the network established by NASA to interconnect its engineering centers in support of the Apollo space program. It is a much simpler system in the sense that existing conference rooms are employed without extensive audio conditioning. Some eleven sites were connected via a four wire telephone network, supplemented by a facsimile graphics interchange capability. NASA conferences could accommodate in excess of 250 participants. The system has since been expanded and now has full operational status. With this sort of system, initial implementation costs are high, but NASA reports at least a 25% reduction in travel costs associated with conferences since the inception of the network. See also paragraph 4.5.5.

4.3.2 Issues associated with audio conferencing.

4.3.2.1 Complexity. The typical setting for audio conferences is the organizational conference room equipped with microphones and speakers. The usual number of conferees who may be accommodated at any one facility is about six. Although it is possible to interconnect a large number of such meeting rooms as NASA does, most conferences involve two or three locations.

These conferences facilities range in complexity from studio-like installations with elaborate control of audio exchanges by support personnel, to simple set-ups where the audio is controlled by the conference moderator or simply by the design features of the system, i.e., voice or gain actuated

microphones near each participant. Acoustic feedback and sound fidelity are typical problems with conference room installations.

Table 3 summarizes the characteristics of several audio conferencing systems which have been implemented both in the U.S. and abroad [2].

4.3.2.2 Cost. Audio conferencing is the least costly of the various teleconferencing methods to employ between office locations (with the possible exception of some current computer conferencing services). However, the initial system costs may vary markedly, depending on their complexity and the extent of the network employed. In continuing operation, the maintenance of conference room centers and the purchase of telephone line service determines the on-going costs. Table 4 illustrates typical costs for audio teleconferencing over short and long distances [2].

One of the frequently cited attractions of teleconferencing systems is the potential for savings in travel expenses to attend meetings. This cost factor is of particular interest to Governmental Agencies. Table 5 presents an analysis of potential savings in travel predicted for several agencies and their contractors through the use of teleconferencing in relation to their total travel budgets [2].

It must be pointed out, however, that such estimates may reflect "travel avoidance" as opposed to real travel savings, in that the money saved, in many cases, is used to allow an increase in other non-conference travel [2].

4.3.2.3 Human factors. The various audio conferencing systems which have been implemented were designed with specific requirements in mind. For example, the Bank of America system required complete audio clarity so that executives could recognize each other's voices. The NASA system was built to accommodate large numbers of participants and relies heavily on facsimile graphics transmission to convey information. Public utilities have implemented "walk in" centers to be leased on an hourly basis by a variety of corporate and private customers and, of necessity, have been designed for general utility. The walk-in center concept has also been applied by Government agencies such as GSA to provide services to organizational entities on a first come first serve basis.

Table 3. Audio Systems Characteristics

NAME OF SYSTEM OR SPONSORING AGENCY	LOCATION OF ROOMS	PARTICIPANTS PER ROOM	ACOUSTIC TREATMENT	SOUND AND GRAPHICS CHARACTERISTICS: MICROPHONES, LOUDSPEAKERS, GRAPHICS, AND OTHER FEATURES	VOICE SWITCHING	GAIN SWITCHING	SPEAKER IDENTIFICATION	TRANSMISSION
Remote Meeting Table (U.K.)	London Southend Norwich Manchester Edinburgh	6 or	Yes, moderate	One microphone and one loudspeaker for each seating position, plus additional speaker. Speaker identification by location of sound.	Yes	No	Yes	4-wire conditioned (C2)
National Aeronautics and Space Administration	Total of 17 locations at present, in six states and Washington, D.C.	15-30, some larger	Some, but very little in most rooms	Variable number of microphones, either suspended from ceiling or placed on table. Speakers in or near ceiling. Heavy use of graphics with specific provisions for facsimile transmission and display.	Yes	Yes	No	4-wire (18 rooms) 2-wire remaining rooms
University of Quebec (Canada)	Quebec City Trois Rivieres Montreal Chicoutimi Rimouski Hull Rouyn	10-15, some larger	None	Uses Bell 50A Portable Conference Telephone. Can be set up in different conference rooms. No special graphics, but facsimile and data transmission available.	No	Yes	No	2-wire dedicated circuits
Department of Communications, Canada (two-node experimental audio/graphic system) (not operational)	Ottawa	7	Yes, substantial	Highly directional mikes on floor, isolated from table. One speaker facing participants. Speaker ID with lighted panels. "Wish to talk",: facsimile, and telewriter facilities.	Yes	No	Yes	4-wire music circuits (8 kHz)
Department of Communications, Canada (DOC regional audio system)	Ottawa Toronto Montreal Moncton Winnipeg Vancouver	4	Little or none	Directional microphones, but with voice switching. Few additional features.	Yes	Yes	No	4-wire standard voice circuits
Department of Indian and Northern Affairs (Canada)	Ottawa Whitehorse Yellowknife	10-12	Yes, moderate	2 microphones in center of table, 1 speaker at end of table (end of room), facsimile transmission equipment (3-6 minutes/page).	Yes	Yes	No	2-wire with 4, 8, or 14 kHz option

Table 3. Audio Systems Characteristics (Contd)

NAME OF SYSTEM OR SPONSORING AGENCY	LOCATION OF ROOMS	PARTICIPANTS PER ROOM	SOUND AND GRAPHICS CHARACTERISTICS: ACOUSTIC TREATMENT	MICROPHONES, LOUDSPEAKERS, GRAPHICS, AND OTHER FEATURES	VOICE SWITCHING	GAIN SWITCHING	SPEAKER IDENTIFICATION	TRANSMISSION
General Services Administration	Atlanta Boston Chicago Dallas Denver Kansas City New York Philadelphia San Francisco Seattle Washington, D.C.		Yes, moderate	System is modeled to large extent on NASA system. Ceiling-suspended microphones, loudspeakers in or near ceiling, multiroom capability, broadcast facsimile machines, rear screen projection in some rooms.	Yes	Yes	No	4-wire switched dedicated network
Union Trust Company,	Stamford New Haven	12-14	Some, but very modest	Stereo system using two isophonic speakers at each end to give directional effect. Six fixed position table microphones, facsimile transmission facilities.	No	No	Partial	4-wire 3 kHz (used in pairs for stereo)
General Electric	Schenectady, New York Greenville, N. Carolina	4-6	Little or none	Speakers in corners facing participants, lavalier microphones, simple operation, no specific provision for graphics.	No	No	No	4-wire 3 kHz
Bank of America	San Francisco Los Angeles	16	Very extensive Specially built rooms with non-parallel walls isolated from rest of building.	Extremely natural sound, one or two microphones in center of table, one speaker at end of room aimed over heads of participants. No specific provision for graphics.	No	No	No	4-wire 3 kHz

Table 4. Audio Teleconferencing Costs for Selected City Pairs*, 1977.

	ROOM COSTS	MONTHLY LINE FEE	LINE COST FOR TWO-HOUR CONFERENCE	TOTAL COST FOR TWO-HOUR CONFERENCE
New York/Chicago	$26	$ 760	$ 36	$ 62
New York/Washington, D.C.	26	310	15	41
New York/San Francisco	26	2,408	115	141
Chicago/Washington, D.C.	26	656	31	57
Washington, D.C./San Francisco	26	2,292	109	135
San Francisco/Menlo Park	26	158	8	34

*Assumes 42 hours of usage per month.

Sources: FCC tariffs, California Public Utilities Commission tariff.

Table 5. Generalization of Potential Benefits

AGENCY	IN-HOUSE TRAVEL EXPENDITURES (MILLIONS)	CONTRACT TRAVEL EXPENDITURES	POTENTIAL BENEFITS FROM TELECONFERENCING		
			IN-HOUSE	CONTRACTS	TOTAL
NASA	$ 18 (.4%)*	$29	$11.9	$10.6	$22.5
ERDA	15 (.2%)	60	9.9	22.2	32.1
HEW	90 (.05%)	33	40.5	12.4	52.9
VA	20 (.1%)	--	9.0	--	9.0
GSA	13 (.3%)	--	5.9	--	5.9
DOT	101** (.6%)	1	45.0	0.5	45.5
STATE OF CALIFORNIA	28***	--	14.6	--	14.6

*Percentage of total 1978 budget as proposed to Congress.
**Includes U.S. Coast Guard training expenses.
***1974 Governor's Budget, state communications agency estimates that 52% of travel expenditures could be foregone with teleconferencing.

Out of this combined experience with audio teleconferencing, several human factors considerations which relate to the success of such systems have emerged. These are, of course, generalizations which require further experimental confirmation.

(a) Intra organizational systems designed to specific requirements appear to be more acceptable to conference participants than do the "generally" designed walk-in conference centers provided by utilities or by Government Agencies such as the GSA. This issue may have a very simple explanation - that of convenience, rather than the nature of the system design. It is easier to walk down the hall to the company conference room than to travel to a public conference room whose connections with other cities is circumscribed by an in-place communication network which may or may not correspond with company locations. No travel is required in the former case. Some travel is required in the latter.

(b) The success, that is the accomplishment of conference goals, of the various systems appears to depend on the nature of the work to be accomplished. Audio conferencing systems have very little to offer high level executives over the person to person telephone call, in establishing a "face-to-face" contact for decision making. Audio teleconferencing seems to work best for mid-level problem solvers. But in order for this conference mode to be effective for the problem solver group, a great deal of pre-conference preparation is necessary. The actual "meeting" is structured by an agenda prepared and distributed in advance. Necessary graphics may be distributed before the meeting, or even during the meeting so that each conference group in remote locations knows the information to be discussed verbally. This process short-circuits misinformed verbal exchanges. NASA has been very successful in implementing this sort of audio conferencing. The key element in the system is the multimedia capability of transmitting graphic material back and forth, which seems to enhance audio teleconferencing.

(c) As is the case with all teleconferencing modes, audio teleconferencing meetings are usually more successful if participants actually meet face-to-face for several days prior to an ongoing conference to establish a group dynamic which makes clear the ground rules of the conference. What are the objectives of the conference? How is the work divided up to meet the objectives? Who is responsible (accountable) to see that the work segments are accomplished? Who are the participants? Which ones are leaders, which ones may be predicted to contribute actively, which ones can be expected to contribute little or nothing? The same assessments must be made with regard to face-to-face conferences. It is doubly difficult for conferees at a distance to understand what is going on unless they have acquired some sense of who the players are and their status/capabilities. These comments apply most especially to ongoing conferences with a definite goal, such as a working group charged with generating a report.

NASA conferences tend to be of the "show and tell" variety. Information is conveyed. Questions are asked. Each participating center knows in advance what it is expected to broadcast to the others.

But the real utility of audio teleconferencing may be for working groups to generate some product (a report) which reflects their joint expertise, and a consensus among the group. For this process to work, there is a necessity for each of the participants to know each other prior to the employment of an electronic medium such as audio teleconferencing.

(d) There is a general consensus of experientially based opinion that audio teleconferencing, particularly when augmented by a graphics capability, is an acceptable substitute for traveling to meetings, although the technique lacks the authenticity of true face-to-face contact. It is also generally agreed that incorporating a video link into the process adds very little to the effectiveness of working groups. The method, in

summary, is an adequate means of conferencing, given the constraints of organizational decentralization and the necessity to reduce travel budgets, but would not be preferred over the interactive richness of face-to-face contact.

4.3.3 Audio conferencing trends. As has previously pointed out, audio teleconferencing has been a well developed technology for a number of years and is becoming increasingly utilized by Government and industry.

This trend will continue into the future as private and Government offices become more decentralized not only to combat energy shortages but to increase effectiveness in their operations by locating to take advantage of labor and residential concentrations.

Audio conferencing continues to be the cheapest means to allow physically separated groups to interact, particularly as the costs of communications come down. Its greatest virtue is that its connectivity depends on the telephone system, a vast in-place network which is now augmented by economical satellite links.

Also, the applications of the technique are growing in variety. An example is the linking of isolated communities to urban centers for the purpose of education and providing consultation in a variety of service areas such as medicine.

Audio conferencing, as will be the case with other teleconferencing methods, will come to be regarded less as a unique technology which alleviates the travel burden of busy executives, and more as part of the repertoire of tools available to the modern office to accomplish its information handling and decision-making functions more efficiently. Along with facsimile, communicating word processors, electronic mail, etc., conferencing methods will become part of an integrated office system during the 1990's.

Several specific trends are seen developing:

(a) Increasing use will be made of digital voice technology to implement audio conferencing. This approach allows voice encryption to be employed, an important requirement for DoD applications and also in the civilian sector where more corporations are becoming conscious of information security.

In the past, digitized encrypted voice systems were of minimally accepted quality so as to detract from the recognition of the speaker. Current systems are quite acceptable and improvements in this technology are predictable.

(b) There will be an increased use of "desk top" audio teleconferencing, whereby the conferee employs his telephone or speaker phone to interconnect with a number of other participants. This communication mode is made possible by the extreme flexibility of modern office PABX systems which allow conference calls to be set up with ease. Conference interchanges thus represent the maximum of convenience since the worker does not have to leave his desk to assemble in a conference room. There is also an advantage that all of his information files which he may need in support of the conference are accessible in his own office. Multimedia features are also possible since other desk top devices such as facsimile, a CRT terminal, and a Picture Phone could also be included in the executive's personal office system.

4.4 Video teleconferencing. The basis for video teleconferencing systems is the television camera and TV monitor accompanied by an audio channel. The video and audio signals may be exchanged over high information capacity communication lines (or satellite transponder links). Slow scan and freeze frame TV requires considerably less bandwidth.

The attractiveness of video teleconferencing is that it is most similar to face-to-face contact experienced in actual meetings. There is an intuitive feeling that this media would come the closest as a substitute for actual human confrontation in meetings and therefore would experience the greatest user acceptance in lieu of travel.

4.4.1 History. The history of video conferencing, as is the case with audio conferencing, spans almost two decades. Experimental and operational systems have been developed nearly as extensively as audio conferencing.

Table 6 lists several of the systems which have been deployed along with their characteristics [21].

Table 6. Video Systems Characteristics

NAME OF SYSTEM OR SPONSORING AGENCY	LOCATION OF STUDIOS	PUBLIC OR PRIVATE	DATES OF OPERATION	DATE OF FIRST PUBLIC OPERATION	NUMBER OF STUDIOS	MAXIMUM DISTANCE BETWEEN STUDIOS (MILES)	NETWORK CONNECTIONS	VOICE SWITCHING	TRANSMISSION	STATUS
Bell Canada	Toronto Ottawa Montreal Quebec City	Public	1968 to present	Trial basis now, public use expected	4	450	One-to-one, any combination	Yes	4 MHz black and white	Operational
Bell Laboratories	Murray Hill Holmdel	Private	1967 to present	--	2	35	One-to-one	Yes	4 MHz black and white	Operational
Confravision (U.K.) (British Post Office sponsorship)	London Manchester Birmingham Glasgow Briston	Public	1967 to present	1971	2 1 1 1 1	394	2 at once or 3 at once, any combination	No	4 MHz black and white	Operational
Confravision (Europe) (Swedish and Dutch PTT Sponsorship)	Stockholm Malmo (Sweden) Amsterdam	Public	1974 to present	1974	1 1 1	(Stockholm to London)	One-to-one	No	4 MHz black and white	Operational
AT&T Intercity Visual Conferencing System	New York Washington Chicago	Public	1974 to present	1974	3 1 1		One-to-one	No	1 MHz black and white	Operational
First National City Bank (Not operational)	New York	Private	1960 to 1972	--	4	4.2	One-to-one	No	4 MHz black and white	Not Operational
Bankers Trust Company (Not operational)	New York	Private	1963 to 1968	--	2	4.2	One-to-one	No	4 MHz black and white	Not Operational
Australian Post Office	Sydney Melbourne	Public	1969 to present	1975	2	400	One-to-one	No	4 MHz black and white	Operational
British Columbia Telephone (Canada) (Not operational)	Victoria Vancouver	Public	1974 only	6-week experiment, no full public use	2	57	One-to-one	No	4 MHz	Not Operational
Dow Chemical Co.	Midland, MI Freeport, TX	Private	1974 to present	--	2	1,200	One-to-one	No	4 MHz Color	Operational

The capability provided is usually limited to a camera giving a view of the conference room, cameras which show individual participants when they are speaking, and another camera reserved to view graphic mateial. The audio problems of acoustic clarity and avoiding unwanted feedback still remain. As in TV station operations, the success of the conferences may depend on the skill of studio personnel who select, filter and present information. Also, the high cost of channels to support conventional video was considered a deterrent to wide-spread use.

These deficiencies were recognized early in the development of video conferencing, and attempts were made to remove some of the obstacles.

For example, AT&T is a pioneer in this field and introduced the Picture Phone. This system was originally intended to augment telephone conversations between individuals by presenting a head and shoulders image of the person one is conversing with but has since been extended to conference use. The system employs a limited video bandwidth (1 MHz as opposed to 4 MHz). This was possible because the individual being photographed by the camera is normally expected to remain relatively motionless. (A capability to record active motion faithfully without blurring requires a higher bandwidth.)

AT&T saw the possibilities of marketing the service, but was delayed in its implementation because the high capacity communication network to support the system was not yet in place and would have required a very large investment to implement. AT&T has since established a limited network.

An innovative attempt was made by the General Electric Company to design an acceptable TV video system also limited to 1 MHz bandwidth, called Sample Dot. The experimental system demonstrated acceptable TV pictures in terms of both image and motion fidelity. The project was deferred because of uncertainty as to its market potential and the cost of further development.

Slow scan TV, which employs voice channel bandwidths, is a possible alternative to live video as an adjunct to teleconferencing. RCA Global Communications has been marketing such systems. Slow-scan TV transmits the images within seconds. A typical application is the transmission of medical x-ray photos, electro-cardiograph traces, and pictures of a patient's injuries. It is extremely useful in connecting remote locations with a central medical facility for diagnosis. The application of the technique to teleconferencing

has not been fully explored, but it might prove useful in the transmission of high resolution graphics and in giving a visual picture of the conference setting and of the individual participants at significant times during their discourse.

There is a technical distinction between slow scan TV and freeze-frame TV although both employ voice bandwidth channels. Slow scan TV transmits a real-time video image seen by the camera. If the subject moves, there is motion blurring as with a photographic time exposure. Freeze-frame TV records a frame instantly, stores it, and then transmits the image at a rate consistent with the band width of the channel. The significant difference between the two systems is the complexity of terminal equipment, freeze framing being much more costly. The latter system lends itself to digitizing and offers possibilities of data compression and encryption.

A few companies have developed full video bandwidth conferencing capabilities between remotely located office centers. Dow Chemical is an example. They have established a 1200 mile link between Houston and Detroit, utilizing backup channels employed by Network TV.

4.4.2 Costs. The primary element of cost is the requirement for the 4 MHz bandwidth needed by conventional TV video systems. And this must be doubled in an interactive system where two locations are interconnected. This cost constraint usually limits the number of sites which may participate in conferences to two or three. Also, there is the problem of availability of high capacity lines between the locations. Video conference rooms are expensive to design and maintain and may require an operational staff comparable to a TV studio to function properly.

For example, the Dow Chemical Company is implementing its video conferencing system between Houston and Detroit and has estimated that the costs per month would be $30K for fifteen hours of use. In comparison, direct travel expenses for each person traveling between the two sites are about $800. If one includes the cost of lost executive time while transiting from one location to the other, travel costs per person would be much higher. Considering the multiple man-trips involved in transporting their many executives to face-to-face conferences in these two locations, Dow concluded that this video conferencing approach was cost-effective.

Table 7 shows one estimate of the relative costs of video, audio, and telephone conferencing modes between distant and close-by locations [22]. These data are presented to convey the relative magnitude of costs to support the various systems. But it is suspected that in the next decade the cost variability will be somewhat reduced, i.e., that video and audio conferencing costs will be less disproportionate. This will mean more freedom of choice in the selection of multimedia approaches to the specific requirements of a particular conference situation.

Table 7. Video, Audio, and Telephone Conferencing Costs for Two-Hour Teleconferences (Dollars) - 1977.

TELECONFERENCING MODE	CITY PAIRS			
	NEW YORK/ SAN FRANCISCO	CHICAGO/ WASHINGTON, D.C.	NEW YORK CITY/ WASHINGTON, D.C.	SAN FRANCISCO/ MENLO PARK
Video	$780	$420	$300	--
Audio	141	57	41	$34
Telephone	26	26	26	3

Sources: Current tariffs, SRI

The table indicates that if current trends continue, video teleconferencing will be 5 to 7 times more expensive to implement than audio conferencing and 30 times more expensive than the use of the telephone.

However, communication costs will decrease along with the costs of computer equipment to switch and process the signal. Also increased demand due to energy conservation efforts will presumably make these markets more competitive.

Also, the high cost of video conferencing has encouraged the development of walk-in centers for public use as opposed to private corporate networks. Although less convenient to use, they are somewhat more economical.

For example, AT&T, retaining its Picture Phone concept, has established conference facilities for the public in the following cities: San Francisco, Los Angeles, Chicago, Detroit, Pittsburg, Boston, New York, Philadelphia, Washington, D.C. and Atlanta. The Picture Phone system has been set up in what has been previously described as a typical studio arrangement: overview camera, individual participant cameras, and a graphics camera. Costs vary according to the locations connected but approximate costs are $5 per minute ($300 per hour). As has been pointed out, these are walk-in centers which must be scheduled in advance. Conference interconnectivity is limited to two cities at a time. And the participants must travel to the studio locations.

Another company which is emerging as a competitor in this market is Sony Video Communications.

4.4.3 Issues. Most of the significant technical and human factors issues surrounding any form of teleconferencing apply to the video mode.

How to make conferences conducted at a distance over communication lines true to real life, face-to-face situations, is a never ending challenge. Technical innovations and human factors research are ameliorating some of these obstacles in a mechanical sense. Remote video conferences will undoubtedly approach face-to-face encounters in realism.

Video systems add to the communication effectiveness of remote conferences and enhance user acceptance to some degree by virtue of being truly multimedia in character and adding more realism through the visual sense. A key research question continues to be to determine how much additional value is gained by their employment over the audio conferencing systems The answers have been ambiguous, probably because video coverage of the proceedings of meetings held in the confines of two interconnected conference rooms, accommodating a limited number of conferees, still retains a studio-like atmosphere and fails to duplicate all of the visual cues which are experienced in an actual face-to-face meeting. The concept of video conferencing creates many expectations of a real-life atmosphere for meetings which are simply not met in practice, regardless of the ingenuity of system designers and leads to disenchantment on the part of the user.

What may be overlooked as a key issue is that the real thing, the face-to-face conference of the old days was not all that optimum to begin with in

terms of getting work done. The new conferencing modes forced on us by a preoccupation over travel costs, may or may not enhance a process which was inherently bad.

Perhaps an examination and improvement of basic conference dynamics would be more cost effective in the long run than an effort to increase the realism of teleconferencing through technical means.

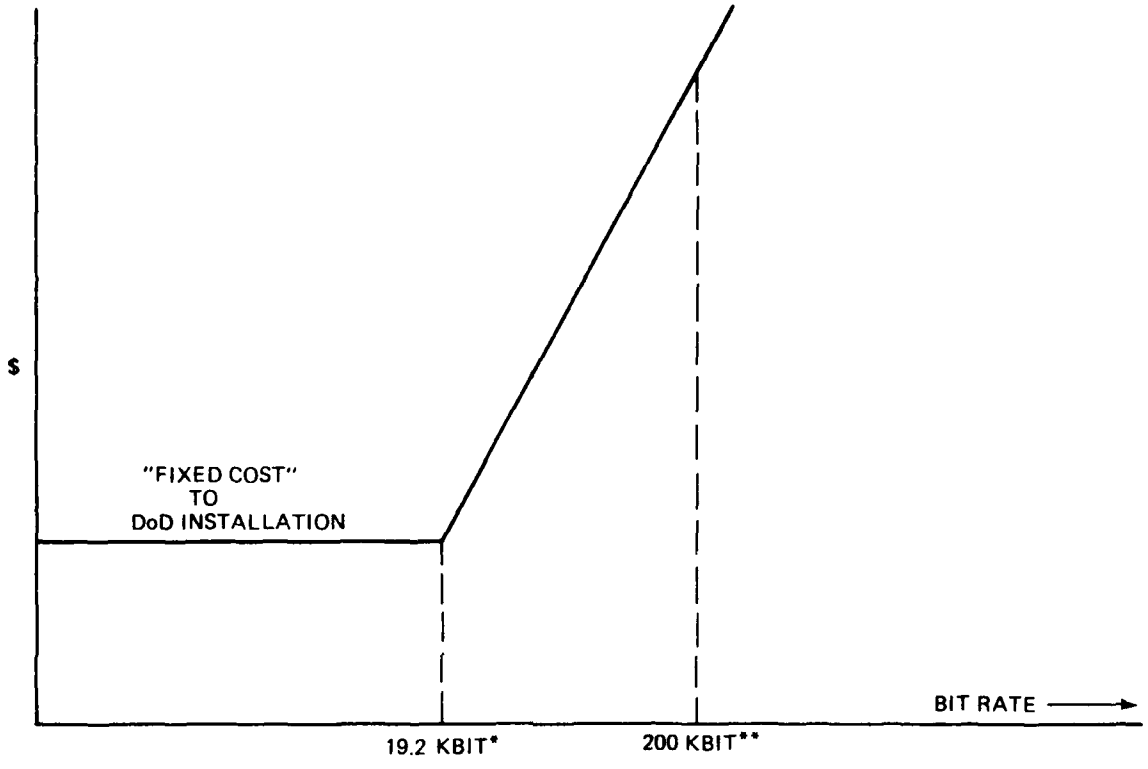
However, the fact still remains that large organizations including the DoD are being forced by circumstances into the teleconferencing mode. The civilian sector will usually be the first to realize the advantages to be gained from employing very sophisticated communications and terminal equipment, a few years in advance of the administrative portion of the DoD.

4.4.4 Trends. Audio teleconferencing may have reached its peak in terms of technology and utility. Video teleconferencing, on the other hand, still stimulates the imagination as to its ultimate applicability. Given the hard reality of curtailed travel opportunities to go to conferences, the ability to see other conferees via television will be perceived as better than not seeing them at all, and hence will be experienced as highly desirable.

Costs will deter many DoD offices from officially requesting the implementation of video systems. But, as is the case with FAX, it is envisioned that many individual DoD offices will experiment with the technology and bootleg useful systems out of their budgets, tailored to their specific needs.

A significant factor exists within the DoD by virtue of its extensive in-place communications network; i.e., AUTOVON, which may encourage a widespread employment of slow-scan/freeze-frame video for many uses including video teleconferencing. Figure 18 demonstrates an unique DoD communications phenomenon brought about by the way AUTOVON is costed to individual facilities.

The figure indicates the almost exponential increase in line costs to support added capacity. What is interesting is the knee in the cost versus bit rate function created by the existence of AUTOVON networks into most DoD installations which incur only a fixed cost to facility. The use of only 2 AUTOVON lines (which is not an undue expenditure of communications resources) could support a reasonably fast freeze-frame video system for conferences and/or the transmission of high resolution pictures.



* Equivalent of 2 AUTOVON lines which would support slow scan video at a frame rate of 1 frame/17.5 seconds.

** Order of magnitude increase in bit rate at greatly increased cost which would support video at a frame rate of 1 frame/second.

Figure 18. Cost Versus Bit Rate Capacity

What is seen here is the potential for the widespread use of video systems in the same sense as convenience FAX is currently being used by many DoD offices.

4.5 Computer teleconferencing. Of all of the teleconferencing techniques, computer conferencing is the most recent to come into its own unique application and useful development.

The history of computer teleconferencing starts essentially in the late 1960's with the attempts of the Office of Emergency Preparedness to appreciate the impact of national crises such as the Administration wage-price freeze of 1971 and the oil embargo of 1973. The problem was to assemble in the shortest possible time information pertaining to these crises and the informed consensus judgements of experts as to the best way to respond and apportion limited resources. The task clearly involved the rapid handling of information and the solicitation of expert opinions. Computer teleconferencing was invented, so to speak, in these series of crises. Page printer-keyboard terminals or CRT terminals, communication links with a computer, and a computer, programmed to store, retrieve, and display the required information were primary elements of the system. A concise history of computer conferencing development is presented in the Network Nation, Chapter 2 [4].

4.5.1 Features and operation. The technique of computer conferencing involves the following elements.

A communication network, such as TELENET or ARPANET, is required to connect the user's terminal with a computer.

The host computer is necessary to facilitate and implement the conference exchanges as well as providing storage and retrieval capabilities. The aim of the programmers of this computer is to make, as much as possible, the system completely transparent to the user. That is, the host computer must adhere to the behavioral patterns and language syntax of the user to perform its function effectively.

The basic feature of computer teleconferencing which makes it most useful is that it provides a facility to exchange message traffic between conference participants as well as a means of storing and retrieving comments and voting responses to questions which are posed by a conference moderator. The mode is ideally suited to the application of the Delphi technique which is used to

gain a consensus of expert opinions on a given subject. The delphi method examines initial responses to questions and then narrows the universe of discourse so that participants are forced to vote their judgements on highly focused issues.

Ideally, the process continues until a consensus rather than a majority opinion on a subject is reached. The method may be used for varying purposes ranging from converging on an agreement on the individual paragraphs of a position paper to a consensus on a goal oriented policy statement, or an informed judgement forecasting future developments in a technological field.

The mode of operations of such conferences is a mixture of real-time communications and an on-going, non-real time exchange of ideas. The time frame for computer conferencing is on the order of hours, days, weeks and months rather than the immediacy of face-to-face conferencing. Participants have the opportunity to assimilate what has gone before in the conference, reflect, and then carefully compose their answers.

The following description sumarizes the various styles of computer conferencing which have developed [23].

STYLE 1: "The Notepad". Style 1 conferencing typically involves unstructured groups and a discussion with multiple topics lasting several weeks or even months. It is almost entirely asynchronous with little interpersonal interaction. The simplest example of this conferencing style is the "notepad" activity of scientific research groups.

STYLE 2: "The Seminar". Style 2 conferencing addresses a specific topic. The most common example is the research seminar or open conference which involves asynchronous usage, possible with periodic synchronous interaction, and which lasts approximately two weeks to a month.

STYLE 3: "The Assembly". Style 3 conferencing is an extension of Style 2. The group can be very large (up to hundreds or even thousands of users), and multiple topics, all related to a single general theme, are considered in separate parts of an agenda. This is the style of a "general assembly" of a major professional society, in which papers are presented, panels respond to questions from an audience, and general discussion takes place.

STYLE 4: "The Encounter". Style 4 conferencing represents the closest computer analog of a face-to-face meeting, in which participants are synchronously discussing a topic for a short time (usually a few hours), possible with role assignments among the participants (as in simulation and gaming) and with some degree of intensity.

STYLE 5: "The Questionnaire". Sytle 5 conferencing involves an unlimited number of participants in a structured question-and-response format. The most common application of this conferencing style is the questionnaire survey, with Delphi and open voting at opposite ends of the spectrum of possibilities. Typically, no direct message exchange is allowed among participants, whose responses are entered anonymously. The conference may last from a few hours to a few weeks.

4.5.2 Costs. Typical costs involved to engage in computer conferencing are as follows:

(a) Acquisition of a terminal device which will cost about $2000 to buy or $100/month to lease. This kind of terminal would be a keyboard-page printing type with acoustical coupler to interface with conventional telephone lines, exchanging information at 300 baud. More elaborate terminals may be used, but a simple, portable terminal is adequate.

(b) Subscription to a centralized computer service designed to handle teleconferencing exchanges between its subscribers. Typical costs for this service are on the order of $70/month.

(c) Use of a communication network to interconnect the user with the teleconferencing host computer. For example, TELENET offers an extensive in-place packet-switched network which provides input ports in most urban areas. Remotely located subscribers may use an in-WATS number to access the TELENET communications network. Typical line charges for communications are on the order of $4/hour for users in CONUS who are located within local-call distance of an access port. The charges for remotely located subscribers outside the U.S. (for example, Hawaii and several cities in Europe) will be much higher.

The cost for the terminal and the computer service are independent of usage. The communication service is usage-dependent.

The price charged for the conference computer service assumes the use of the features already designed into an existing system. Modifications to the basic program to tailor the service to the specific needs of certain customers such as the DoD would require additional programming costs, payable to the organization offering the computer service.

An organization offering such a service is the New Jersey Institute of Technology. The designation of the service is the Electronic Information Exchange System (EIES). One of the principals involved in this effort, Murray Turoff, was formerly associated with the Office of Emergency Preparedness during the 1973 oil crisis and pioneered the development of computer teleconferencing techniques.

The ARPA network with its access to a number of host computers, for example the USC computer in Los Angeles and its teleconferencing program, provides an alternate system for computer conferencing to DoD subscribers. The ARPA communications network exists at a "fixed cost" to DoD subscribers in the same sense that AUTOVON is available at a fixed cost. Subscription to any given host computer and its facilities requires a fee, but this cost usually is absorbed into the DoD activity overhead, within limits of prescribed usage. Teleconferencing technology has been rapidly developing within the ARPA network, primarily as a result of interest from the scientific community within the universities and consulting firms affiliated with Government projects. But this capability could be developed to meet specific DoD requirements with some redesign effort.

AUTODIN II, also a packet-switched network, could easily provide the backbone communications for a computer conferencing capability between DoD offices.

4.5.3 Issues. As with other teleconferencing methods, computer conferencing is worthy of intense psychological investigation. The medium of computer teleconferencing is still in the formative stage, that is, it could be structured to conform effectively with the needs of remotely located conferees who are constrained not to travel. Since this mode is tentative in its ground

rules and structure, there are possibilities to engineer computer teleconferencing for maximum benefit. EIES is actively engaged in exploring the human problems of teleconferencing. (See chapter 3 of "The Network Nation") [4].

One of the attractions of computer conferencing therefore is that there is a possibility of employing improved group dynamic principles as an alternative and perhaps more effective method other than the usual face-to-face encounter. This possiblity exists because the method is so novel and is not yet an inflexible part of our usual conference behavior.

Whatever the advantages of computer conferencing as a technology, there is a danger that DoD personnel will discover the utility of such systems as a rapid, informal message exchange capability and thus fail to see its advantages as a unique adjunct toward improving conference behavior.

If a DoD facility has the justification and/or inclination to subscribe to packet-switching and host computer systems for computer conferencing they will use the capability to advantage and particularly the "mail box" feature. Ingenuity has already bridged the interface gap between commercial systems and the ARPA network. Thus, message access is almost world-wide and it can be used in preference to the normal DoD message procedure, and definitely in preference to the military mail system.

These impromtu solutions, which circumvent normal communications channels, are symptoms which point to an inadequacy in existing communications procedures. If one can't communicate within the provided capabilities and the rules normally imposed on official communications, then knowledgeable DoD employees will find a way around the impediments. A case in point is the proliferation of informal, not accounted for, FAX machines used by the Government agencies to circumvent message and mail delays.

4.5.4 Future potential. Computer teleconferencing was originally conceived as a medium for the free exchange of ideas between conferees and the convergence of a consensus over key issues. It is a leisurely process, not requiring real-time interaction and responses. As a communication technique, it has the virtue of simplicity. The only requirements are a terminal, and a telephone line. One can interact and contribute at any time by dialing a telephone number, placing the handset in an acoustic coupler, and applying a simple protocol for accessing, entering, and using the system.

There is an informal and improvised DoD network with a great deal of capacity already in place to perform scientific tasks as well as the function of computer conferencing. It is a hybrid system, DoD and civilian, carried on at least cost within the constraints imposed by the formal policy of Government Communications doctrine. To date, the capability has been used by the "insiders" who understand the "system" and know how to use it to accomplish their specific goals.

By the 1990's there will be a widespread need to employ some form of computer conferencing among most DoD offices as a substitute for travel because of the increasing energy shortage. Also, the advantages of this form of conferencing will soon become apparent to most users for handling many situations where it is important to "be there" and being perceived as "contributing" to the conference. It is almost effortless as a process, with a little prior training, and it is inexpensive.

Computer conferencing has a very high potential to replace face-to-face contact in meetings. There are several distinct advantages: 1) one doesn't need to be physically present at a meeting and suffer the indignity which often results from either winning or losing in personal confrontation, 2) when one asserts worthwhile opinions, these are a matter of record; and 3) the desired degree of anonymity or visability at "meetings" is a matter of personal choice. The psychological dimensions of computer conferencing are thus completely different from other conference approaches and conceivably could be optimized.

These features are not characteristic of audio or video conferencing, both modes being real-time in character.

Whether or not productive work can be accomplished via computer conferencing in DoD application is a question for investigation.

4.5.5 Department of Defense (DoD) tests. Recent tests have been conducted by the Defense Communications Agency (DCA) to appraise the utility of computer teleconferencing for DoD application.

The tests provided a means for two ongoing communications working groups, one concerned with defining the architecture of world-wide digital systems and the other assigned the task of drafting MIL-STD-188-115, to conduct their

deliberations via a computer conferencing network in lieu of attending face-to-face meetings.

There were approximately twenty participants in each group representing most of the major Army, Navy, and Air Force commands concerned with these communication topics. Their geographic locations were widely dispersed, some participants being as far away as Europe and the Canal Zone. Clearly, successful conferencing via computer means would point to possible travel cost savings.

The communication network employed was a hybrid mixture of TELENET, AUTOVON, WATS, and the ARPANET, with the necessary interfaces being arranged for the purposes of the conferences. The EIES program refered to earlier was employed as the functional tool needed to implement the conference exchanges, utilizing EIES control computer facilities.

The computer conference test has just concluded and the evaluation of the effectiveness of the method is underway. Some preliminary results will be presented here. First however, a brief description of the structure of the conferences will be helpful.

Both conferences required the drafting of documents. Sections of the documents were composed and distributed to participants, via the network, soliciting comments, and suggested alterations to the text. As items in the documents were finalized, these were submitted to the membership for approval, usually through a voting procedure. The processing was essentially asynchronous, i.e., non-real time and continued for about six months.

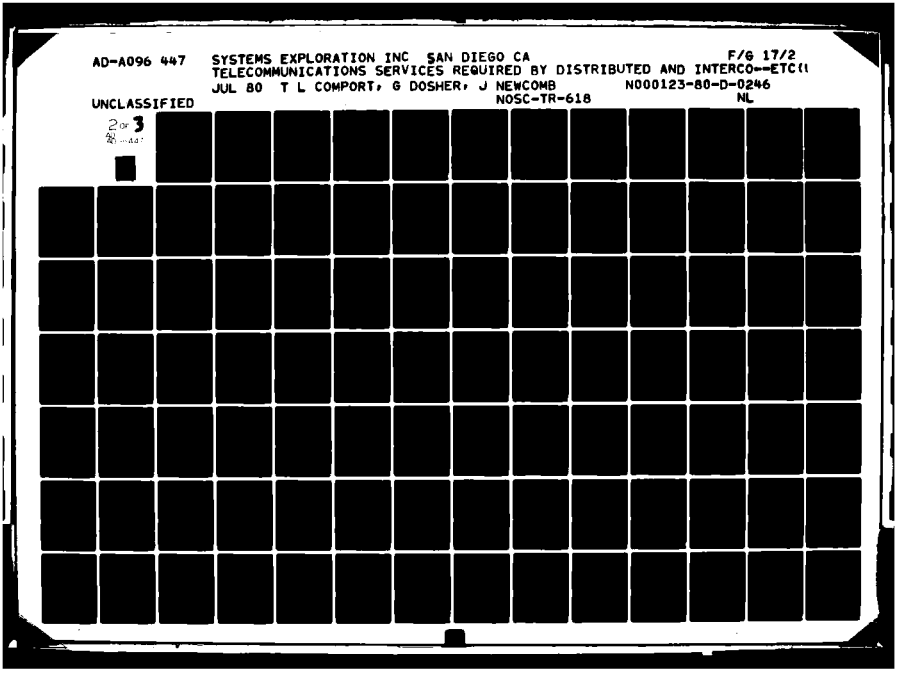
The EIES system provides many features and capabilities, but the key ones are as follows:

(a) Capability to send and receive messages, text, and comments among members of a group participating in a conference.

(b) Capability to send and receive general messages within the network.

(c) A "scratchpad" for composition and editing of text before being sent.

(d) A "notebook" wherein individuals may store the textual material they generate, individually, but which may be transferred to the general membership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(e) Storage areas to preserve general text, for example, documents being prepared.

(f) Storage and retreival features which allow access to material on the basis of item numbers, key word descriptors, dates, names, etc.

(g) Capability to vote on items in a conference.

4.5.6 Preliminary results of DCA test. The following list of general observations may be made with regard to the DCA computer teleconferencing tests. These comments are preliminary and are contingent on a final detailed analysis:

(a) There were administrative and logistics problems associated with starting up the conference. That is, in solving the communication network interface problems, insuring that all participants were equipped with terminals compatible with the system, etc. This process caused some delay but in general was handled satisfactorily. The cost was approximately $25K to put a system, including EIES, in place for the use of some forty participants.

(b) Indoctrination of participants in the features and use of the system was handled by the distribution of a clearly written user's manual. The basic functions of logging in, signing off, composing and sending messages and comments, receiving messages and comments, accessing individual messages, etc., could be mastered in several hours of practice. The query response nature of the system, that is, leading the user systematically through a series of options and choices in order to arrive at the desired function, may have proved to be too time consuming for the busy executive who also had the responsibility of participating in a conference. There are many tricks and shortcuts which may be used to reduce the time of user-system interaction. However, these require considerable practice and knowledge of the system to employ, probably beyond the motivational level of the average participant. Although EIES has been thoughtfully human engineered for a wide variety of users, the time element

involved for the busy and relatively uninitiated DoD user may have affected the participation level of individuals in the conference.

(c) The single most significant problem encountered with the teleconferencing system concerned voting procedures. There were more complaints and expressions of frustration about this system feature than any other. The procedure was simply too cumbersome and time consuming for the busy, casually trained user to tolerate. The original EIES system was designed with the idea that conferences would consist of much discussion and voting on relatively few issues. The DoD conferences dealt with a minimum of discussion and voting on many items. The problem was compounded by the rule that there must be at least three voters on any item for it to be resolved. Unfortunately, there were so few conference participants who could or would persevere in penetrating the procedure, that there was a growing list of unresolvable items in each conference.

(d) Figure 19 presents the usage statistics recorded at one point in the conference procedings in terms of number of times participants logged on into the conference process and the total number of hours used by participants in conferencing. The table is interesting in what it suggest by way of user participation. There were three conferees who didn't participate at all (this may have been because of logistic problems). There were two members who used the system extensively, probably the conference moderators.

One interpretation of the tables is that many conferees tried the system (logging on) but curtailed their use of it (hours of use) and that several continued to employ it thereafter. A questionnaire has been distributed to explore this process, but the results have not yet been analyzed. It is important to point out that the participation pattern is very similar to that encountered in face-to-face meetings. There are the

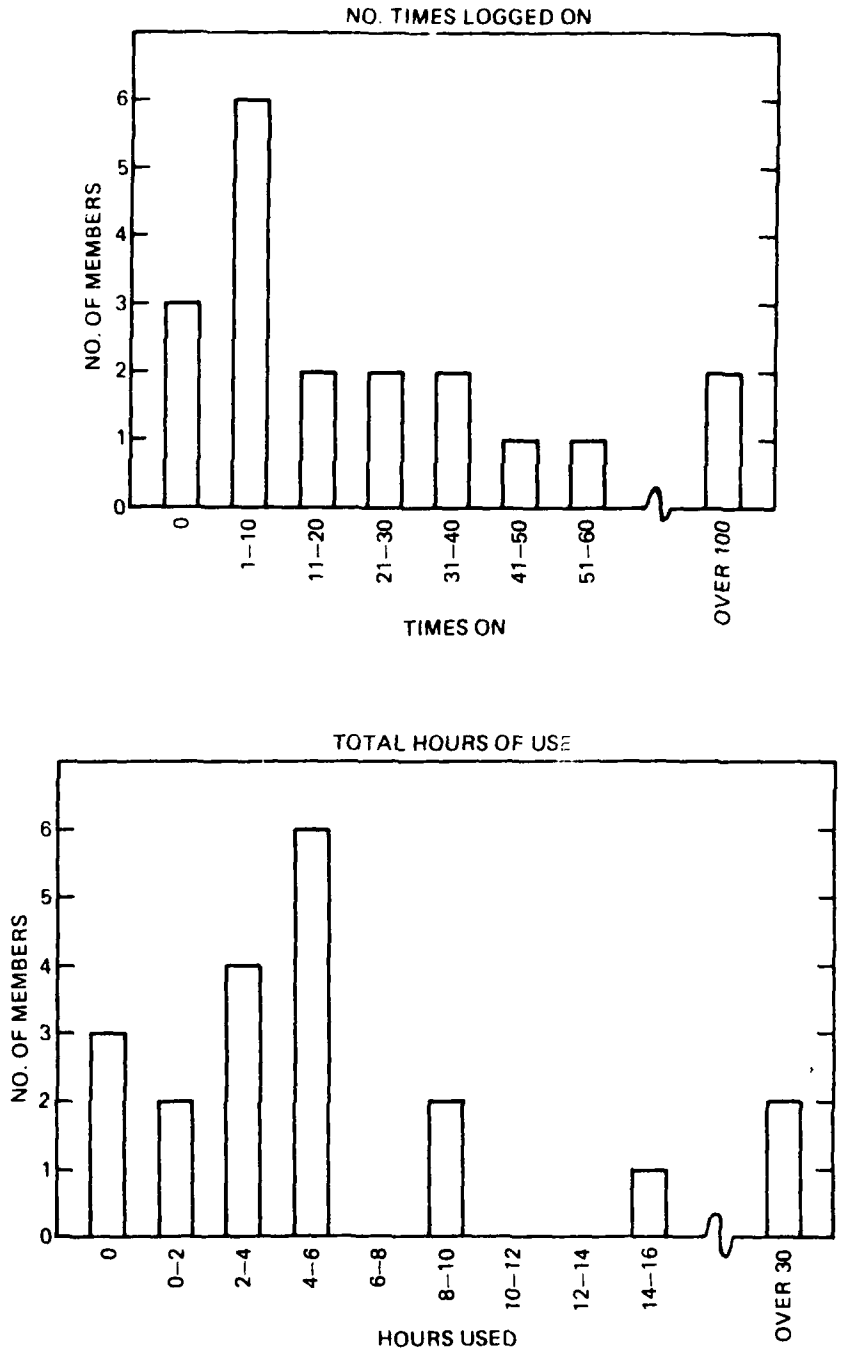


Figure 19. A Sample of User Activity Statistics for DoD Field Test

leaders, several active participants, occasional participants, and non-participants.

(e) Most, but not all, of the conference members had previous face-to-face contact with each other in the working groups. However, time pressure and travel costs precluded an initial meeting to explain the objectives, process, and final goals of the computer conference. This omission may have significantly influenced the outcome, as it would in the success of any face-to-face conference.

(f) In a specific sense, the perception of the success of the teleconference was mixed, many reactions being negative. In spite of this, the issue of the general applicability of computer conferencing within DoD was viewed positively, given that the technique can be modified to facilitate specific applications.

4.6 Summary Observations.

4.6.1 Review. The basic technology to support teleconferencing in its various forms is well developed and has been tested in actual usage for many years. Audio, video, and computer conferencing are acknowledged to be feasible as acceptable alternatives to typical face-to-face meetings. The proliferation of teleconferencing is directly correlated with the growth of sophisticated and inexpensive communication networks, and increasing travel costs.

It is generally recognized that the teleconferencing media cannot exactly duplicate the phenomenon of face-to-face meetings. It is also recognized that the new forms of conferencing may open up opportunities for improving the productivity of groups by stimulating an examination of the basic dynamics of human processes that occur in media specific "meetings" and how to improve these toward accomplishing work goals more effectively.

Of the teleconferencing methods, full bandwidth video systems are almost prohibitive in cost in relation to audio and computer conferencing. High fidelity video does not add enough additional realism to the conference to justify the high cost. Digitized, compressed video and freeze frame video appear to be acceptable, less costly alternatives.

Services such as the Satellite Business System (SBS) offered by the American Satellite Corporation may provide sufficient flexibility in scheduling and compacting digital traffic at least cost to accommodate the teleconferencing requirements of many organizations along with their other data needs.

4.6.2 A look into the future. An overriding theme in discussions of teleconferencing is that the technique may offer a cost savings in travel. Perhaps the issue might be more realistically stated to emphasize the notion that teleconferencing in the future may be the only feasible means for people who are geographically separated to meet, given that long distance travel and even local trips, will become prohibitively expensive and inconvenient.

This perception, in a positive sense, has stimulated thinking about imaginative new ways of doing business within organizations which doesn't require extensive travel and commuting back and forth.

Telecommunications technology, as envisioned in the next decade or so, is giving rise to new concepts such as "Office of the Future," the "Electronic Office," the "Automated Office," the "Global Village," etc. These futuristic ideas have as a basis the marriage of computer and communications technologies to facilitate information exchange at a distance and to change that last great bastion of labor intensive human endeavor: the traditional office wherein executive, clerk, and typist alike gather each day between certain hours to perform information handling, processing, and decision-making tasks in inefficient ways.

The ultimate vision is to convert such activities into a cottage industry where there is no legitimate requirement in information handling businesses for executives or workers, given appropriate terminals and a central computer, to leave their residences to perform required tasks.

If this is to be the future trend, as is likely, according to the authors of many articles in semi-technical, popular publications, then teleconferencing emerges as an extremely important element in the office systems of the future, because it is the closest equivalent to human contact. Interactions between people have always been considered as essential in the traditional office as probably will be the case in future offices. The electronic media will be required to help provide this human dimension.

There are counter-arguments to the futuristic trends being proposed for business operations, most of them involving human factors. In general, these may be summarized as follows:

Future office concepts imply that fewer people will be needed at a time when our social and political system may require labor intensification rather than the opposite. Extensive decentralization to conserve energy does not take into account that many people require the traditional office atmosphere for psychological survival in their complex family-business lives. Many people are incapable of imposing structure and self-discipline on themselves and hence would be unable to work independently in an effective manner away from a traditional office where supervision is directly experienced. Futuristic offices, in concept, are often perceived as downgrading human values and depersonalizing human communication.

With regard to teleconferencing, specifically, there is a widely held view that the process is almost useless in furthering human negotiation, persuasion, and bargaining and is more suited to handling routine business.

Several popular articles present a cross-section of recent viewpoints with regard to the Office of the Future concept and the role of teleconferencing [24], [25], [26].

5. FACSIMILE

5.1 Definitions. For purposes of this report the definition of facsimile as stated by The Institute of Electrical and Electronics Engineers [27] will be used: Facsimile (in electrical communications) is the process, or the result of the process, by which fixed graphic material including pictures or images is scanned and the information converted into signal waves which are used either locally or remotely to produce in record form a likeness (Facsimile) of the Subject Copy.

5.1.1 Terms. The terms analog and digital as used in this report refer to the signal transmission method (machine output) and the following definitions apply:

(a) Analog. The amplitude of the output signal is continuously proportionate to the stimulus, the proportionality being limited by the resolution of the device.

(b) Digital. The output signal represents the size of the stimulus in the form of a series of discrete quantities which are coded to represent digits in a system of numerical notation.

5.2 Background. The term facsimile, or FAX, is firmly established in the minds of many people as descriptive of a rather simple machine and process used to transmit news photographs and weather maps from one place to another by electrical means. For many years that was indeed the primary function of FAX but it has recently been expanded to include the transmission of other specialized graphic and narrative information. Invented in 1842 by a Scotsman, improved in 1850 by an Englishman and made practical in 1902 by a German, facsimile is the second oldest electronic communication device. The first commercial facsimile network was in operation in Europe by the year 1907.

The growth of facsimile over the past fifty years has been slow but now in 1980 it seems to be expanding at a rate so fast it is sometimes described as an explosion. By 1970 there were a total of 24,000 facsimile installations in the United States and, inspired by Xerox's technological developments in the low priced analog machine market, industry analyst predicted a total of 200,000 facsimile installations by 1975. Instead, the number only reached 100,000 units and the growth rate was slow until the advent of new technology machines brought forth through the development of microprocessors and high speed digital transmission of the signal.

Facsimile is a communications technique that generally falls between the mail system and other methods of page transmission, e.g., teletypewriter. In this position, facsimile has such a broad range of applications that future utilization is almost unlimited. One of the previous limiting factors on the growth of facsimile was the high relative cost per page transmitted as compared to the mail system. Increasing mail costs and delivery delays within the U.S. Postal Service coupled with decreasing costs associated with facsimile have had a positive effect on the movement toward greater utilization of facsimile for transmission of time sensitive material. The telephone company's adoption of a one minute rate, and development of facsimile machines capable of transmitting a page with extremely high resolution in as little as 20 seconds has now made the per page transmission cost by facsimile much more attractive.

Economic or operational advantages to be gained from delivery of material within minutes or hours by facsimile as opposed to days by the U.S. Postal Service in some instances outweigh the per page cost considerations by so large a factor as to make the per page costs of little consequence.

When delivery of facsimile transmitted material is made via a communications satellite distribution network, delivery to any potential receiver on the earth may be accomplished in essentially the same time as delivery to a receiver "next door" and the cost will be very nearly the same.

5.3 Application. The use of facsimile is generally divided into two application categories, convenience and operational [1].

5.3.1 Convenience facsimile. Wherein the service is offered primarily for the convenience of a general class of users and the terminal is operated by the user, rather than by specifically assigned personnel.

5.3.1.1 Desk top convenience facsimile. A decentralized convenience facsimile application wherein the facsimile terminal is located either on the desk of the user or in his immediate vicinity. Facsimile equipment in this category is generally considered to be office equipment and is characterized as being low cost, operating in the analog mode, portable, and connected to the communications network via an acoustic coupler and a dial-up phone line.

5.3.1.2 Centralized convenience facsimile. An application wherein the facsimile terminal is provided for the convenience of the user, but at a central location serving a larger group of users. Terminal equipment is generally

more expensive than for desk top facsimile and may have added features such as automatic loading, automatic transmission, and loss of line indication, which simplify facsimile operation. Equipment in this category still operates primarily in the analog rather than the digital mode due to the current lower cost of analog equipment. The digital mode may be used, however, where other considerations such as security and volume, are overriding issues. Connection to the communications network for either mode of operation may be by an acoustic coupler or by a special interface device supplied by the communications network.

5.3.2 Operational facsimile. Wherein the service is offered primarily in support of a specific operational function, such as weather dissemination, mail distribution, or command and control, and the terminal is operated by specifically assigned personnel.

5.3.2.1 Mailroom facsimile. A centralized operational facsimile application wherein the service provided the user is "over-the-counter". Operational applications other than mail distribution are also included in this category, provided that they are centralized and require specially assigned personnel other than the normal user to operate the terminal. Terminal equipment serving this category may be either analog or digital and, depending upon the usage expected, may vary widely in cost and operational features. Connection to the communications network may be via a dial-up telephone line or an equivalent data grade channel operating at data rates currently up to 9.6 kb/s.

5.3.2.2 Wideband facsimile. A facsimile application in which the bandwidths required for operational reasons are greater than those available from a normal dial-up telephone line or an equivalent data channel. This application is further divided into the two subcategories of Electronic Mail Systems (EMS) and High Resolution Photography (HRP), depending upon whether the bandwidth forcing function is volume (EMS) or resolution (HRP). Terminal equipment associated with this application category is generally expensive and connectivity to the communications network is via special wideband channels.

5.3.2.3 Special purpose facsimile. A category which incorporates all applications requiring specialized facsimile terminal design. This type of application primarily comprises graphic material such as weather data, news

photographs, fingerprints, and checks, which do not efficiently fit into the normal page sizes of general-purpose terminal equipments.

A partial listing of the areas in the business world where there are practical applications for facsimile is given in Table 8 and shows examples of the detailed expansion which is possible for each application [1].

Within the Department of Defense, facsimile application does not appear to be as widespread as in the private sector and development seems to trail industry trends. Principal applications are currently centered on the transmission of meteorological maps, data and photographs, and administrative materials. In order to show how extensive the applications of facsimile could be in the military, a compilation of major facsimile application areas is given in Table 9. Each of these application areas can be expanded into subsets that indicate the numerous methods, actions, forms and data that could be transmitted via facsimile. In fact these are the things that will be transmitted via facsimile under the concept of the fully integrated electronic office of the future. An expansion has been completed for the administrative area and is listed in Table 10. Tables 8, 9, and 10 emphasize that there is a broad spectrum of applications and uses for facsimile transmission today, and utilization will increase in the future.

5.4 Standards. Until quite recently American manufacturers of facsimile equipment have paid little attention to the development of or adherence to standards which would allow free communication between all facsimile machines. The result in this country has been a proliferation of equipments which are not compatible and which will not communicate with each other directly. Often, the different models of a single manufacturer are not compatible. Certain manufacturers seemingly have taken the attitude that their equipment is or will become the standard and have proceeded accordingly. Recently, front end and stand alone processors have been developed to overcome this incompatibility and perform the speed, code and protocol translation necessary to let any facsimile machine talk to any other facsimile machine. Machine to machine adaptation is accomplished either as a part of the handshaking protocol when two machines are connected directly or as a feature of the communications network.

Table 8. Facsimile Application Summary

Commercial:

- Control shipping of goods: forwarding way bills, bills of lading, manifests, etc. by air freight, trucking and railroad industries.
- Expediting customer orders: forwarding orders from sales offices to centralized operations by steel industry; forward customer service orders to field yards by utilities.
- Expediting monetary transactions: verification of signatures by banks and financial institutions; dispatch of notices from central accounting and posting departments to branches by banks.

Publishing:

- Expedite graphic communication between editorial offices and printing facilities.
- Dispatch news copy from satellite offices/bureaus to main newsroom.
- Eliminate duplicate typesetting effort for separate printing facilities.

Engineering and Manufacturing:

- Liaison between manufacturer's engineering and production facilities.
- Exchange of engineering data and change orders with sub-contractors.
- Forward oil well drilling logs from off-shore sites to land-based geology department.

News pictures:

- Associated Press and United Press International transmit several hundred facsimile photographs daily for subscribing newspapers.

Law Enforcement:

- Forward photographs, "mug shots," and fingerprints within police department and between law enforcement agencies.

Libraries:

- Supplement limited book collections at satellite libraries by Pennsylvania State University.
- Massachusetts Institute of Technology's Project Intrex, an experiment in information retrieval through forwarding microfilm via facsimile.

Weather Forecasting:

- Transmission of weather maps, data and satellite photos by the National Meteorological Center to local Weather Service offices over the National Aviation Meteorological and Forecast Office Networks.

Table 9. Major Military Facsimile Application Areas

Operations/Deployment	
Intelligence	
Communications	
Logistics	
Personnel	
Shipping/Transportation	
Maintenance & Repair	
Medical	Public Relations
Accounting/Finance	Chaplain
Administration	Legal
National Guard	Library
Reserves	Post Exchanges
Research & Development	General

Table 10. Facsimile Applications Subset for Administration

Plans/Policy/Orders/Transfers/Travel/Contracts/Conferences/Forms Control/ Liaison/Audits and Inspections/Facilities/Engineering/Mail and Files/ Publications/Environmental Services/Safety/Fire/Security/Food, etc.

Plans/Policy/Orders:

Plan of the Day distribution, movement orders, maps, sketches, travel orders, plans, logistics data, policy implementation, policy changes, policy reminders, policy enforcement, policy familiarization, policy distribution, policy interpretation, responsibilities, authority, inquiries, inputs.

Transfers and Travel:

Travel tickets and orders, hotel reservations, BOQ requests, car rental, communications, clearances, moving/shipping documents, destination maps, housing allocation, facility clearances.

Contracts:

Initiation, vendor inquiries, clarifications, drawings, dimensions, specifications, interpretations, negotiation with procurement activity (changes, inputs, responses to inquiries), bidders conference, RFP communications, Business Commerce Daily publications, status inquiries, bidder/vendor evaluation, coordination with sponsors, contract administration (progress reports, accounting data, schedules, inquiries, inspections), termination documentation and negotiations.

Conferences:

Staff meeting (schedules, assignments, agenda, location), survey conferences (information coordination, planning), forums, seminars, user requirements and task assignments, overseas meetings, troubleshooting, symposia, presentations (slides, pictures, maps, photos, classified materials), working groups (memos, specifications, drawings, schedules, interactive correspondence), crisis resolution.

Forms Control:

Distribution, acquisition, rush shipment, signatures, review, filing, broadcast copies to.

Liaison:

Base/headquarter traffic, Government/vendor communication, intrabase equipment/facility coordination, lab/sponsor traffic, chain of command traffic.

Table 10. Facsimile Applications Subset for Administration (Contd)

Audits and Inspections:
Coordination, reporting, background data transmittal, requests for information.
Facilities:
User inquiries and reservations, utilities telemetering, construction contracting, maps, drawings, pipeline layouts, cable diagrams, survey work, work assignments, reports, accounting, schedules.
Engineering:
Maps, drawings, diagrams, specifications, contracts, memos, purchase orders, schedules, reports, cost estimates, plans, inspections, testing maintenance (parts ordering, stock number retrieval, parts tracking), lab operations, x-ray crystallography, stress analysis, chromatography, flux patterns, structural design (beams, facilities, hardware, roads, bridges, buildings), excavation, cost reports, power network transients, antenna patterns, contour maps, hydraulic engineering, mathematical equations (functions, matrices, dynamic programming, Fourier, curve fitting, statistics), etc.
Mail and Files:
Information retrieval, user inquiries, reports, message center functions.
Publications:
Response to user requests for data (maps, graphs, specifications, photos, brochures).
Environmental Services:
Weather maps, reports, flight weather data, pollution monitoring.
Safety/Fire/Security:
Fingerprints, photographs, maps, overlays, routes, itineraries, orders, memos, correspondence, accidents, arrests.
Food Service:
Purchase orders, accounting, reports, menus, recipes.

European and Japanese manufacturers have been more cognizant of standards developed by the Consultative Committee for International Telephone and Telegraph (CCITT) and for that reason have achieved a high degree of intercommunication between their machines. American manufacturers have begun to develop their equipments to meet CCITT standards and the newer machines operate on the CCITT standard while having the ability to interface older non-standard machines.

The CCITT is a forum for member countries of the United Nations to study telecommunications equipment and recommend standards in design and operation. Once every four years the members of CCITT meet in plenary session to officially sanction the work of its study groups which meet continuously between sessions. Study Group XIV was chartered to investigate facsimile equipment and its operation over various transmission facilities. CCITT categorizes facsimile equipment into groups:

5.4.1 Group 1. Facsimile equipment which sends a letter size page in about six minutes. These standards were set at the 1972 plenary session and are a matter of public record.

5.4.2 Group 2. Facsimile equipment which sends a letter size page in about three minutes. These standards were set at the 1976 plenary session and are also a matter of public record.

5.4.3 Group 3. Facsimile equipment which sends a letter size page in about one minute. Standards for Group 3 digital equipment have been agreed to by the members of Study Group XIV. They are expected to be formally ratified at the 1980 plenary session.

5.4.4 Criteria. Study Group XIV has established criteria for: the size of paper the equipment handles; the way the document is read by the scanner; the code which is used; the methods and speeds at which the information is sent and; the protocol by which two units establish contact.

(a) Paper Size - The equipment will handle at least a letter size document. The international standard for letter size 8 1/4 X 11 3/4 inches (210 X 297 mm), is the recommended criteria. The fact that U.S. letter size is 8 1/2 X 11 presents no problem as most equipment will handle the wider paper.

(b) Scanner - The scanner will read the entire width of the document up to 8.46 inches (215 mm). The scanner will read 1728 points along the 8.46 inch line. This is known as the horizontal resolution and equates to 204 lines per inch. The scanner will read these 1728 points 98 times per inch going down the page. This is known as the vertical resolution. As an option, the equipment may also read 196 lines per inch to produce a higher quality image when needed.

(c) Code - The information read by the scanner is put into code before it is transmitted. Study Group XIV has specified a run length approach based on a modified Huffman Code, which is a binary, one-dimensional code.

(d) Modem - The information must be sent in a certain way at certain speeds. The modem regulates this operation. The recommended speed is 4800 bits per second (bps) with the ability to slow down to 2400 bps. Manufacturers may, at their own discretion, incorporate 9600 and 7200 bps speeds as well. CCITT adopted modem standards in the 1976 plenary session known as V.27 ter and V.29. Study Group XIV is recommending these same standards for Group 3 facsimile equipment. Table 11 equates bits per second to transmission time.

(e) Protocol - Before two machines can transmit documents, they must exchange preliminary information to be sure they are compatible and synchronized. This preliminary information is known as the HANDSHAKE PROTOCOL. CCITT adopted a handshake protocol in the last plenary session, known as T.30. The digital portion, however, is provisional. Study Group XIV has now defined the digital section of T.30.

Figure 20 provides a comparison of the employment of facsimile equipment by CCITT category versus the application category of the equipment.

5.5 Equipment. Extensive and detailed descriptions of the techniques employed by facsimile machines and technical details of their performance are discussed in NOSC TN 524 [1] and DCEC Technical Report No. 10-79 [28] and no attempt is made here to again address those subjects. This section will limit

Table 11. Bits Per Second Equated to Transmission Time

BITS PER SECOND	TRANSMISSION TIME TIME IN SECONDS
9600	20
7200	30
4800	40
2400	80

APPLICATION CATEGORY / CCITT CATEGORY	CONVENIENCE		OPERATIONAL		
	DESK TOP	CENTRALIZED	MAIL ROOM	WIDE BAND	SPECIAL PURPOSE
GROUP 1 4–6 MINUTE	●				●
GROUP 2 2–3 MINUTES	●	●	●		●
GROUP 3 ≤ 1 MINUTE		●	●	●	●

Figure 20. Facsimile Equipment Employment by CCITT Category and Employment Category

itself to a brief discussion of the general equipment types now available on the market and an overview of their features.

Facsimile equipments on the market range from the low speed analog desk top unit designed with the convenience user in mind to the high speed digital floor console designed for high volume electronic mail applications.

The simplest manual machines require operator attendance throughout the facsimile transmission process. The operator at the transmitting site must dial a telephone and make verbal arrangements with the operator at the receiving site for the transmission. This procedure includes the placement of paper in the receiving machine by the receiving operator and the placement of copy in the transmitting machine by the sending operator. The operators must agree upon transmission speed (if that is optional), place their telephone handsets into the acoustic coupler on the facsimile machines, wait for the machines to synchronize and the copy to be transmitted. The receiving operator must assess the quality of the received copy, and if it is not acceptable request another transmission, possibly at a slower speed. When the transaction is concluded the operators must hang up their telephone handsets. This may require in excess of eight or ten minutes for a single transmission of one page received in good order.

At the other end of the spectrum is the completely automatic machine which sends and receives documents without operator attention in as little as twenty seconds per page. Various models incorporate a number of the following features in order to provide a user with such capabilities as he may require and/or be able to afford.

(a) Downward compatibility to link major high volume offices with medium and low traffic branches which are equipped with lower speed or less sophisticated machines.

(b) Full-duplex operation, the ability to send and receive simultaneously.

(c) Completely automatic operation in which the machine sends and receives documents without operator attention. Unattended transmission is acomplished by using an automatic stack feeder which will accept up to fifty average size documents of mixed sizes and paper weights. Transmission is initiated

by a preset digital clock. Transmission routing to intended recipients is accomplished by an electronic telephone directory and dialer within the machine or by loading coded routing cards in the document feeder ahead of material to be transmitted. Recognition of busy receiving machines and redial retry features are included in some machines.

(d) Polling, or the automatic reception of from 50 to 800 documents is possible by unattended receiving machines.

(e) Transmission and reception over voice grade lines without special conditioning by the telephone company.

(f) Incorporation of a "hand shake" identification code to prevent unauthorized polling by units outside of the user's network.

(g) Printout units which employ roll-fed paper to produce copies ranging in size from 8 1/2 inches wide to some predetermined, copy defined or continuous length (up to the limit of paper roll size).

(h) Conduct of protocol to verify sending conditions with the facsimile receiver. The machines will automatically adjust transmission speed to match line conditions. Some machines notify the operator (if one is present) should certain specified low speeds be exceeded or should other corrective action be required.

(i) The sending machine queries the receiving machine to determine condition of received copy and will adjust sending speed to compensate for poor line conditions prior to resending the previous copy or sending the next copy.

(j) A broadcast feature in which the same document may be sent to multiple remote locations simultaneously.

(k) Built in telephone handset and dial assembly for establishing interconnect with remote receivers when automatic operation is not feasible.

(l) Integral modem for converting the digital facsimile signal into an analog tone for phone line transmission.

(m) The capability to operate as an office copier, producing about six copies per minute. Copying will automatically be discontinued should a facsimile signal be received.

(n) Compliance with CCITT international standards.

5.6 Facsimile networks. Presently, the majority of facsimile machines operate on dial-up voice grade telephone lines. The continuing development of high speed digital machines and increasing acceptance of facsimile as a transmission medium will create a greater requirement for development of dedicated facsimile networks or for the incorporation of facsimile into other digital data networks.

The linking of integrated electronic offices through a common digital data transmission network which will handle computers, communicating word processors, teleprinters, digitized voice and digital facsimile offers great potential for versatility and economy.

Reference should be made to NOSC TN 524 [1] and DCEC Technical Report No 10-79 [28] both of which examine and discuss current (or near current) Department of Defense utilization of DCS circuitry in support of facsimile and make predictions relative to future trends.

According to Harold Folts, a member of the U.S. standards team represented at CCITT, "All of the facsimile standards up to now have been aimed at the general switched telephone network, but the future for digital fax is in public data networks and digital data services" [29]. Common carrier services and large corporations have already begun to develop such networks and services. The corporate networks have much in common with AUTOVON, AUTODIN I and AUTODIN II in the way they are configured and controlled. "Value added" common carrier networks are somewhat different in that they offer a service for a fee on an as-required basis.

An example of a "value added" facsimile network is FAXPAK offered by ITT Domestic Transmission Systems, Inc. This is a nationwide facsimile transmission service that combines a computerized store and forward capability with packet switching. Delivery to any point within the United States is guaranteed in either of two priorities - 15 minutes or 2 hours. Different price schedules exist for each of the priorities and range from 16 cents for each minute of

terminal connection during business hours (8:00 am - 6:00 pm) under the 15 minute delivery priority down to 6 cents per minute of terminal connection during all other times under the two hour delivery priority. The service is capable of interfacing incompatible machines. Additional features offered include storage of copy destined for busy receiving machines or closed office until delivery becomes possible. ["Broadcast" delivery service is offered with the ability to pre-store individual receipients or entire "mailing lists" and then call them out with an abbreviated code [30]. Similar services are offered by other companies. Adaptation or expansion of such service on a worldwide basis will provide true international electronic mail delivery.

5.7 Economic factors. The economic factors to be considered relative to facsimile applications include those costs directly attributable to the facsimile machine and its associated costs and also the savings and/or convenience which are derived from the use of facsimile in lieu of some other communications medium. Table 12 presents a range of costs associated with operation of the three CCITT groups of machines under typical loading conditions. The three machine groups represent the market choices currently available. Costs for machine rental, supplies, operator expense and telephone line costs actually cover a broader range than indicated but these figures were chosen as representative in order to make the comparisons indicated. No costs were included for document preparation due to the variety of material to be transmitted and the various methods and techniques involved in the preparation. Figure 21 is based on Table 12 and makes a graphic comparison of the total average cost per page, by machine groups, for typical number of pages transmitted on a monthly basis by users of the listed machine types.

In each of the three groups machine costs are the major portion of expense for users with few copy requirements relative to machine capacity. Group 1 machines have previously been defined as "convenience" in nature and the high cost/page associated with their use must be set off against the advantages they present the user rather than cost justified as a prime criteria for their use. In terms of cost effectiveness, Group 1 machines give way to Group 2 machines about the 70 copies/month point while Group 2 machines give way to Group 3 machines at about the 200 copies/month point, all derived from the examples given. Use of the Group 3 digital equipments will present greater cost savings to users who have the ability to interface their machines into an

Table 12. Ranges of Facsimile Costs

	PAGES SENT/ MONTH	EQUIPMENT COST/PAGE (NOTE 1)	SUPPLIES COST/PAGE (NOTE 2)	OPERATOR COST/PAGE (NOTE 3)	TELEPHONE LINE COST/PAGE (NOTE 4)	TOTAL AVERAGE COST/PAGE	TOTAL COST/ MONTH
CCITT-GROUP 1	5	14.00	.08	.50	2.02	16.60	83.00
LOW SPEED	10	7.00	.08	.50	2.02	9.60	96.00
	25	2.80	.08	.50	2.02	5.40	135.00
	50	1.40	.08	.50	2.02	4.00	200.00
	100	.70	.08	.50	2.02	3.30	330.00
CCITT-GROUP 2	25	7.00	.08	.17	.82	8.07	201.75
MEDIUM SPEED	50	3.50	.08	.17	.82	4.57	228.50
	100	1.75	.08	.17	.82	2.82	282.00
	200	.88	.08	.17	.82	1.95	390.00
	300	.58	.08	.17	.82	1.65	495.00
	500	.35	.08	.17	.82	1.42	710.00
CCITT-GROUP 3	50	8.30	.08	.05	.52	8.95	447.50
HIGH SPEED	100	4.15	.08	.05	.52	4.80	480.00
	200	2.08	.08	.05	.52	2.73	546.00
	300	1.38	.08	.05	.52	2.03	609.00
	500	.83	.08	.05	.52	1.48	740.00
	1000	.42	.08	.05	.52	1.07	1070.00
	5000	.08	.08	.05	.52	.73	3650.00

NOTE:
1. Figured on basis of following monthly machine rental costs: Group 1 - $70; Group 2 - $175; Group 3 - $415.
2. An average cost for paper, toner, etc., is used for this comparison.
3. Operator salary figured at $5.00/hour for transmission time only.
4. Rate figured on basis of 52¢ for first minute and 30¢ for each additional minute during business hours.

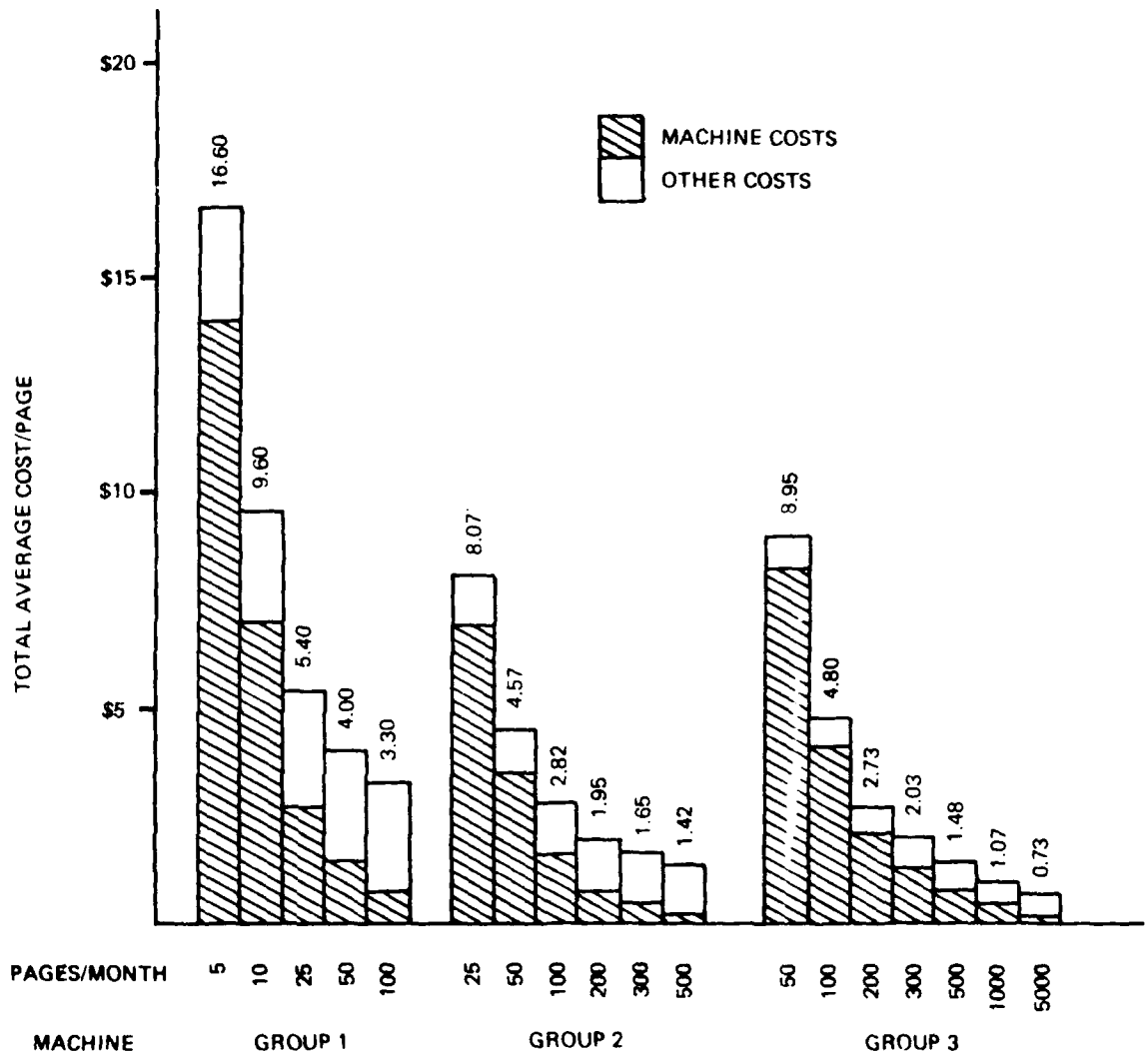


Figure 21. Comparison of Facsimile Costs

existing data communications networks which support other data transfers through reduced telephone line costs.

5.8 Trends. Facsimile machines are being adapted to communicate with devices other than another facsimile machine. The ability now exists to enter information from a keyboard or other type of computer terminal in ASCII or teletypewriter format and have it reproduced on a remote facsimile machine. An ability to transmit documents which have been stored on tape is being developed. These features coupled with polling, "broadcast" or multiple addressing, and automatic retry after receipt of a busy signal tend to lead toward the day when a facsimile system may be hooked up to bulk storage such as a central data base, or "file cabinet" for documents. With such a system, a request for document transmission could be entered from a conventional terminal and the central FAX system would transmit the document to a remote machine at a specified location.

Development of machines which produce copy on plain paper rather than coated paper is expected to decrease paper costs from the present 2 to 10 cents per sheet to about one cent per sheet.

Signal compression has substatially reduced the high bit rate nominally associated with digital transmissions. Economy in transmission time is accomplished by inhibiting the scanner when it is passing over large blank spaces or by rapidly passing over blank spaces. Various algorithms have been developed to further optomize these features. Even further economy, along with higher quality copy, is expected from machines which will preview a document then select an algorithm from its memory which will best handle the type of document to be transmitted (i.e., line drawings, text, photographs, microfilm).

5.9 Related Services. Popular usage of the term facsimile no longer refers only to the transmission equipment and process as defined in paragraph 5.1. The term has been expanded to include the function of transferring various forms of information, some without being transformed into hard copy form, from one place to another. Facsimile is becoming a generic term which refers to a variety of equipments and capabilities. Technologies, equipments and processes which are closely akin to and associated with the new definition of facsimile include: graphics; computer graphics; micrographics; image processing; digital image processing; microimage; directly perceived image; video disc; slow scan raster; cathode ray tube displays; computer

output microfilm; optical character recognition (OCR); Hybrid FAX/OCR; Tele/Pointer and Electronic Blackboard. As may be seen this is a rather extensive list and contains some terms which are synonymous. It is not complete and is subject to considerable addition, deletion and redefinition as industry proceeds with the normal processes of defining and redefining terms and technologies.

6. WORD PROCESSORS

6.1 Background. Word processors and word processing are terms which are used with increasing frequency in conjuncton with correspondence and document preparation and handling. While word processing could be said to originate with the typewriter in the 18th century, or with electric typewriters in the 1930s, widespread use of word processing really dates from IBM's announcement of the Magnetic Tape Selectric Typewriter (MT/ST) in 1964 [31]. For awhile IBM had the only offering in the field of word processors but now there are more than sixty companies offering various types of word processors and word processing software.

6.2 Word processor categories. Word processors may be divided into four basic categories for convenience in discussing capabilities. There is some overlap from one category to another and the distinctions become more blurred as competition between manufacturers causes the continual addition of new features to equipment lines.

6.2.1 Standalone hardcopy WP equipment. Standalone hardcopy equipment includes all types of less sophisticated, less expensive "blind" systems, those without video displays. Such equipment is employed for such tasks as automatic typing of repetitive letters, merging of prerecorded (boilerplate) paragraphs, revisions of short documents, and so forth.

6.2.2 Standalone display WP equipment. Standalone display equipment generally consists of a display (from part of a line to a full 66-line legal-size page), married to magnetic media (frequently, but not always diskette) and some type of letter-quality printer, most often a daisywheel printer with output speeds of 30 to 55 cycles per second.

6.2.3 Shared logic WP equipment. Shared logic equipment has evolved through several steps and examples of each are in current use.

6.2.3.1 Original configuration. Shared logic word processing had its beginning when printer terminals and display terminals shared the capability and storage of a CPU (generally a standard mini-computer). Additional storage (typically tape or disk) and printers were added as required. These configurations allowed several users to share the costs of a sophisticated system, thus bringing down the "per station" costs considerably. Disadvantages were encountered when more than one user wanted access to a limited feature of the

system at the same time; and when the system failed, all user stations were out of business until it was fixed.

6.2.3.2 Cluster configurations. In an effort to overcome the difficulties encountered in the original configuration manufacturers devised the cluster configuration, a smaller shared logic system with a maximum configuration of typically four to eight stations. The use of two or more of the smaller configurations overcomes having everyone out of business when one cluster fails.

6.2.3.3 Distributed logic systems. In distributed logic type of systems the intelligence, or at least a part of it, resides at the terminals and the sharing that is done is basically a sharing of peripherals or jointly accessed storage. Since any minicomputer system can be configured in this fashion, a number of equipment manufacturers and systems houses are offering some sort of data processing system for which word processing is just another software application package.

6.2.4 Time shared services. Time sharing services for word processing are much like time shared services for data processing. If a user has a need to occasionally make use of a large, sophisticated word processing system, a time sharing service can give him a level of word processing he could never otherwise afford. Or the service may offer access to large data bases, maintained for all interested customers, such as a library of engineering or architectural specifications. Other services offered might include output to photocomposition, interface to telegram and mailgram programs, and low-cost, off-line storage of infrequently accessed information

6.3 Typical workstation. A typical word processor work station is built around three units, a CRT terminal with keyboard; a storage station and; a printer station.

6.3.1 CRT terminal with keyboard. The CRT terminal and keyboard are the operator's prime tool in entering information into the word processor and manipulating information to produce finished correspondence and documents. There is considerable variation in the size of cathode ray tubes employed and they are capable of presenting from eight lines of information to 66 lines. The keyboard is generally similar to that of an electric typewriter and has a number of control keys in addition to the alphabet keys. In some instances

there is a numeric keypad for entry of data. The keypad may be separate from the alphabetic keys or incorporated into them.

6.3.2 Storage station. The storage station supporting the word processor may be a single small diskette incorporated into the CRT terminal or it may be quite elaborate and include diskettes, hard disks or computer main memory.

6.3.3 Printer station. The printer station may be a simple printer unit that requires the operator to insert a single sheet of paper for each page to be printed or it may be any of several printer types capable of unattended operation.

6.4 Typical word processor capabilities. A detailed examination of capabilities offered by each of the individual manufacturers of word processors in specific equipments is beyond the scope and requirements of this report. A representative listing of capabilities has been compiled from literature supplied by manufacturers and is presented as typical of what is available [32]. Activities having a requirement for word processing equipment must consider several points in making their selection in order to arrive at the proper procurement decision. Activities whose primary function is to prepare correspondence will require equipment incorporating different capabilities than an activity which must combine word processing and data processing in one work station. Some equipments offered in the marketplace have a far greater range of capabilities than others and careful examination of needs versus equipment capabilities is indicated prior to making any commitment to lease or purchase.

Since the purpose of this report is to assist in defining information processing and transfer technologies which require communications support, it is herein assumed that only shared logic systems and time shared systems are under consideration and that standalone systems are not included.

6.4.1 Capabilities listing. Table 13 contains a listing of word processor capabilities. Though extensive, the list is not necessarily complete. No single word processor system has all the capabilities listed. It is expected that over the next ten years more sophisticated systems will include most, if not all, of these features. The features listed and described below are available to the operator, either as part of hardware or as software, to aid in performing fast, efficient, processing of information.

Table 13. Word Processor Capabilities

Abbreviation dictionary. Provides a dictionary of abbreviations used in the document.

Alphabetic cataloging. Automatically catalogs stored documents in a two level alphabetic system.

Alternate character set. Permits an operator to type and display extra characters, in addition to the basic set, when performing scientific and multilingual typing.

Archive access. Allows an operator to revise and print text from an archived document without altering the original document.

Automatic carriage return. See continuous typing.

Automatic centering. Enables an operator to center text automatically, one line at a time, between left and right margins.

Automatic indexing. Provides a document management system that automatically retains document integrity for the operator.

Automatic pagination. Moves text forward or backward from one page to another (without operator intervention) to accommodate revisions to text. Pages remain in the same sequence and format as originally typed.

Background mode. Allows printing to be performed from one diskette while functions such as inputting new data or editing are performed on the second diskette. In the preparation of long documents from boilerplate materials, for example, this feature allows sections of the document to be assembled on one diskette, and later be transferred to the second diskette for printing. It prevents a common situation of a document unavailable for edit because it is queued for the printer. If used in a communicating system, allows communications to take place to/from one diskette while local work is being performed on the other.

Block select. Allows an operator to select a column of text and move that text to another column on the same page or to

Table 13. Word Processor Capabilities (Contd)

another page of any document or diskette; also enables the operator to erase, delete, or print the selected text.

Boilerplate storage. Allows operator to recall and insert text which is used in repeated applications without rekeying the information each time it is used.

Call page. Enables an operator to move directly from the current page to any page in any document.

Column move and interchange. See block select.

Concurrent print. See background mode.

Continuous print. Enables an operator to print one or more documents, unattended, from one diskette while simultaneously editing documents on the other diskette.

Continuous typing. Enables an operator to continuously key text at draft-typing speeds without carriage-returning at the end of each line.

Custom margin. Enables an operator to offset the printout of a page. Useful for addressing envelopes.

Data protection. Prevents the filing of a document which is too large for available diskette file space, thus saving the operator time by immediately reporting the storage condition. Operator informed via message on video screen that insufficient space exists, allowing diskette to be replaced or document to be placed on two or more diskettes.

Decimal tab. Enables an operator to set decimal tabs (the same way as text tabs) to automatically align decimal points.

Deletions. An editing feature that allows operator to delete material by characters, words, lines or blocks.

Disk password security. Prevents access to information stored on a disk without application of a password.

Diskette duplicate. Enables an operator to duplicate one or more existing documents, up to an entire diskette, onto a second diskette.

Display advance. Enables an operator to successively display page segments of already-keyed text.

Table 13. Word Processor Capabilities (Contd)

Document append. Enables an operator to combine various documents, or parts of a document (up to a full page at a time), with another to form a single document on the same diskette. All documents appended to another document remain on diskette as if they were archived.

Document assembly. Enables an operator to combine two or more documents from one diskette into a single document on a second diskette.

Document copy. See document append.

Document duplicate. Enables an operator to duplicate an existing document onto an empty portion of the same diskette.

Document password security. Prevents access to information in a specified document without application of a password. Up to three levels of security may be specified.

Document protection security. Prevents documents from being modified or deleted from the system except under certain specified conditions.

Document sharing. Allows two operators to work concurrently on different sections of the same document.

Dual hopper sheet feed. A paper supply device for printers which permits two different sizes or types of paper to be made available to the printer. Different sizes of paper may be used in each of the two hoppers or one hopper may contain letterhead and the other plain paper.

Edit indication. Automatically indicates on rough draft copy those lines which have been edited. Saves the author from having to read the entire copy to find revisions.

Footnote control. Numbers footnotes in a continuous string or in a separator string under operator control. Assures that footnotes appear on page where referenced, or optionally, at end of text.

Table 13. Word Processor Capabilities (Contd)

Form letter. Enables an operator to print single-page form letters from a prepared address list and automatically insert the date, address, salutation, and variable text within the body of the letter. Addresses can be selected automatically from the list, based on predefined qualifiers or ZIP codes.

Form tab. Enables an operator to merely touch a key and move quickly to the exact position of the next blank to be filled in on a form.

Full-page preview. Enables an operator to preview a reduced version of the full page and then change the format, as required, before printing the page.

Global hyphenation. Scans an entire document to allow hyphenation decisions by the operator prior to printing.

Glossary. Commonly used instructions, words, phrases, or standard paragraphs may be instantly retrieved and displayed on the screen with only two keystrokes, saving keystrokes and time.

Headers and footers. Heading and ending material on a page may be automatically inserted.

Highlighting. Allows operator to highlight information of special interest on the video display. Material may be brighter than other information on the page or may be caused to blink.

Hyphenation. Automatically hyphenates words which fall into a specified zone at the end of a line.

Incremental system expansion. Features in a system which allow the system to be expanded through addition of hardware/software as user requirements increase.

Interact communications. Working through a data set and over telephone lines, some word processors can send or receive documents to or from another system, communicate with a wide range of computers, and access a data processing system for conversational and remote job entry functions.

Table 13. Word Processor Capabilities (Contd)

Line drawings. Allows operator to create and revise line drawings, charts, and graphs on the video screen.

List/merge. See form letter.

Magnetic card reader. Magnetic card readers provide a bi-directional link between magnetic card systems and word processors. Material prepared on a magnetic card typewriter may be read into a word processor from the card or the word processor may prepare a card for use on a mag-card typewriter.

Math package. Software math packages allow the operator to perform common mathematical functions on numbers that are part of a standard word processing document. Numbers in a document can be added, subtracted, multiplied, or divided, either by other numbers in the same document or by numbers the operator enters. Operations such as column addition, crossfooting, percent calculations, and many others may be performed without the aid of a calculator. Special operations such as add rows, add and grand total rows, add columns, add and grand total columns, add and grand total rows and columns, and perform arithmetic functions on rows may be performed. Editing features in this package allow entire columns or portions of columns to be moved or deleted very simply by a few keystrokes.

Menu selection. Provides prestored menu selections of functions which may be selected by the operator.

Monospace justify. Enables an operator to print text automatically with a right-justified (even) margin - by page or by document.

Movable keyboard. Keyboard is not physically attached to the console and may be placed at operator's convenience within limits of the connecting cable.

Table 13. Word Processor Capabilities (Contd)

Multilingual package. From two to more than a dozen languages are available through a combination of hardware/software supplied by various vendors. All required characters of the languages may be displayed and printed.

Nonprint. Enables an operator to specify fields of displayed text that are to be skipped over during printing. This allows two-pass printing of a page that has a mix of type styles, languages, or colors - and the print wheel or ribbon need be changed only once.

One-third page display. Shows an exact, one-to-one image of one-third of the in-process full page.

Operator prompts. Guide an operator through required steps to perform functions. Reduce time and enhance ease of operation; serves as a training aid for new operators.

Optical character reader. Optical character readers are input devices for use with word processing equipment which allow typed material which has been prepared on typewriters equipped with specified type fonts to be automatically scanned and entered into the word processor recording system.

Originator directory. Maintains a directory of records by author and typist.

Outline numbering and formating. Automatically numbers and formats material into designated outlines.

Paragraph dictionary. Presents a preselected list of paragraphs for operator selection and automatic insertion into text.

Partial-page select. Enables an operator to select up to 22 lines of text and move that text to another location on the same page or to a different page of any document or diskette; also allows operator to print the selected text.

Phrase dictionary. Presents a preselected list of phrases for operator selection and automatic insertion into text.

Table 13. Word Processor Capabilities (Contd)

Printer selection. Allows operator to select printer compatible with requirements without leaving workstation.

Productivity report. This is a special report that can be displayed or printed and shows the number of lines printed, edited, played and recorded at a work station.

Reformat. Enables an operator to automatically change both the left and right margins and line spacings on a page or throughout a document. The operator can print the reformatted document, store it on diskette, or both.

Reformat to second disk. In a two disk system, allows operator to reformat a document on the second disk. Data that should not be reformatted, such as tables and graphs, may be protected. Reformating may be done page by page or on an entire document. A message is automatically placed on the document index indicating that a document has been reformatted.

Repage. Allows operator to select the number of lines per page with that number of lines then automatically being placed on each page, even if the document is revised or reformatted.

Scrolling. Allows operator to scroll through document either up and down, left and right, or by page (forward and reverse).

Search. Automatically searches for a specified text string, page, or document under operator control.

Search and replace. Allows operator to locate and replace a word or a phrase that occurs frequently without retyping a whole report. Specific words or phrases are located by scanning the page then replaced either automatically (global replacement) or under operator selective control (verified replacement).

Table 13. Word Processor Capabilities (Contd)

Security option. When applied, this option prevents unauthorized personnel from seeing confidential information by simply assigning a secret password to documents. Once a password is assigned, the document cannot be edited, copied, displayed, printed, or communicated without knowledge of its password. Some vendors offer security options which meet security standards of the DoD.

Selective retrieval. Allows operator to selectively retrieve specific information from a document or a file for printing or merging with other information.

Simultaneous input/output. See background mode.

Sort. Text or data can be sorted alphabetically or numerically in either ascending or descending order. Multilevel sorts may be performed (for example, Name within Town within State). Accuracy to the first 25 characters in the field to be sorted is available.

Stop code. Enables an operator to specify positions in text in which to stop the printer during printout.

Superscript, subscript, overstrike. Enables an operator to (1) type superscripts and subscripts automatically and (2) type one character over another to create special symbols (for example Ø).

Tab setting. Tab sets may be made either vertically, horizontally, for decimals, or for automatic stop at the next space in a form.

Tape adapter. Allows a tape drive to be externally attached to a word processor, thereby providing a dual-media system. Documents may be converted from tape to diskette, or vice versa.

Ten-key pad. Provides a calculator-type ten key number pad for keying in statistical reports and financial statements.

Table 13. Word Processor Capabilities (Contd)

Text assembly. Enables an operator to prepare standard paragraphs in any order then select certain paragraphs and assemble and print them (and insert variables) as one document. Also, the assembled document may be recorded on diskette for future use.

Text editing. Enables an operator to insert or delete characters, words, and lines; to break lines of text from one line to another (when inserting additional text); and to bring text forward from one line, page, etc., to another.

Time/date logging. Automatically maintains a time/date log of documents created.

Typesetting. Material prepared on word processor may be printed on a typesetting device which provides different type styles and sizes. Accomplished through software program or via a paper tape punch peripheral.

Typethru. Enables an operator to use word processor CRT terminal exactly as a typewriter by keying text and having it simultaneously shown on the display and printed on paper.

Underscoring. Allows the operator to define exactly what is to be underlined with simple commands. Automatic underscoring can be accomplished while typing or later during editing. Operator can underscore by line, block or page by simply defining each, and can automatically change from full-line underscoring to underscoring only words and characters, thus leaving spaces between words non-underscored. Automatic double underscore, used in accounting and financial reports, underscores only characters.

Underscore delete. Allows operator to define areas from which the underscoring is to be removed by line, block or page.

Word wraparound. Adjusts line endings without the need to use the return key at the end of every line or to consider line endings or hyphenation decisions. Allows for quicker input.

6.5 Typical word processing software packages: A number of processing software packages are available from vendors. Typical packages are listed here without any attempt to assess their individual capabilities.

(a) Letter writer
(b) Letter writer with variable insertion
(c) Upper/lower case letter writing
(d) Letter writer and mailing system
(e) Letter writer and mailing list
(f) Generalized letter writer
(g) Text processing system
(h) Word processing system
(i) Text editor
(j) Text editor and formatter
(k) Word processing and job entry system
(l) Text editing and job entry system
(m) Math package

6.6 Typical time-shared word processing services. Word processing services provided by time-sharing service organizations include:

(a) Text editing
(b) Photocomposition
(c) Information retrieval
(d) Labels
(e) Personalized letters
(f) Specification writing
(g) Remote job entry
(h) File inquiry
(i) Trade notification
(j) Direct mail
(k) Typesetting
(l) Document storage
(m) Computer output microfilm (COM)
(n) Electronic mail

7. INTELLIGENT COPIERS.

7.1 Definition. Intelligent copier, communicating copier, and intelligent copier/printer are terms alternately applied to a new technology in the field of copying and printing. Intelligent copiers are really hybrids that combine a number of technologies, such as those usually found in digital computers, phototypesetters, and the standard variety of xerographic-style copiers. Simply stated, an intelligent copier is a new type of peripheral device that can be used as an output printer for both word- and data-processing systems, in place of, but more likely in addition to, daisy-wheel printers, matrix printers, or even photocomposition units. In operation, all intelligent copiers receive digitized information, then re-create a line of characters that is scanned by a fiber-optic wafer, a low-powered laser, or some other device. The digitized signal is then transmitted through either fiber-optic rods, mirrors, or wires, to a photo-sensitive device that reconstitutes the image dot matrix on a master, drum, or belt. The process is completed with the printing of the required number of pages in the specified number of sets. The most outstanding characteristic of intelligent copiers is their speed of operation. The performance measurement of intelligent copiers is put in terms of pages per minute, as opposed to the traditional characters per second or lines per minute. The second characteristic of all intelligent copiers is that they have a multiple-font capability [33].

7.2 Concept of operation. Input to intelligent copiers comes from either computers, communications lines, or word processing systems in electronic form; there is no imaging directly from a document. The device uses some type of digital technique for image generation and this may include a variety of technologies for the imaging: lasers, ink jet, "infinite" dot matrix, CCD, fiber optics. Production of the image involves translation of the text from characters ("byte mode") to character dot patterns ("bit mode"). This is done by calling out a prestored pattern of dots that represent characters as sets of on/off points. These digital font masters are then stored in a page image or bit-map memory. Each bit in memory represents a picture element (pixel) that is either white or black in the output. The pattern is sent to the beam controller of the image generator. In a laser device, the data tells the modulator when the beam of laser light is to hit the photoreceptor surface and when it is to be deflected. The pattern of hit or no-hit lays down on the

electronically charged surface a duplicate of the character master pattern. Once the page is imaged (charges have been cleared, or allowed to remain, from each pixel point on the photorecepter), it goes through the standard electrostatic toner/fusing cycles. Ink jet imaging is somewhat simpler, although it uses the same concept of imaging from a bit-map memory. The actual image production is accomplished by modulating the flow of ink to the jet nozzle head as it travels back and forth across the output media. The functional concept of intelligent copiers is shown in Figure 22. [34]

7.3 Advantages: Advantages currently incorporated into intelligent copiers include: [35]

(a) Multiple font. As many as ten type styles may be selected under operator control. Documents may be produced with different type styles and sizes, and often with intraline mixing of type styles and sizes.

(b) Merge data. Data may be merged from various electronic sources. For example, a form may be called up from a storage device and filled in with information from a communicating word processor to provide a finished procurement document.

(c) Originals. Only one electronic original exists. Each hardcopy is an original document regardless of the number of copies or the distribution requirements.

(d) Versatility. Portrays any alphabet, logo, graphic representation of information, or signature. Forms may be designed or altered on site. Page orientation may be rotated or horizontal and vertical type may be mixed on the same page. Different forms may be used for each page, up to six per report, with no reduction in printing speed. Computer output may be customized without changing applications program.

(e) Quiet. Printer operates at very low noise level.

(f) Communications. Able to communicate with other intelligent copiers and receive digital input from computers, word processors, magnetic card peripheral devices, magnetic tape devices, line modems, and optical character readers. May output to a magnetic recording device in batch mode for later printing on a different printer type. Developmental work to

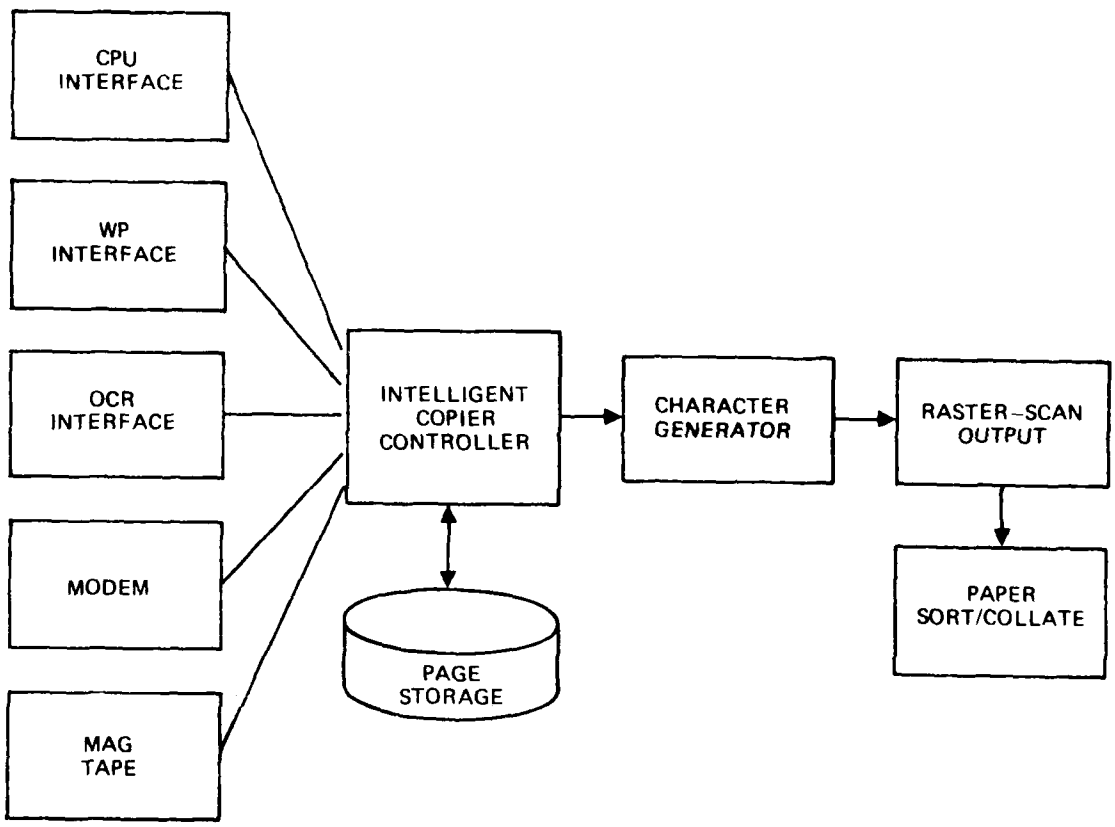


Figure 22. Intelligent Copier Functional Concept

allow input from or output to facsimile, optical disk, and computer output microfilm are underway.

(g) Local/remote printing. Reproduces hard copy at local or distant site, via communications lines, without operator intervention.

(h) Printing. Prints both sides of paper on a single pass at speed of from 10 to 120 pages per minute.

(i) Condensed text. Text may be condensed to a smaller size without losing clarity.

(j) Paper selection. Different sizes and weights of paper may be selected automatically (two choices).

7.4 Pricing. At the time of preparation of this report only three manufacturers, Xerox, IBM, and Wang, had intelligent copiers on the market and there was considerable range to their prices and recommended user volumes.

7.4.1 XEROX 9700 Electronic Printing System. The manufacturer's recommended user volume for this equipment is from 500,000 to 2 million copies per month. Pricing is as follows:

(a) Purchase price: $285,000.

(b) Service charge on purchased equipment: $3,900 per month (includes 1.7 million copies). Additional copies above 1.7 million charged at $0.0015 each.

(c) Rental price: Various plans ranging from $5,000 to $9,000 per month plus copy charges.

7.4.2 IBM 6670 Information Distributor. The manufacturer's recommended user volume for this equipment is from 30,000 to 70,000 copies per month. Pricing is as follows:

(a) Purchase price: $75,000.

(b) Service charge on purchased equipment: $355 per month (includes 5,000 copies). Additional copies above 5,000 charged at $0.025 each.

(c) Rental price: (24 month plan) $1,375 per month (includes 5,000 copies). Additional copies above 5,000 charged at $0.025 each.

7.4.3 Wang Image Printer. The manufacturer's recommended user volume for this equipment is from 30,000 to 40,000 copies per month. Pricing is as follows:

(a) Purchase price: $32,000

(b) Service charge on purchased equipment: $365 per month (includes 30,000 copies). Additional copies above 30,000 charged at $0.015 each.

(c) Rental price: $1,375 per month (includes 30,000 copies). Additional copies above 30,000 charged at $0.015 each.

7.5 Applications. Because of their speed and multiple-font capability, intelligent copiers are extremely versatile. Print requirements for multiple sets of multi-page documents are completed literally with the speed of light, in a variety of formats, with minimum of operator intervention, maximizing efficiency and minimizing wasteful operations. It may sound as if intelligent copying may be destined for use exclusively by printers, but the real market for the intelligent copier is the office. Reports which must be completed utilizing data from storage devices or remote data banks together with newly generated material may be produced with far less effort than that expended in todays report generation procedures. Once the report has been assembled it may be printed locally or distributed electronically to remote sites for printing near the location of the end user without the necessity to process and distribute large volumes of paper. No doubt there is considerable application for these equipments in printing facilities but they will also be most useful in the office which must complete large volumes of printed documents and forms in a short period of time.

8. ELECTRONIC FUNDS TRANSFER

8.1 Definition. Electronic Funds Transfer (EFT) refers to the concept of a checkless, cashless transaction mechanism by which funds are transferred automatically by electronic means [36]. EFT recognizes that money is merely a form of information. The dollar bills that pass from pocket to pocket have become merely a confirmation of man's ability to pay. If money is merely information, then that information can reside in computer storages, and payments can consist of data transfers between one computer and another [37].

8.2 Background. Before money was invented, trade was carried out by barter. Within early societies certain goods developed as standards of value against which all others were measured. In a society where a cow was the value standard, so many bags of wheat equaled one cow, or so many cows equaled one wife. Some of these barter societies have persisted to present times but some form of currency has generally taken over as the value standard in modern societies. For most of recorded history gold has been the universal standard of value and until quite recently every piece of currency said that a central bank "promised to pay the bearer on demand" the value represented by the bill. Paper money didn't exist until 1694 and from that time till this has been regarded with some suspicion by many people. As a medium of payment cash has given way to checks, checks to credit cards and credit cards are now giving way to electronic funds transfer. Each of these steps has been evolutionary and all the media still exist and are in daily use, overlapping and supporting each other even as they change. There were, and are, sound reasons for each step taking place. Currency replaced the barter system because paper is a lot easier to carry around on ones person than is a bag of wheat, a pouch of gold, or a cow. Besides, the value of the bill is printed on its face and doesn't require any haggling to arrive at its value. Checks are even easier to handle than are currency, having the ability to be drawn for an exact amount, large or small, on a single piece of paper. Unfortunately, as checks became more common in regular usage more and more of them became instruments of fraud due to the fact that they were not backed by sufficient funds to cover their stated value. This turn of events led to great reluctance on the part of merchants to accept checks from persons who were not well known to them and, directly, to the development of the credit card. The

credit card, issued by a banking institution or a credit card company, is capable of being verified through a simple telephone call to a computer center - if the amount involved is large enough to require verification - or the card may be accepted without central verification for smaller amounts provided its expiration date has not occurred and some sufficient additional identification is presented by the purchaser. The merchant receives cash, less a handling fee, from the credit card issuing agency and the agency collects from the customer, perhaps earning an additional fee or interest in the process. Electronic funds transfer is now coming onto the scene for the simple reason that the volume and velocity of transactions which are taking place are greater than a paper based fund accounting and transfer system can keep up with and because the paper based systems represent an item of expense which is fast becoming overwhelming. An examination of Figure 23 will help to understand the magnitude of this problem. The costs involved with each of the media include personnel, document processing equipment, losses from forgery or fraud, security and protection, and so forth. For currency, these annual costs are over 6 percent of the total amount of currency in circulation; for credit cards the annual costs are almost 5 percent of transaction value. Available figures don't permit a similar evaluation for costs involved in handling checks but these is evidence to show that the average cost for handling currency, checks and credit cards is over 6 cents per transaction. There is no direct comparison possible between the present-day systems and EFT because there are too many variables which affect the costs on an order of magnitude or more. EFT is a new technology with the normal high start-up costs for development, equipment, training and advertising still required and not yet absorbed. Present costs for an EFT transaction are still very high when considered on a per-transaction basis but will decline as usage volume increases and start-up costs decrease. There are advantages to be derived from EFT which offset the direct costs and these include such things as savings of interest on money in transit, elimination of float, decrease in losses attributable to fraud and the ability to deliver funds to a distant point in a very short period of time.

8.3 Types of EFT systems. There are several types of EFT systems. Their use is dependent upon the application and environment in which they exist. The things that all of them have in common is a computer to perform the processing and a communications system to interconnect the various nodes. The types include:

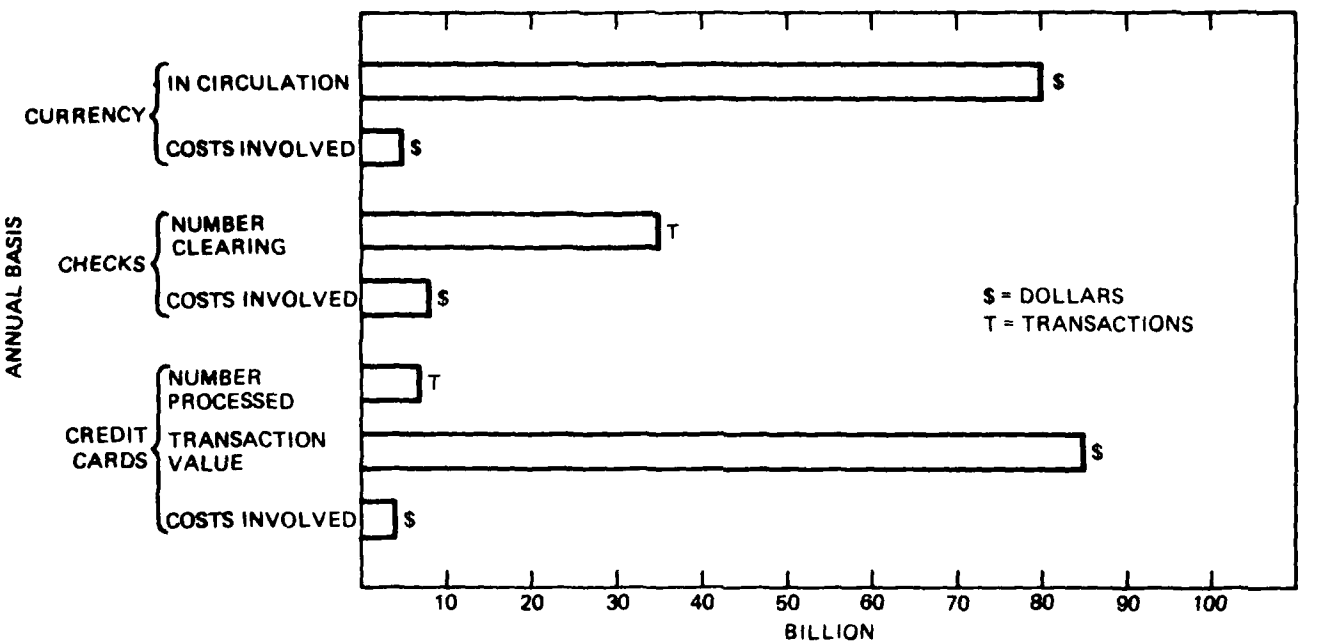


Figure 23. *Economic Factors Associated With Cash, Checks, and Credit Cards*

8.3.1 Preauthorized banking services. Preauthorized banking services provide for the automatic deposit of payroll or Social Security funds in a designated account or the automatic debiting of mortgage or loan payments from a designated account.

8.3.2 Customer-directed payment systems. Customer-directed payment systems enable a bank customer to utilize a telephone or EFT terminal to direct a bank to pay funds to a designated account. This includes such things as payment of utility bills, payment on retail credit accounts, and transfer of funds between checking and savings accounts.

8.3.3 Point-of-sale systems. Point-of-sale systems use a terminal on the premises of a merchant that enables the customer to authorize payment from his account to the merchants'. The terminal used in point-of-sale systems is a communication and data capture terminal located where goods or services are paid for. The terminal may serve merchant accounting needs and may assist in processing financial transactions. In the latter case, the terminal may operate as part of an authorization/verification system or initiate direct exchanges of value among merchants, customers and financil institutions.

8.3.4 Credit verification/authorization systems. Credit verification/authorization systems enable a merchant to check the credit of a customer by automatic query of a centralized bank or credit card company computer. There is some thought that such systems do not truly represent an EFT function but if it is considered that the computer verifies the customers line of credit and issues an authorization code for a given transaction it may be seen that a debit has been entered against the customer's name/number.

8.3.5 Automated banking facilities. Automated banking facilities include automatic cash or travelers' check dispensers providing 24-hour service to the customer. These machines may fall into either of two categories depending upon their location and use. The amount dispensed may represent a withdrawal from a deposit account or an extension of credit [38]. Access to the machine by the customer is generally controlled by means of a plastic card (which may double as a credit card) which has a magnetic strip with coded identification and account number information. This card, when inserted into a special reader in the machine, together with a secret numerical code which is separately entered by the card user, serves as the key to machine functions.

8.3.5.1 Automated Teller Machine (ATM). This machine is capable of processing a variety of transactions between a depository institution and its customers. These functions might include accepting deposits, providing withdrawals, transferring funds between accounts, and accepting instructions to pay third parties in the transaction. An ATM may or may not be on-line to a computer system and may be placed on or off the premises of a depository institution. Placement in certain locations may permit customer access seven days a week, 24 hours a day.

8.3.5.2 Customer-Bank Communication Terminal (CBCT). This is the name given by the Comptroller of the Currency to remote electronic devices (i.e., not on bank premises) through which customers may withdraw, deposit or transfer funds from or to his checking or savings accounts. These include automated teller machines and service counter terminals and may include point-of-sale devices.

8.3.5.3 Service counter terminals. Service counter terminals are relatively simple, manned devices, located in retail stores and similar places, through which individuals can obtain access to funds (and possibly credit) at their disposal for purposes of making deposits or withdrawls, and potentially for making third party payments. Includes capability for confirming deposit balances or remaining credit available.

8.4 Growth of EFT. The greatest acceptance of EFT principles, as well as the greatest application, has been in the area of commercial banking. The growth of funds-transfer operations in commercial banks has been staggering to the banking industry. Annual growth rates of 20 - 30 percent are not uncommon. Many banks are transferring funds at daily volumes exceeding their assets and, in some cases, twice their assets. A number of banks have found it necessary to upgrade their internal operations from manual, labor-intensive procedures to faster, more efficient automated funds-transfer service [39]. The conversion to automated systems has been possible only because of developments in the field of EFT technology which have occurred during the past two years. A nationwide electronic payments network has come into full operation, thus making possible direct deposit payrolls, automatic bill payment and other electronic banking services by individuals, businesses and government. This network of automated clearing houses (ACHs) in 32 locations represents a giant step in the link-up of banks in the 48 contiguous states, and provides a system

for the electronic movement of funds between widely dispersed locations. Another development during the past few months in the field of EFT is something called "check truncation". This means a bank holds onto a check it receives, converts the required information to electronic impulses and transfers the data through the EFT network back to the check-issuer's account. Checks are retained for a short period of time before being destroyed. Microfilmed copies of the checks, front and back, are retained for record purposes and to meet legal requirements. Copies of the microfilmed checks are available upon demand and may be located almost instantly through the use of computer aided retrieval techniques, even from among several million stored records. Another development in EFT was the passage by Congress late in 1978 of two laws related to EFT and the privacy of individual financial records. The Electronic Funds Transfer Act assures that customers will have knowledge about and access to their records maintained in EFT systems and will have fair treatment in handling disputes. The Right to Financial Privacy Act encompasses provisions of various bills introduced to carry out recommendations of the Privacy Protection Study Commission and spells out specific procedures that federal authorities must follow to obtain records of an individual or small partnership customer or financial institutions, such as banks, savings and loans, or credit unions [40]. Regional and international EFT networks have been in place and operational for some time. Combining these regional and international networks with the nationwide automated clearing house network will speed the development of EFT and bring greater user acceptance.

8.5 EFT in use. The federal government and certain state and local governments are already committed to the use of EFT in the conduct of their daily business. Social Security payments, welfare payments, government payroll (both civilian and military), pension and retirement payments, and government-to-government funds transfers are already handled by EFT systems and have provided many benefits to everyone concerned. Benefits include:

(a) Elimination of loss and theft of checks.

(b) Funds deposited to account on date due and available to recipient without making a trip to a bank in order to deposit/cash a check.

(c) Decreased robbery of poor and elderly individuals while transporting funds derived from check cashing.

(d) Elimination of problems associated with mis-addressed or misdirected checks resulting from local moves by payee.

(3) Improved accounting practices (such as electronic balancing) on the part of disbursing agencies.

(f) Decreased costs associated with check preparation, handling, postage, and archiving of returned (cashed) checks.

8.6 Possible additional employment of EFT within the DoD. Several possibilities exist for expansion of EFT technology within the DoD for purposes of cost savings or improved operation. These include:

8.6.1 Payroll deposits. Extension of the direct deposit of pay and allowances program to other DoD agencies in addition to those currently involved; enrollment of additional personnel in the existing programs.

8.6.2 Point-of-sale terminals. Installation of point-of-sale terminals in commissaries, exchanges, and mess/club facilities.

8.6.3 Service counter terminals. Installation of service-counter terminals at small or remote sites and aboard ships to permit personnel to conduct financial transactions without the necessity of visiting a central finance office or having finance personnel visit the remote site/ship.

8.6.4 Application of EFT principles to additional functions. The addition of a magnetic coding strip to military and civilian personnel identification cards which would identify the user when the card was inserted into a special reader, in the same way a credit card now serves that purpose, offers possibilities for expanding the principles of EFT technology to additional fields. Some of these include:

8.6.4.1 Issue of material. Insertion of the ID card into a reader at the time of material issue would provide identification of the recipient without requirement for a verbal exchange or completion of a written form and the possibility for error associated with each. Such a device would resemble a point-of-sale terminal and would provide accounting and inventory control in addition to identification. A manned terminal would provide the capability to verify identificaion of the card user.

8.6.4.2 Operation of security devices. Application of additional security coding to personnel ID cards would permit the card to serve as a key to

security areas. Loss of the card would result in issue of a new card and a new code. Compromised coding information would be deleted from the system or placed in a special alert file designed to detect an unauthorized use attempt.

9. COMPUTER AIDED INSTRUCTION

9.1 Definition. Computer aided instruction (CAI) refers to the concept of using computers and computer technology to supplement conventional educational techniques and implies an interaction between a computer and a student during the education process. The terms computer aided instruction, computer assisted instruction, and computer based instruction all carry the same general connotation. Another term, computer managed instruction, is somewhat different in that the computer serves as an aid to a teacher in selecting and assigning specific work to individual students rather than the computer interacting directly with the student. CAI refers to any of a wide range of educational techniques that rely on a computer to assist in the presentation of learning material. CAI can help to evaluate a given student's progress, or present lessons in appropriately ordered small steps. In return, it receives and is sensitive to the student's response, and frequently to the student-initiated inquiry. It can be highly limited in capability, with only a small computer connected to a series of button boxes, one for each student. Alternatively, it can be quite extensive in capability, with a powerful computer time shared between many students, each one having his own display terminal or console, complete with keyboard, light pen, television style presentation, and an audio/visual system to allow slides or films to be presented in addition to printed teaching material. The central computer may have an extensive library of information stored within, providing the additional capability to look up answers to a student's questions, and to recall and make use of his earlier responses [41]. CAI extends well beyond the conventional classroom situation in which students sit at a desk or workstation while pursuing an academic course of study. CAI encompasses gaming and simulation and may be adapted to group learning situations as well as individual instruction. CAI may provide basic skills to the uneducated child or the undereducated adult; advanced studies possibilities to the university graduate student; basic flight training in an aircraft simulator; space flight training in a capsule simulator; evaluation and correction of a pilot's performance in a simulated air combat situation; war gaming for at the command and staff level or at the weapon/system operator level; basic and advanced education for military technicians; familarity with new skills at any level; the list and possibilities are nearly endless, dependent only upon the imagination of potential users and availablity of supporting systems.

9.2 Discussion. The advantage of a learning system of which a computer is an integral part lies in the potential flexibility of the system in respect of the number and type of instructional functions it can perform in its potential for adaptivity. Further advantages suggest themselves:

(a) The capability of attending to many individual idiosyncrasies and preferences, simultaneously, and in detail unattainable by a human teacher.

(c) The possibility of offering tuition at times and places at which no human teachers may be available, and in subjects for which local demand may not justify a human teacher.

(d) The potential for carrying out routine instruction and practice work free from fatigue and without emotional response to student inadequacies

(e) Potential for supervision and management of learning situations, particularly those situations occurring in a dynamic atmosphere

(f) Assistance to teacher-authors in preparing self-instructional material or learning packages

(g) Practical assistance to researchers in studying the elements of the learning process and optimization of learning.

9.2.1 Student/computer communication. It is not essential for students to be continuously in communication with the computer to obtain the benefit of a computer based system. Indeed, it is possible to conceive of systems where the student is only in intermittent contact with the computer, and these may in fact be economically if not educationally the most profitable systems to develop. It has been shown, however, that on-line "conversation" between the student and computer is an important component of such systems. Computer based systems must not be considered as entirely divorced from the normal human interactions of traditional teaching; they are most likely to complement standard teaching techniques and become integrated with them.

9.2.2 CAI impact on the teacher and the curriculum. CAI does not replace the teacher, it supplements him in the same manner that films, typewriters, and the library do. Teachers and curriculum planners have the responsiblity for establishing a complementary relationship between the CAI portion of the course and the material presented by teacher, students, or textbook.

Although some subjects might be taught by computer alone (especially introductions to technical subjects for more advanced students), this is no substitute for classroom teaching since computerized instruction can offer only limited types of presentations, and cannot answer all of the students' questions. Various computerized aids to learning are being developed in many subject areas, but like textbooks, they provide only one element of teaching, and still require an instructor for a balanced presentation [41].

9.3 Modes of operation. There are two recognized modes of interaction between student and computer, direct and indirect.

9.3.1 Direct interaction. Computer based education systems which are operated to give direct instruction to learners fall into a few easily recognized categories.

9.3.1.1 Drill and practice. This is concerned primarily with automation of the routine inculcation of basic skills and is perhaps the most readily programmable operation. Drill is a technique to add to a student's basic store of information by memorizing commonly used facts and skills. Practice repeatedly applies this set of facts and skills to a task until a recognized standard is reached. The computer system presents graded series of exercises, and by comparing and timing responses it presents the learner with selected feedback and adapts the sequencing to the individual performance of students. The computer also records an accumulated history of performance, which may or may not be utilized to govern the degree of adaptivity of the system.

9.3.1.2 Tutorial. In the tutorial mode, the system first presents the learner with facts and examples, and then begins to ask questions relating to the information just presented. The student composes answers and these the system judges by comparison with expected responses stored within it. If the learner finds the questions too difficult he may ask to be branched to easier material; likewise if the system analyzes consistent poor performance by the learner it will branch him to a less demanding sequence. In this mode the author of the material maintains the initiative throughout, and plans an optimum path through the program which he expects the majority of students to follow. The advantages of computer presentation include the capacity to process constructed responses, accommmodation for complex branching strategies of predictive models and flexibility in control and concealment of material.

9.3.1.3 Inquiry. An inquiry mode is characterized by the system permitting dialogues between the learner and the computer. Typically, general problems are presented to the student, who, in order to solve them, must request and organize appropriate information from the system. The student may be finally asked to demonstrate his achievement by answering further questions. The program author retains considerable control over the learner's behavior since he may describe, by a set of conditional statements, the dependency of computer replies not only on the last response of the student but also on the history of the conversation. The author may also sequence the availability of facts and data during the information gathering stage; and in the decision-making stage guide the student towards an acceptable solution. This mode has found uses in teaching medical diagnosis, engineering design, and the mechanics of rigorous mathematical proof.

9.3.1.4 Problem solving and exploration. In this mode the initiative is almost entirely with the student, who is able to utilize the computer system to give him access to subject matter in such a way that he may plan his own instruction and virtually learn by discovery. The technique will allow for students to approach a topic in different ways, and cater, for instance, for one who wishes merely to browse through a course, and another who needs certain information to enable him to solve a specific problem. The student may be presented with an outline structure "map" of the course material indicating the various concepts and topics included and their sequence and interrelation. By choosing the area that interests him the learner is confronted with a more detailed "map" of this section of the course, and by successive choices he is led to the most appropriate material for his immediate needs. At this lower level the computer system may pose problems that require responses, but the student is free to request more information and call up computational routines, or to turn to other elements of the course, or even to related topics in other courses. This approach has been applied to a program on statistics but is expected to have applications in more open-ended arts and humanities courses.

9.3.1.5 Simulation and gaming. This mode includes a number of concepts including test and assessment of rather simple learning techniques and also of more complex learning problems. The computer-controller simulator may be programmed so that the student operates it in a self-instructional mode, with the machine providing basic tuition, automatically setting up problems for the student to solve, giving specific assistance where necessary and assessing the

learner's performance. In gaming situations it is possible to program the machine to control group interaction as a function of group performance, as well as utilizing its computational and referee functions.

9.3.1.6 Training in task skills. Certain training situations require a student's responses to be measured immediately, evaluated, and transmitted to the student before the next response can be made. High speed skills, such as keyboard operation, and tracking, and discriminatory skills such as those required of radar operators, are markedly improved by linking the training device to a computer, which may be general purpose or special purpose incorporating an adaptive technique. Further, it is possible to accommodate training situations involving conceptual skills by specifying teaching strategies implemented by continuous application of decision rules. Learning behavior may be built up through a chain of "categories", and the student may only progress if he maintains a satisfactory level of performance in all the subskills previously learned. Any decline in performance involving an earlier category is detected by the computer system and results in remedial measures.

9.3.2 Indirect interaction. The use of computer based systems to fashion learning behavior indirectly is also of great importance, but curiously enough much less attention appears to have been given to this aspect.

9.3.2.1 Progressive test and assessment. In this application the computer system is used intermittently to administer criterion tests to measure whether educational objectives are being met. The test procedure provides the student with immediate reinforcement when correct answers are achieved, and employs a diagnostic strategy to discover exact learning difficulties and misunderstandings. Such tests may profitably be used in conjunction with a programmed package of self-instructional learning materials; the test data indicates to the teacher how students are individually performing, and which parts of the course need improvement. The computer system also assembles information to assist the teacher in preparing and scheduling future classwork.

9.3.2.2 Indivdualized programmed learning. The computer system is used to assemble individual programmed texts on the basis of a learner's current ability and aptitude as measured from a computer-administered criterion test, and from his accumulated history and that of his peer group. The student thus alternately works at a specially tailored session of programmed instruction and is tested as to his progress by the computer system. The system can "learn"

from its own performance, since the texts it is issuing are continuously being validated, and can hence be improved upon if necessary; it also "learns" about the characteristics of individual students and may issue texts to accommodate these.

9.3.2.3 Activities programs. A computer based learning system may be designed to steer students through an entire course, continuously collecting the information essential to do this and also that information essential to the development of the course. The core of the system would be a well structured series of work assignments or activities which would call upon all available learning resources and which would include many parallel options. After each activity the learner would be tested by the computer system, which would in turn determine his next assignment. An analysis of the test data would be made available to the teacher to indicate the progress of each individual student; and also the collected test data could be directed to evaluate the separate teaching elements of the course. Although the instructions generated by the system intend to provide optimum teaching for each individual, each activity so allocated involves the use of some facility which is part of the resources of the overall system. Thus the activities program has in practice to be constrained by a resource allocation program so that the student actually receives the best that the system can in fact give [42].

9.4 Examples of CAI.

9.4.1 Control Data PLATO. The PLATO system uses a large computer connected to remote terminals by way of a communications network to provide individualized education at several levels [43]. Special courses have been prepared to meet business and government requirements as well as general courses for broad application. Some of the more than 100 courses available include: Fundamentals of Finance and Accounting for Non-Financial Managers; Understanding Financial Statements (sequence); Learning to Learn; Problem Analysis and Decision Making; How to Select and Get a Job; Planning for Retirement. One of the courses is tailored to teach the mechanics of a specific heavy equipment model - in two languages.

9.4.1.1 The Basic Skills Learning System. The Basic Skills Learning System is a comprehensive and self-contained instructional curriculum designed to help functionally illiterate adults and under-achieving students in grades four through eight become competent in reading, language and mathematics. The

system provides guidance on a personal level and allows each student to set his or her own instructional pace. The student has the freedom to learn without fear of failure, appearing ignorant to others, and falling behind, helping the student gain self-esteem. Often, the discouraged student who has failed in traditional educational settings approaches the learning environment with little motivation. The system rekindles the student's excitement for learning through its unique delivery system and well-defined curriculum. Text, graphics and animation are displayed on PLATO screens in a readable and highly instructional format. Included in this material are tutorial lessons, remedial help sequences, review activities, and diagnostic, mastery and retention tests. Students respond to these lessons by either touching the screen or typing responses. Immediate feed back and self-pacing are provided for each student. In this manner each student moves at his or her own pace, thereby reducing feelings of frustration, anxiety and failure. And, to create greater control over their own learning environments, students are able to choose their own paths of instruction. The series of courses is a composite of educational materials, adapted to the system of individualized instruction. The program is organized into a modularized system encompassing the following major content areas:

(a) Basic mathematics skills. Basic number concepts; basic arithmetic operation; special applications: ratio, proportion, percent, geometry and measurement

(b) Basic reading skills. Basic fundamentals of word structure; fundamental vocabulary; basic comprehension skills

(c) Basic language skills. Basic language structure and word useage; sentence and paragraph structure; mechanics and conventions in writing.

On the average, individuals have advanced an entire grade level in reading in about twenty-one hours and two grade levels in math in twenty-five hours with the Basic Skills Learning System.

9.4.2 Naval Warfare Gaming System. The Navy's Center for War Gaming at the Naval War College in Newport, Rhode Island, maintains the Navy Electronic Warfare Simulator (NEWS), an older analog gaming facility, and the newly installed Warfare Analysis and Research System (WARS). The combined systems make

up the Naval Warfare Gaming System (NWGS). The current facility allows simultaneous simulation interactions between naval air, surface, and subsurface platforms, weapons, and sensors in real or accelerated time. The NWGS serves four major functions:

(a) Curriculum support
(b) Training of fleet staffs
(c) Testing of operation orders/plans
(d) Support of Navy research projects

Students use the war gaming facility to improve their decision-making capability and to enchance their knowledge of tactical and strategic considerations. During the Naval Operations trimester, each seminar develops an operation order and plays a war game based on it. Additional curriculum support is provided through automated demonstrations of selected significant naval events.

For roughly 50 percent of each year, the game facilities are made available to fleet commanders. Fleet commanders regularly conduct training war games wherein operation orders and plans are tested and tactical decision-making skills are honed. This continuing series of games is a key element in the Fleet Readiness Program.

The NWGS is also used to develop and refine employment concepts for future naval forces.

System improvements have been developed and funded which will enhance the NWGS capacity to support large numbers of forces necessary for fleet-level games or to conduct many simultaneous student educational games. The system's capacity will be expanded to permit computer control of all forces. Additionally, the system's ability to collect and reduce data to support research will be improved. Future plans also include provisions for the fleet user through the establishment of remote terminals in areas such as Norfolk and San Diego. These terminals will be linked directly to the system and enable fleet personnel to participate in war games without the need to travel to Newport.

9.4.3 Apollo Simulation, Checkout, and Training System (ASCATS). ASCATS was a complex, computer-driven, real-time simulation system. This system was designed to duplicate the actual flight controller mission environment with a high degree of realism while maintaining maximal operational flexibility in

its use as a teaching system. The Apollo manned space flights represented one of the most complex man-machine systems ever devised up until that time. ASCATS provided the medium for training the flight controller team which was responsible for mission control and monitoring of the flights. Without a system such as ASCATS it is doubtful that the Apollo series of flight could have been successfully completed, perhaps even attempted. Team task skill training was provided at a level which developed confidence and a high degree of proficiency in the teams. Table 14 demonstrates the training which was made possible by this system and which would not otherwise have been available. The flight controllers were able to amass a total of 222 hours in performing some 99 simulations of 9 different mission phases for the Apollo 11 flight [44].

Table 14. Apollo 11 Simulation Summary

Mission phase simulated	Number of times performed	Total time (hours)
Launch	23	13
Translunar injection	11	28
Translunar coast	2	7
Lunar orbit insertion/Abort	8	31
Lunar descent	33	60
Lunar surface	4	13
Lunar ascent	9	44
Transearth injection	1	2
Reentry	8	24
Total		222

10.0 COMPUTER OUTPUT MICROFILM

10.1 Background. Information is being generated and duplicated at an astounding rate. And, because of the massive volumes of documents that must be controlled, traditional methods of records management are simply not satisfying user needs. Not only are records users faced with skyrocketing costs from processing, storing and reproducing all this information, but professionals in every discipline are spending as much as 20 percent of their time looking for it. This clearly is not acceptable. As the cost of maintaining mushrooming satellite files continues to increase, administrators are looking for alternative records management systems and demanding records management approaches that go beyond traditional archival files. The use of computer output microfilm (COM) and computer-assisted retrieval (CAR) in creating, storing and accessing files and records offers a solution to many of the problems in record management [45].

10.2 Advantages of COM/CAR systems. There are a number of advantages to COM/CAR systems when compared to the traditional paper based filing systems [46].

(a) Access speed. Microfilm is rated five times faster than a paper-oriented manual file system. Typical access times for microfilm files are from 5 seconds to 1 minute, with access to additional pages after the first page being less than one second.

(b) File integrity. Using COM files, control can be maintained to insure that only the latest versions of the reports are used. Since a microfilm reader is required to read the report, establishing control procedures to replace outdated files with current information is generally simpler than for paper-oriented systems. Utilization of CAR techniques in accessing and refiling film decreases opportunity for misplacing film in the file.

(c) File updates. Because of the ease of updating and regenerating files, information can be provided to the user groups on a more timely basis. Often, frequent updates of files maintained in paper-oriented systems may have been impossible because of the time required to print the information on the

computer high-speed printer or for other printing and distribution related reasons.

(d) Space savings. Microfilm requires only 2 percent of the space used by an equivalent paper file. Usually 2,000 or more pages of information can be contained on one reel of microfilm, or 100 - 250 pages on one fiche. A microfiche may contain up to 288 times more information than a standard size computer printed page.

(e) Paper cost savings. Costs savings for COM systems over paper-oriented systems have been found to be in the neighborhood of ten to one. Savings may be realized through elimination of ten to one. Savings may be realized through elimination of costly multi-part paper, bursting and decolating.

(f) Handling and distribution savings. Costs involved with distribution of documents to remote users may be reduced significantly through use of COM. Many pounds of paper may be represented by less than one ounce of microfilm.

(g) Computer storage savings. Material stored on COM is removed from expensive computer (core) storage and retained in a much less expensive medium.

(h) Computer time savings. Some reports requiring a great deal of computer time to reproduce on paper may be compiled in a fraction of the time on a COM system.

(i) Magnetic storage savings. There are considerable savings to be realized from micrographic storage of information when compared to the cost of magnetic storage [47]. With magnetic image storage, an 8 1/2 X 11 inch document, when scanned at 200 dots per inch, requires approximately 4 million picture elements (pixels). If calculations are based on a generous 75 percent compression with ten bits per byte, the a 300 megabyte Direct Access Storage Device can store 3,000 8 1/2 X 11 inch documents. With micrographic image storage, more than 25,000 8 1/2 X 11 inch documents can be stored permanently in a 4 X 4 X 1 inch Kodak Ektamate magazine at a cost of less than $11.00 (includes file and processing).

One film magazine can store as much data as 8 of the 300 megabyte Direct Access Storage Devices mentioned above. A large, rotating microfilm access file allows up to 50 million documents to be stored and retrieved at fingertip reach with hard copies available at the touch of a button. Figure 24 illustrates the above figures and devices. Figures furnished by PRC Image Data Systems Company [48] for their Telefiche System indicate that 14 million characters may be stored in micrographic form for the same cost as storing a single character in computer core memory, 240 characters on magnetic disk, or 4.5 million characters in hard copy form. COM/CAR systems have greater applicability than merely as tools in managing large operational or archived files. They provide great potential for supporting active operating systems. An example of such support is given in paragraph 6.7

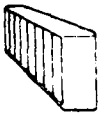
MAGNETIC			MICROGRAPHIC		
TYPE	DEVICE	STORAGE CAPACITY	TYPE	DEVICE	STORAGE CAPACITY
300 MEGABYTE DASD		300 8 1/2 x 11 DOCUMENTS	MAGAZINE		25,000 8 1/2 x 11 DOCUMENTS
MASS STORAGE		5 MILLION 8 1/2 x 11 DOCUMENTS	ACCESS FILE		360 MAGAZINES 9 MILLION 8 1/2 x 11 DOCUMENTS
			ROTATING ACCESS FILE		2,000 MAGAZINES 50 MILLION 8 1/2 x 11 DOCUMENTS

Figure 24. Comparison of Magnetic Versus Micrographic Storage Capabilities.

10.3 Types of microforms. Several different types of microforms are available for use in COM information systems with 16, 35, and 105 mm microfilms being the kinds most commonly used. Several factors should be considered when choosing the type of microform. These include:

(a) Volume of records in the file
(b) Frequency of file updates
(c) Number of file inquiries
(d) Number of copies required of the file
(e) Access speed requirements
(f) Type of readers currently being used for other microfilm applications

10.3.1 Film types. There are a number of film types in use for producing COM, however, their technical attributes are not really germane to this report. It is sufficient to know that the film may produce either a positive image (black letters on a white background) or a negative image (white letters on a black background). Darkroom facilities are not required for film processing. Film suitable for long term (30 years) archiving is available.

10.3.2 Microform applications. The common microforms in use include roll, fiche, ultrafiche, and aperture cards.

10.3.2.1 Roll film. Depending on the reduction ratio used, generally 2,000 or more pages of information can be placed on a roll of microfilm. Roll film is commonly used for larger files, files which are updated in their entirety, and applications requiring fewer numbers of readers. Roll film can be loaded onto spools or cartridges. Roll film has several advantages over the other types of microforms, including the maintenance of file integrity, the ease of storage for large files, and the minimization of manual handling of the film. Its disadvantages include the higher cost of the readers required for viewing the film, the necessity of usually regenerating the entire file, and the difficulty of selectively distributing parts of the file.

10.3.2.2 Fiche film. Two sizes of fiche are commonly used for microfilm information systems. The first, and most common, is approximately 4 X 6 inch, or 105 X 148.75 mm. The second is tab card size, 82.55 X 187.25 mm. Fiche have several advantages, including:

(a) Inexpensive copies. Fiche copies generally cost between 10¢ and 25¢ each, depending on such factors as volume and type of film. The first fiche, or fiche master, generally costs between $3 and $5 to produce. Therefore, as the number of copies of the file increases, the cost per copy page, including the cost of generating the master fiche, decreases, and the desirability of using fiche increases.

(b) Inexpensive readers. Some fiche readers can be purchased for less than $100, significantly less than roll film readers. Because of their low cost, fiche readers are commonly used for those applications requiring the use of many readers in an off-line mode of operation.

(c) Selective dissemination. Various parts of a fiche file can be selectively duplicated and distributed, depending on the requirements of the application.

(d) Selective updating. For some applications, only certain parts of the file need be updated. In these cases, selective fiche are updated, duplicated, and distributed. Procedure manuals and catalogs are common examples of this type of application. Once received by the user departments, the updated fiche are inserted in place of the outdated fiche in each copy of the microfilm file.

Fiche disadvantages include file integrity, or the misfiling of film. The misfiling of a single fiche means that from 60 to over 200 pages of information are temporarily lost. The problem of file integrity is increased for those applications in which selective updating, or selective dissemination, are required.

10.3.2.3 Ultrafiche. An ultrafiche is a specially prepared fiche containing upwards of 10,000 pages. Because of the costs involved in producing the master fiche, and since only relatively few microfilm production facilities are capable of generating them, the use of ultrafiche is generally restricted to special applications.

10.3.2.4 Aperture cards. A piece of 35 mm film is inserted into a tab punch card. Identifying information can be keypunched into the card. The primary use of aperture cards is for graphic type applications in which

illustrations, such as engineering drawings, are stored. Large 18 X 24 inch prints can be generated from the aperture card microfilm. Significant space savings can be achieved by placing drawings onto aperture cards. One of the main problems in working with an aperture card file, though, is insuring file integrity. Also, passing the cards through a high-speed sorter may damage the microfilm. To prevent this, a duplicate set of punched cards without the microfilm inserts can be used for sorting.

10.4 Use of microfilmed documents. Once a document has been converted to COM, the retrieval of that document may be either non-computer-aided (non-CAR) or computer-aided (CAR) [49].

10.4.1 Non-CAR retrieval. The non-CAR systems often look a great deal like filing systems, with the microfilm or microfiche being stored in reels, cartridges, trays, racks, modules or carousels. Operators locate particular items of information in the files through a look-up guide which is itself microfilmed and accessed via a viewing device called a microfilm reader.

10.4.2 CAR retrieval. CAR systems are divided into two categories; computer guided and fully automatic. Computer guided systems provide information to an operator via a CRT display which guides the operator to a specific roll and frame or fiche and page where desired information is located in a manual accessed filing system. The use of a minicomputer to store an index of the microfilm allows the operator to call up information by any one of several parameters. Fully automatic CAR systems are capable of handling issuance, tracking, revisions, storage, duplication and distribution of microfilmed information under control of a CPU without operator assistance. Users can obtain data through CRT terminals, keyboards, or touch-tone telephones with audio response. Master file searches can be conducted, drawings and text can be selected for TV-monitor viewing and duplicates can be ordered. Aperture cards can be duplicated on-line within the system. Fiche can be automatically pulled from the carousel, digitized and electronically transferred to a computer disk. The digitized information is transferred to the display at the operators console. If a hard copy of the information is desired, it can be called up at a hard copy unit. The operator can enter searches for multiple retrievals at the same time. More than one user can enter searches for multiple retrievals at the same time. More than one user can access the same material at the same time. Files are completely random access and are composed from the index,

therefore data records of new documents can be added to the data base without the old fiche being reformatted: the index merely notes where the new page is stored and presents it in the proper sequence when required. In the event a user requires an old fiche to be reformatted so that it includes the new data records this may be accomplished through software application. Image enhancement provides the capability to furnish a copy whose quality exceeds that of the stored original. The microform library may be located in close proximity to users or, if supported by an adequate communications system, may be remotely located at any point on the earth.

10.4.3 Film readers and electronic terminals. Film readers and electronic terminals are utilized to make COM information available to users.

10.4.3.1 Film readers. Film readers magnify and display either a single frame of rolled microfilm or a single page of a microfiche. The simpler forms of readers are primarily mechanical in nature and under manual control of the operator. More elaborate readers have electrical or electronic controls associated with them for the purpose of faster access to desired information once a roll or fiche has been inserted into the reader. Readers may be desk-top, freestanding, wall projection, or hand-held depending on user needs. Some readers, equipped with a supply of sensitized paper and an image printer, can provide hard-copy of material selected by the operator. These readers are essentially stand-alone devices and do not require on-line communications support.

10.4.3.2 Electronic terminals. Electronic terminals may take one of several forms and may interact directly with the COM database or be interfaced into COM systems via a computer.

(a) Intelligent display terminal. Intelligent display terminals provide access to COM for viewing, on-line computer interaction, and special purpose graphic CRT applications. Some such terminals may function alternatively as a member of a microform storage and retrieval system or as a node in an on-line processing system with options for local or remote use in communications with a microform database or a digital facsimile unit.

(b) Image processor. Image processors convert micrographic images into digital signals and can operate either under operator control or under computer control. Compatible with digital facsimile transceivers and printers.

(c) Digital image transceiver. Digital image transceivers communicate with micrographic image systems, computers, and other digital facsimile units. Transmission of hard copy is accomplished by a digitizing scanner for transmission.

(d) Digital image printer. Digital image printers handle high volume printing requirements of COM systems. The printer accepts data in raster (line) format and prints each representative bit. Hard copy is generated on paper cut to size according to user requirements. Operates in either stand-alone mode or interfaced with an intelligent display terminal.

(e) Recorder/processor. Recorder/processor units may operate as stand-alone or on-line devices to receive digital information and process it into either rolled microfilm or microfiche automatically.

(f) Tape drive/disk drive. Tape or disk drive units may serve as on-line devices for transmitting or receiving digitized COM information in batch mode.

10.5 Document to microfilm conversion. Film which is to be used in a COM system may be prepared by photographing the document directly with a special microfilm camera or by photographing the face of a CRT which has the desired information displayed upon it. Merging of material may be accomplished on CRT displays. Documents which are to be electronically incorporated into a system associated with a computer are scanned and converted into digital information suitable for computer processing. An on-line document scanner capable of digitizing over 1,800 source documents/hour with 200 lines/inch resolution is an example of an input generation device in regular use. Digitized images may be stored on a disk for instantaneous retrieval or may be directed to a raster-scan recording unit and permanently stored on rolled microfilm/microfiche. Material on COM may be alpha-numeric or graphic or both and can be in the form of text, charts, maps, or photographs in either black-and-white or color.

Capabilities exist for simultaneously producing microfilm copies, digitized images, and hard-copy from a single input transaction [49].

10.6 Computer requirements. The computer utilized in a COM/CAR system may be a mainframe computer used in routine data processing; a mini-computer interfaced to a mainframe; a dedicated mini-computer; or a time-shared computer network [50].

10.7 Examples of COM usage. Two examples are given to demonstrate some of the variety of uses made of COM in reducing costs and increasing workflow.

10.7.1 Example one. Westinghouse Power Systems Company, Pittsburgh, PA, is an in-house service bureau supporting its subsidiaries [51]. The company receives input from design engineers, accountants and other data originators, computerizes, processes and delivers output to customer sites twice daily, with delivery to on-site users every hour during the daylight shift. During 1978, the company, which is 25 percent of Westinghouse Corporation, generated over 80 million frames of COM. On printed paper, the monthly computer output would have translated into a stack of paper taller than the Empire State Building. Costs of mailing the paper to sites as far away as Belgium, Spain, Canada and the Far East would have been prohibitive. The company sees other savings besides just the cost of paper and postage. Savings of 12 printers and six personnel to operate them are cited. The COM operation is physically located with the computer operations center and is managed and operated by computer personnel. A total cost saving of 90 percent in comparison to a paper based system are stated in addition to improved distribution.

10.7.2 Example two. The Hyster Company of Port and, Oregon manufacturers lift trucks and operates worldwide [52]. Hyster has been using microfiche since 1970 in support of its catalogs, brochures and other sales and pricing information. Microfiche replaced parts, service, training and pricing literature. The company maintains 2,000 microfiche libraries and employs COM in the pricing portion of those facilities. Every lift truck parts manual is on microfiche. On paper this would add up to 40 books. Service facilities have eleminated some 20 feet of shelf stored paper manuals through use of microfiche. The microfiche library for each site is contained in a single three ring binder. Service trucks carry their own microfiche service libraries and a special 12-volt operated viewer. The supervisor of parts publications

estimates the company has saved 75 percent of the cost of paper printing, handling and mailing in the first eight years of operation.

10.8 Economic factors. A number of examples have previously been cited in this paragraph which indicate that considerable cost savings may be realized from proper application of COM systems in the management of records. No firm figures are available to this analyst to indicate trends in procurement of COM hardware and services but as paper, distribution and personnel costs continue to increase, along with the mass of information to be managed and stored, and costs associated with computer and microform technologies continue to decrease the application of COM is bound to increase at an ever accelerating rate.

11. COMPUTER GRAPHICS

11.1 Definition. Computer graphics entails the use of a computer to draw a two or three dimensional picture, map, graph, chart, diagram, or rendering for the purpose of illustration or demonstration. The graphic may be displayed on a cathode ray tube (CRT) or on a plotter which draws directly on paper or overhead projector transparency. Graphics displayed on CRTs may be "dumped" to a plotter or printer which will provide hard copy, or photographed with a high resolution camera to provide a film record.

11.2 Discussion. Overloaded with work and pressured to make quick decisions, many managers would prefer scanning a single picture to reading through reams of printouts that pile up on their desks. Man does not think naturally in strings and arrays of numbers, but rather in images. Presentation of information through computer graphics allows managers to start their thinking processes quickly [53]. The usual method of presenting information involves evaluation of much cumbersome material. A "picture" may tell a manager immediately what he wants to know. Information in this visual aid might otherwise be buried in stacks of computer-generated reports.

Managers, of course, have always had access to high-quality color graphs and charts drawn by in-house artists. But computers ensure that information is received before it becomes stale. Charts that once took as long as two weeks to develop are now produced in a few hours or minutes, thus enabling managers to see more up-to-date data and to request new presentations on short notice. Middle managers will also be able to play more "what if" games, asking the computer to plot out the results of more than one business scenario [54].

Computer graphics has been around for years, but only recently has it become quick, inexpensive, and friendly via a desktop computer and optional peripherals. Computer graphics may be prepared by a system as small as a "personal" computer with a built-in electrostatic printer or by a large system based in a central computer and having a number of interactive edit terminals, several input devices and a selection of output media. Communications capabilities make possible the use of remote databases in preparing computer graphics as well as the delivery of graphics to remote and portable terminals. Development of the microprocessor and decreasing computer and peripheral costs

together with a greater understanding of computer graphics capabilities makes it easy to understand the increasing demand for computer graphics in mamagement situations.

11.3 Computer graphics applications and trends. Computer graphics, especially those produced on plotters, have been used in technical and design work for many years. Presently, only one in ten graphics terminal is used in general management applications but prediction to the effect that one out of every two graphics terminals produced will be for business applications by 1983 has been made by Venture Development Corporation of Wellesley, Mass. and quoted in Business Week magazine [54]. Not only are the ratios predicted to change, but also the number of terminals shipped - less than 50,000 in 1980 to about 210 thousand in 1983. The New York market research firm, Frost & Sullivan, Inc., [55] has predicted the market for computer graphics software and services, at $201 million in 1978, will go to $1 billion by 1986, as shown in Figure 25. Computer graphics is also playing an expanding role in military applications, particularly command, control, communications, intelligence, battle field simulation and tracking and other specialized fields. This report will be limited to so called "business graphics" and will not consider military, technical and design applications.

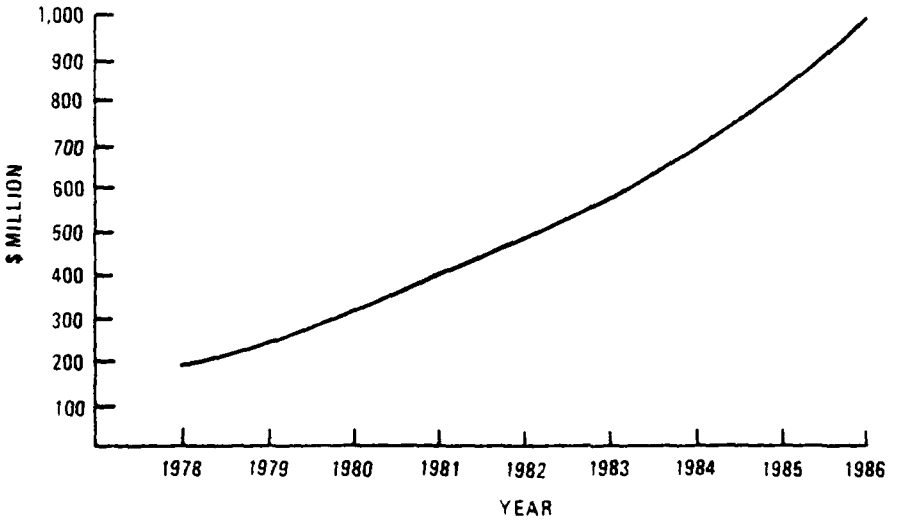


Figure 25. Market for Computer Graphics Software and Services

11.4 Systems and equipments. Managers who perceive a requirement for computer graphics systems have several alternatives for procurement, depending upon requirements and availability of funds. Those offices which already have a central processor available to them may acquire software programs and appropriate peripheral devices and become timesharing users of the CPU. Those who have only a small requirement may acquire desktop minicomputers and tabletop plotters, or they may acquire a terminal and use it to access a remote database via communications circuits, again on a timesharing basis. Those who have a somewhat larger requirement may find it necessary to acquire their own processor and more sophisticated peripheral devices. Some vendors offer minicomputer based turnkey systems designed to fill user requirements as of the date of installation and capable of being expanded as requirements grow.

11.4.1 Turnkey systems. A typical turnkey system consists of a graphics input system composed of a free or constrained cursor digitizer tablet to encode X-Y coordinate data. Many vendors will also support a host of other input devices: function keys, joysticks, keyboards, or photogrammetric input from a stereoplotter. Output stations will consist of a flatbed, or rotary drum, or table plotter, but, once again, vendors will support other hardcopy output devices such as a light-beam, microfilm, or, increasingly, an electrostatic plotter.

The interactive graphic edit station, the heart of the turnkey system, consists primarily of direct view storage tubes (DVSTs) and a keyboard, but more often of raster and vector refresh CRT displays. The graphic workstations tend, for the most part, to be menu-driven, with the user specifying such functions as adding or erasing lines, circles, or other output graphic primitives; adding attributes (nongraphic information) to the graphic data base; calculating distances and areas; and specifying graphic and nongraphic data base functions.

In addition to these graphic workstations are the usual complement of computer peripherals such as disk (average systems are shipped with at least 80 megabytes) and tape drives, printers, the minicomputer CPU itself, and in some cases, communications capabilities to a remote host CPU [56].

11.4.2 Input devices. Material may be entered into the computer for incorporation into graphics by several methods.

11.4.2.1 Keyboards. Keyboards allow the operator to interact with the computer program in exercising the program to develop graphic displays.

11.4.2.2 Digitizers. A digitizer is a graphic peripheral input device for transmitting points, lines, and curves from the surface of a flat matrix table to a computer which accepts the data for immediate processing or future use and modification [57]. Intelligent digitizers incorporate microprocessors and automatically perform such functions as calculating areas, linear displacement, and perimeters, and for relocating origins, converting binary to BCD and formatting output data [58].

11.4.2.3 Preprocessing systems. Preprocessing systems are remote job entry devices designed for off-line digitizing and storage for subsequent entry into any graphic system or data base. Preprocessing reduces communications and host processor loads.

11.4.2.4 Edit terminals. Basic edit terminals consist of a keyboard and a CRT display. More elaborate terminals may include a light pen, joystick, trackball, numeric keypad, and special function keys. Edit terminals are interactive with the operator and the computer.

(a) Display. Displays for graphic CRT terminals comprise two types: Direct-view storage and internally-refreshed. In the direct-view storage CRT terminals, characters and lines are written and stored directly on the same CRT faceplate as that viewed by the operator. The basic advantage of this terminal is that there is no intermediate storage. The cost of the terminal can be low, with extremely good performance and good picture resolution. The primary disadvantages of this terminal are that the storage phosphor tends to "wear" in high-use areas and the display brightness is not as great as those below. Internally refreshed CRT terminals use a CRT very similar to a home television's 525-line system. The simplest terminals are "glass teletypes", alphanumeric CRT terminals with limited, graphic capability. By reversing the video, these terminals have the ability to generate horizontal and vertical bar charts. As data come into the terminal, logic generates a dot-matrix pattern to form characters or lines.

The pattern is stored in semiconductor random access memory (RAM), and this is fed through a video generator to the CRT. In addition to semiconductor RAM refresh memory, terminals are also manufactured with scan converters as the refresh memory. They have the advantage of higher resolution and the ability to selectively write or erase any portion of the image. Also, the magnification of part of the image (zoom, or window) is done in hardware, with no requirement for computer intervention [59].

(b) Color. Just as the addition of graphics can increase comprehension over tables of numbers, the addition of color can help a user more readily visualize solutions. Terminals are available with black-and-white or green CRT displays and many of these offer much higher resolution than do the less sophisticated color terminals. Color terminals at the lower end of the scale offer four color displays, and the capabilities go up as the price goes up. Eight color and sixteen color (eight foreground with eight background) models are becoming more popular and one manufacturer (at least) offers a color display and graphics firmware package that provides 4,913 displayable colors (that's 17 cubed; there are 17 steps between the three primary colors) [60].

11.4.3 Output devices. Computer graphics may be output from the computer in one or more of several forms. Display on the CRT of an interactive edit terminal is discussed in paragraph 11.4.2.4. Other media include:

(a) Plotters. Plotter capabilities range from a simple device with one drawing pen and the ability to make simple two dimension charts and graphs (e.g., bar charts and function plots) on 8 1/2 X 11 inch paper up to the ability to produce three dimensions, hidden surfaces, and images (e.g. equipment design) on paper up to 8 X 8 feet and in four colors. Plotters are described as desktop, flatbed, beltbed, drum, continuous roll and electrostatic. Some relatively small plotters can perform long axis plots (in excess of 14 feet) by employing bi-directional paper stepping. Others are

capable of combining graphics and text printing on the same page. Paper may be stepped both forward and backward and may be cut to size and stacked automatically under computer control, permitting unattended operation.

(b) Printers. Electrostatic, sensitized paper, or impact printers produce hardcopy from CRT or video sources. Printers may operate under computer control via an interface or directly from the video input of the CRT terminal, a video monitor, or TV set. Impact printers use multicolor ribbons and bi-directional paper drive to produce their copy.

(c) Film. Graphics images may be captured on film by desktop units or special high resolution cameras. A typical desktop unit produces prints on Polaroid SX-70 or Polacolor 4 X 5 inch films as well as with conventional color negative or 35-mm slide transparency film and copies computer graphics or TV video stills [61]. High resolution camera systems convert raster scan color terminal output to photographic hardcopy on Polaroid 8 X 10 inch film, 8 X 10 inch color transparencies for overhead projection and backlit display, 35-mm color slides, 60-image color microfiche, or 16- or 35-mm color animation film, allowing related and sequential images to be arranged in orderly arrays, simplifying comparison and analysis. Microprocessor based electronics provide automation and calibration features as well as color separation, self diagnosis and remote control [62].

11.5 Advantages of computer graphics. In addition to the ability to examine "what if" situations as mentioned above computer graphics offer many other advantages to both mid and top level management. Comparison of computer generated graphs in comparing this year's figures against last year's figures or this year's figures against this year's projections provides much more meaningful information in a fraction of the time required to perform the same analysis by examining stacks of computer output numerical data. Use of graphics displays to present briefing information has been observed to shorten meetings by a considerable margin. One company reports that meetings that formerly took over two hours on a regular basis now take about twenty minutes

as a result of using computer graphics. The perception of trends is more readily apparent when presented as a graphic display then when buried in a stack of numbers and statistics. Sometimes the numbers are necessary but the graphic display can help in understanding what otherwise might be nearly incomprehensible.

12. PORTABLE COMMUNICATIONS AND RADIO PAGING

12.1 Definition. For purposes of this report portable communications and radio paging will be examined and discussed only to the extent that they directly support and interact with DoD information processing and transfer systems of the future. This is seen as primarily the support of executive and management level personnel engaged in information processing and transfer, and in providing support to those executives and managers who are the end users of those systems.

12.1.1 Portable communications. Portable communications, in the context of this report, implies the employment and application of systems and equipments which will serve to extend those technologies discussed in the report to areas outside of the normal office environment.

12.1.2 Radio paging. Radio paging involves transmitting a signal to activate a paging receiver carried or worn by someone being paged.

12.2 Discussion. Forecasts of our communications future tend to be oriented toward fixed broadband systems, but the growth of CB radio in the past four years has brought attention to the world of mobile radio. However, full appreciation of the present and potential economic and military importance of mobile radio services and other portable communications media has yet to develop.

Aside from the special case of CB radio, the remarkable increase in demand for mobile radio in the past decade reflects important economic gains that can be expected to continue. On the basis of present trends, it is reasonable to project continued expansion and growth of present services - mobile telephone, paging, dispatch, CB. But technological developments in the past few years suggest more than mere growth of present services; they suggest a transformation in the services themselves. The development of a "celular system" is an advanced form of multi-channel trunking which will permit expanded and more efficient use of mobile radio. Other technological developments promise even greater expansion of an innovation in mobile services. For example, the technical feasibility of linking satellites with hand-held or even wrist-worn radios has already been demonstrated. A second development that promises expansion of mobile services is "packet radio" - employing digital transmissions for both voice and data communications, and packet switching techniques

similar to those now used by certain specialized private-line telephone carriers. Such a system offers not only a more efficient utilization of the spectrum, but the advantages of a multiple access broadcast capability.

These systems are of importance in the context of this study due to their potential interconnection with long-haul communications and because our highly mobile DoD elements are characterized by long distance movement, a high degree of dependence on trucks to transport personnel and goods, and an extensive network of bases around the country and overseas, and an elaborate communications network for providing commercial telephone services to offices and personnel. Under these circumstances, it will not be surporising if entrepreneurs, first on a small scale, begin to connect mobile telephone systems to long-haul networks. Later the the trend will spread, limited only by cost and technological considerations.

The potential for growth of mobile telecommunications within the DoD is thus evident, although it is important to distinguish between one-way and two-way mobile systems. The former technology is used for paging, the latter permits conversations. Differences in spectrum demand are substantial. A 1 MHz block can accommodate some 200,000 five-digit paging units, or 7,000 dispatch users, but only 650 mobile telephone users without quality parameters inferior to those of the standard telephone.

Today, some 700 independent radio common carriers supply mobile telephone services through interconnect modes with the wired system. Wireline common carriers (such as AT&T) also operate some 1,300 mobile telephone systems, in addition to paging services. Demand for mobile telephone services is strong and in many areas there is a long waiting list for service. Because of the high loading of channels, the quality of the service provides has been inferior to what is technologically possible if more spectrum were used. Widespread mobile telephone service of a quality comparable to that of the fixed telephone is now possible with the additional spectrum allocated in recent regulatory decisions. Estimates of the number of mobile telephones in usage range from 100,000 to 130,000, totals that have not changed appreciably during the past few years; estimates of recent growth rates vary from 1 to 6 percent per year.

As the federal government alone operates more than half a million vehicles, this constitutes a massive market, and government procurement decisions can influence development of the technology, making such growth projection plausible.

12.3 Sources of radio portable communications and radio paging services. In the civilian sector, ground, air, and marine mobile radio service and radio paging service may be obtained from radio common carriers (RCCs) or may be self provided by the user.

12.3.1 Radio common carriers. RCCs are government regulated companies that furnish communications facilities for voice and message traffic and for radio paging. RCCs offer a wide range of services which include simple one way signaling; signaling and response; ground, air, and marine radio telephone; data communications channels; interface between RCCs and wire common carriers. RCCs which serve small urban areas have few problems in providing adequate service to their customers, having a sufficient number of frequencies and channels available to meet their needs. The situation is much different in the big cities and their extended metropolitan areas. Lack of sufficient radio frequencies and channels presents the biggest problem, followed by range limitations. Greater utilization of single-sideband (SSB) transmission and action by the Federal Communications Commission to make available additional radio frequencies and channels is helping to solve some of the problems. The development of cellular systems is solving some more.

12.3.1.1 Cellular radio systems. Most mobile telephone systems operating today use one centrally located set of relatively high-powered transmitters to communicate with all mobile units in the service area. Each of the system channels handles one call at a time. Channels cannot be reused in nearby service areas because the transmitted signals are strong enough to interfere with one another. This conventional technology does not make large-scale service practical. As an example, the Bell System can provide mobile phone service to fewer than 1,000 customers in New York City. And with only 12 channels available, there is more than a 50 percent chance that a New Yorker's mobile call will not be completed on the first try during peak traffic periods [63]. On a nationwide basis, most radio telephone service companies cannot accept new customers and most have waiting lists at least half as long as their

customer list. Cellular technology makes use of low powered FM radio transceivers strategically located within an area in such a manner that a single channel may be used several times to provide service within different "cells" without causing adjacent cell interference. Channels may be used simultaneously 20 or more times in an area where a conventional channel could only be used once. In low demand areas, cell size may be as large as 12 square miles but in high demand areas cell size may be as small as one square mile [64]. Once a cellular system has been established, additional cells may be added to accommodate increased requirements without degrading the existing system. New cells are simply added between the old and equipment and power adjustments realigned. Examples of cellular systems now exist in the following areas:

(a) Chicago. Ten cells cover about 2,100 square miles in and around the city and handle both voice and data. (Bell System)

(b) Washington/Baltimore area. Provides voice channels in a seven cell configuration. (American Radio-Telephone Service and Motorola)

The potential for nationwide mobile communications network using the existing dial network has been discussed and seems to offer some small possibility for future adoption [65].

12.3.2 Air-ground radiotelephone system. Air-ground radiotelephone service has been available in parts of the US since the late 1950s when AT&T started the service as a developmental venture. The service was regularized by the Federal Communications Commission in the late 1960s and additional stations were authorized in the US and its possessions. The system currently contains ground stations operated by AT&T, independent telephone companies, and radio common carriers. As of the end of 1978 there were 52 ground stations with an additional 30 stations planned, and there were approximately 4,000 aircraft terminals. Primary users of the system are corporate aircraft. The service is available to anyone who has the proper equipment and licenses. Service in some areas of the country is outstanding but some problems have been encountered with certain of the small independent telephone company and RCC operated stations. All calls are operator assisted and billing to the user is via his sponsoring telephone company. Availability of the service is dependent

upon location of the ground station and the altitude and distance of the aircraft from the ground station. The range of operation at jet altitudes may be anywhere from 300 to 400 miles depending on the siting of the ground station [66].

12.3.3 User provided services. Services provided to himself by the user may be as simple as a single radio channel with only two terminals or as elaborate as the systems maintained by smaller RCCs, depending upon the user's requirements.

12.4 Portable communications terminals.

12.4.1 Vehicle mounted terminals. Terminals mounted in vehicles are:

(a) Radiotelephone. Some terminals require operator assistance in completing calls, others are capable of hands-off operation.

(b) Data Sets. Data sets may transmit via a keypad or a full typewriter-like keyboard. The receive display may be a paper hard copy, dot matrix, light emitting diode, or cathode ray tube display. Some terminals have buffer storage capability for both transmit and receive functions. At least one manufacturer [67] sells a data terminal for land mobile use which offers a 320-character display with storage of up to six full screen messages (pages), plus 10 pages of forms and lists for immediate recall.

(c) Facsimile. No example of a civilian mobile facsimile set was found in the literature search conducted, however there is at least one military tactical digital facsimile set in production, the AN/UXC-4, which was developed under US Navy contract by Litton DATALOG [68].

12.4.2 Hand-carried terminals. Hand carried terminals may be interfaced onto either radio circuits or wire circuits (telephone lines).

12.4.2.1 Radio terminals. Generally, a radio telephone which may operate directly to a central office with each terminal having its own unique telepone number, or may be an extension of a mobile or regular wired telephone link (cordless phone).

12.4.2.2 *Terminals for use on wire circuits (telephone lines).* A number of truly portable and easily hand-carried terminals are available. They usually have a built-in acoustic coupler (and if required, a modem) to permit use on a telephone line without direct wired connection. Size and weight of these terminals is comparable to a portable typewriter and some are battery operated for use where no electrical power is available (such as in a telephone booth). Terminals which interact with computers generally have a tone-generating keypad built in. Separate tone-generating keypads are available for use with terminals not so equipped and are mechanically inserted between the telephone handset and the terminal's acoustic coupler. Terminal types available include:

(a) Teleprinters
(b) Data sets
(c) Facsimile
(d) Special purpose.

12.5 Radio paging service. Radio common carriers provide the majority of radio paging service with telephone companies and private systems handling the remainder. The ratio is about 9 to 1 for the RCCs. Wireline common carriers are expected to move into this marketplace because of radio channel congestion and some experiments with communications satellite based paging systems have been conducted. A number of RCCs are moving to develop networks extending beyond their service areas, to regional and eventually even nation-wide networks for intercity paging operations, which would allow a user carrying a pocket pager to be signaled no matter where he or she is in the country [69]. Regional paging already is a reality in such areas as Boston, Chicago and Los Angeles where extended coverage is provided by RCCs. One regional system along the Eastern seaboard provides coverage from Atlantic City, New Jersey to New Haven, Connecticut [70].

12.5.1 Types of pagers. A variety of pocket pagers is now available. They have in common the fact that they are generally about the size and shape of a package of cigarettes, are lightweight, and are easy to carry in a pocket or clipped to a belt.

(a) Tone signaling. Either one or two tones may be sounded to get the attention of the pagee who must then call a predetermined telephone number in order to receive a message.

(b) Tactile. The pager vibrates but does not emit a tone.

(c) Tone signaling with voice message. A tone is sounded and immediately followed by a voice message which may or may not be repeated.

(d) Tone signaling with graphic display message. A tone is sounded and an encoded message up to eight characters in length is stored in the receiver until the recipient has an opportunity to view it.

12.5.2 Trend in pager use. Figure 26 demonstrates the trend in the use of radio pagers and reflects the findings of a study conducted by the Federal Communications Commission. The convenience and inexpensiveness of paging systems is leading to this increase in their utilization. The number of units in operation increased from 512,000 in 1975 to 1.0 million units in 1980 and will be nearly 3 million by 1985.

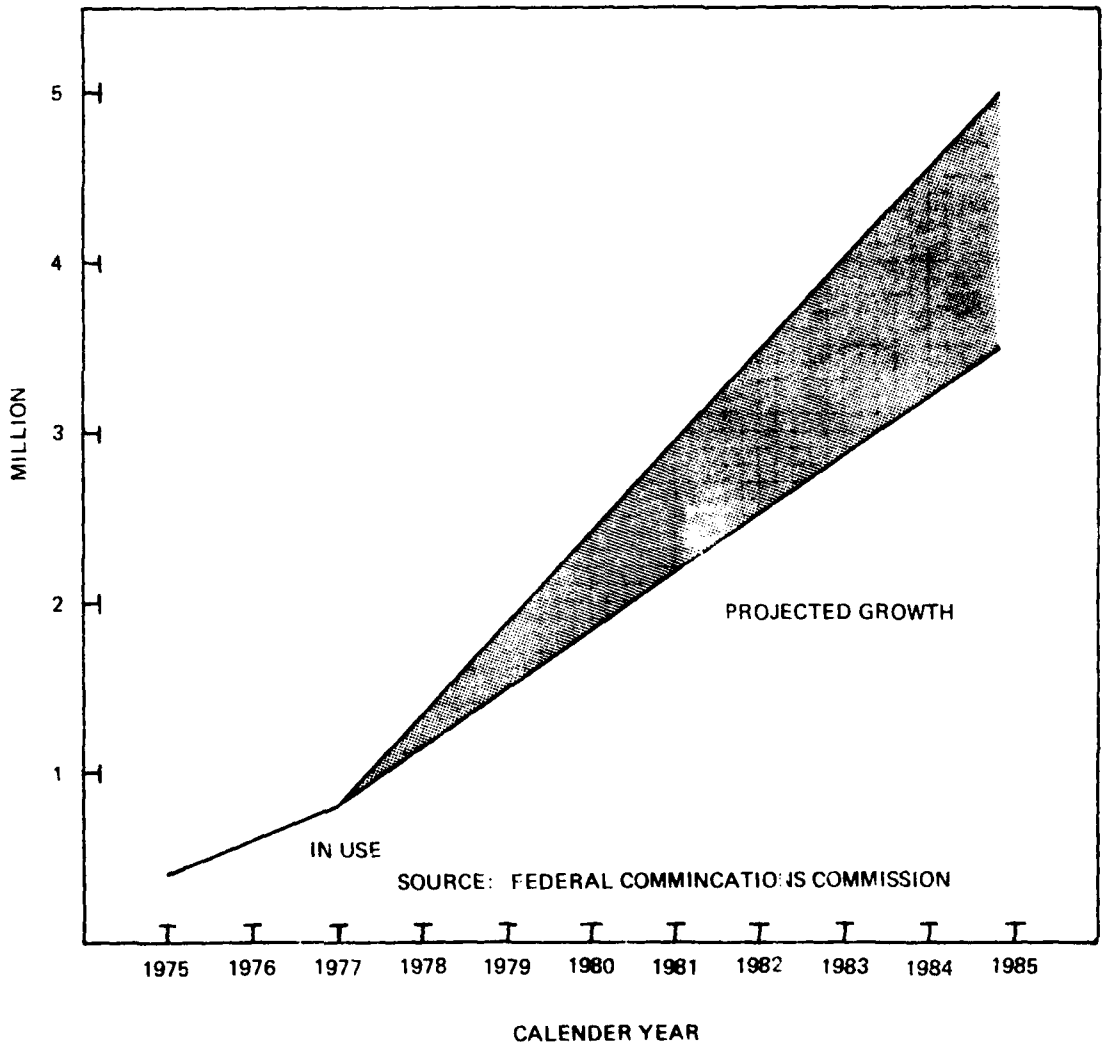


Figure 26. Pagers In Use and Projected Growth

13. TELECOMMUNICATIONS PROBLEMS AND ISSUES.

13.1 Discussion. Certain problems and issues pertaining to telecommunications aspects of the examined technologies must be considered and overcome in achieving a fully responsive interaction between offices/work centers in like or different application categories for which a need to interact is considered reasonable. Discussions in paragraph 2 relative to digitization of machine outputs/inputs and the use of computers to act as controlling switches are germane to this section as regards achieving fully responsive interactions and overcoming certain of the problems. Some of the problems and special issues do require further examination.

13.2 Techonologies vs problems/special issues. Figure 27 and its accompanying notes provide a comparison between the technologies and the problems/special issues pertaining to each. It will be noted that there are fifteen entries under "technologies" in the matrix while we have examined only ten major technologies in the report. Problems and issues attending electronic mail, teleconferencing, and facsimile are sufficiently different in derivation and degree for each sub-technology under those headings that separate examination is warranted for each. Further discussions of the problems and special issues relating to each of the technologies and sub-technologies is contained in the following paragraphs and is based on the matrix.

13.2.1 Electronic mail - facsimile based. Refer to paragraphs 13.2.7 and 13.2.8.

13.2.2 Electronic mail - word processor based. Refer to paragraph 13.2.9.

13.2.3 Electronic mail - computer based.

(a) Traffic scheduling possibilities. Computer based electronic mail systems offer excellent opportunities for traffic scheduling. Messages may be held in memory until the computer is polled by potential recipients at random or prescheduled times, or transmitted during low traffic/low circuit cost times.

(b) Response time - operator/machine. Delays encountered as a result of entry queing or communication network loading must not be so long as to invalidate a computer for electronic

PROBLEMS/SPECIAL ISSUES / TECHNOLOGIES	BANDWIDTH NOTE 1	INTEROPERABILITY NOTE 2	TRAFFIC SCHEDULING POSSIBILITIES NOTE 3	CONNECTIVITY NOTE 4	RESPONSE TIME–OPERATOR/MACHINE NOTE 5	RESPONSE TIME–END-TO-END NOTE 6	AREA COVERAGE NOTE 7	SECURITY REQUIREMENTS NOTE 8
ELECTRONIC MAIL – FACSIMILE BASED	●	●	●			●		●
ELECTRONIC MAIL – WORD PROCESSOR BASED		●	●					
ELECTRONIC MAIL – COMPUTER BASED			●		●			
TELECONFERENCING – AUDIO				●				●
TELECONFERENCING – VIDEO	●			●				●
TELECONFERENCING – COMPUTER			●		●	●		●
FACSIMILE – ANALOG		●	●			●		●
FACSIMILE – DIGITAL	●	●	●			●		
COMMUNICATING WORD PROCESSORS		●	●					
INTELLIGENT COPIERS		●	●					
ELECTRONIC FUNDS TRANSFER						●		
COMPUTER AIDED INSTRUCTION				●	●			
COMPUTER OUTPUT MICROFILM	●		●		●			
COMPUTER GRAPHICS	●				●			
PORTABLE COMMUNICATIONS/RADIO PAGING		●					●	●

Figure 27. Technologies vs Problems/Special Issues

NOTES FOR FIGURE 27.

1. BANDWIDTH. Refers to the bandwidth of the communication channel required to support the technology.

2. INTEROPERABILITY. Refers to the ability of machines to communicate among themselves even if they are of different manufacture, are different models, or are different technologies. Concerns operating speeds, modes, protocols and algorithms.

3. TRAFFIC SCHEDULING POSSIBILITIES. Refers to the capability for storing communication traffic for delayed transmission (during low traffic load times on a given circuit or during lower circuit cost times) as opposed to a requirement for real-time end-to-end communication or immediate operator/machine interaction. Storage may be effected by any of a number of media such as scheduling the start time of a facsimile transmitter which has been pre-loaded with documents or electromagnetic storage in a tape or disk peripheral device or in a computer main memory.

4. CONNECTIVITY. Pertains to the requirement or need to connect to more than one distant terminal simultaneously.

5. RESPONSE TIME - OPERATOR/MACHINE. In order for the system to be responsive to operator requirements in interactive systems the time involved must be very short. Response times of one second or less are required to avoid loss of operator attention.

6. RESPONSE TIME - END-TO-END. Requirements relative to end-to-end response times vary by the priority of the material to be delivered by the system. An electronic message system serving senior executives may have a requirement for delivery of a message to its furthest point in less than one minute while overnight or two day delivery of lower priority material may be completely acceptable.

7. AREA COVERAGE. Pertains to the availability of coverage of any given area for those portable terminals which operate on radio links and for radio paging devices.

8. SECURITY REQUIREMENTS. It is considered that the requirement for communications security in the time frame under consideration will be almost universal and that all sensitive/essential digital circuits will have been provided with encryption devices. Security requirements, as a problem area, are therefore not addressed except in those circumstances seen as exceptions, such as analog circuits and wideband video circuits which will exhibit extremely high bit rates.

mail applications. A response time of less than one second for keying in new material is required and entire pages must be displayed in about one to two seconds in order to avoid operator boredom and frustration.

13.2.4 Teleconferencing - audio.

(a) Connectivity. The advent of computerized private branch exchanges (CPBX) makes it quite simple for individuals or CPBX operators to set up their own audio conferences without involving telephone company personnel. Connection of many terminal points may be accomplished with comparative ease.

(b) Security requirements. Until such time as all telephone conversations are digitized and encrypted, the telephone will continue to be a major security problem as regards the unauthorized transmission of classified material.

13.2.5 Teleconferencing - video.

(a) Bandwidth. Slow scan and freeze-frame video can be transmitted over voice grade lines without special conditioning. Studio quality television transmissions require a 4 MHz bandwidth for black and white transmissions.

(b) Connectivity. Video conferencing is essentially limited to the connection of only two conference points at one time. Connection of additional points compounds the problem by an order of magnitude for each connection and is not practical.

(c) Security requirements. In order for video conferencing to have any real value to the DoD, encryption of transmitted video and associated audio signals is essential.

13.2.6 Teleconferencing - computer.

(a) Traffic scheduling possibilities. Since computer conferencing is a non real-time application, traffic scheduling, or more realistically stated, operator access, may be scheduled at operator convenience or to take advantage of low circuit load and cost times.

(b) Response time - operator/machine. As indicated in Note 5 this response time must be kept extremently low in order for the operator/machine interactions to be effective.

(c) Response time - end-to-end. This aspect of computer conferencing is more a factor of circuit availability to support each of the human participants in accessing the computer and of their own personal schedules than a communications engineering problem.

(d) Security requirements. For the forseeable future, those participants who have a requirement to access classified information will be required to utilize terminals located in security cleared areas and attached to encrypted circuits.

13.2.7 Facsimile - analog.

(a) Bandwidth. No particular problems exist for analog machines, which operate on voice-grade telepone lines.

(b) Interoperability. Because of speed and protocol differences many analog machines currently in use are not capable of interconnection. This problem is being overcome by front-end and in-line converters and by adoption (slowly) of industry wide standards.

(c) Traffic scheduling possibilities. Possibilities for scheduling traffic are excellent with facsimile machines of all kinds. Many machines are capable of unattended operation, both transmit and receive, and can be polled or programmed for transmission at predetermined times. Value-added services offered by common carriers include store-and-forward, permitting an originator to transmit traffic and recipients to receive traffic at the most opportune times for each.

(d) Response time - end-to-end. End-to-end response time is a factor of the priority assigned to material entered into the system. On real-time circuits the end-to-end time is limited only by the speed of the machines and ranges from two to six minutes per page.

(e) Security requirements. Encryption of analog signals poses more problems than encryption of digital signals and for this reason the widespread use of analog machines on circuits requiring communications security is not foreseen.

13.2.8 Facsimile - digital.

(a) Bandwidth. Many digital output machines are capable of operating on voice-grade telephone lines but as the transmission speed increases so does the requirement for conditioned lines and greater bandwidth. Conversely, compression techniques being applied to digital signals are decreasing bandwidth requirements. Bandwidths range from 4.8 KBit to 56 KBit with 9.6 KBit being the most common.

(b) Interoperability. As with analog machines, some problems do exist as regards interoperability of various makes and models of digital machines. Front-end and in-line processors are overcoming some of the problems involving speeds, protocols and algorithms and greater attention is being paid to application of international standards for digital signals than for analog.

(c) Traffic scheduling possiblities. Comments in paragraph 13.2.7 (c) apply equally to digital machines.

(d) Response time - end-to-end. Comments in paragraph 13.2.7 (d) apply equally to digital machines.

13.2.9 Communicating word processors.

(a) Interoperability. Some problems do exist because of speed, protocol, and algorithm differences in word processors and many of them are not capable of direct interconnection. Some of the problems are being overcome by front-end and in-line processors and the industry is beginning to pay some attention to adoption of a national standard.

(b) Traffic scheduling possibilities. Because of their capability for storing traffic on a magnetic disk or tape and transmitting when polled or at a predetermined time, traffic scheduling possibilities are excellent for communicating word processors.

13.2.10 Intelligent copiers.

(a) Interoperability. Some problems may be encountered in interfacing intelligent copiers directly with some word processors or peripheral devices, however, since they normally interface a computer or off-line magnetic tape device few real problems with interoperability are anticipated.

(b) Traffic scheduling possibilities. Because of the speed at which these machines operate and their ability to input/output to/from magnetic tape peripherals traffic scheduling involving intelligent copiers offers great possibilities.

13.2.11 Electronic funds transfer.

(a) Response time - end-to-end. Transfer of funds from banking facility to banking facility in one hour or less is generally acceptable. Real-time or near real-time response is required for most other electronic funds transfer transactions.

13.2.12 Computer aided instruction.

(a) Connectivity. The ability to connect two different computer aided instruction systems together is seen as an extremely large problem because of data base differences and incompatibility of software and hardware. Practically, it probably will not be attempted.

(b) Response time - operator/machine. Response times of one second or less are required except in those cases where the computer must conduct library searches.

13.2.13 Computer output microfilm.

(a) Bandwidth. COM libraries may be supported by voice grade lines for the most part but extremely high volumes of traffic could result in a requirement for data conditioned lines.

(b) Traffic scheduling possibilities. Batch mode updates of COM libraries may be scheduled for low circuit load and cost times but the usual mode of user access is real time and can tolerate only slight, if any, delays.

(c) Response time - operator/machine. Response times of one second or less are generally required and expected in COM library systems.

13.2.14 Computer graphics.

(a) Bandwidth. The bandwidth requirement is dictated by the computer and operator terminals employed. Generally requires a voice grade line with some requirements for data grade lines.

(b) Response time - operator/machine. Very fast data entry and display times are essential in interactive applications and should be on the order of one second or less for data entry and less than one minute for display.

13.2.15 Portable communications/radio paging.

(a) Interoperability. The trend in portable communications terminals for use on wire circuits is to incorporate both text and data processing capabilities and for the terminals to operate on voice grade lines. Many terminals have common operating codes and bit rates with interoperability being not much of a problem. Radio terminals must meet governmental regulations and except for the the usual frequency and bandwidth limitations inherent in individual nets there are few interoperability problems.

(b) Area coverage. Large parts of the United States have radiotelephone service available on area wide basis but no truly nationwide radiotelephone or radio paging service is yet available.

(c) Security requirements. The use of portable terminals, either on wire lines or on radio circuits, poses a special problem for security. Encryption of communications involving portable terminals may be easily accomplished but accounting for the encryption devices and keying material and physical control over them poses the main problems.

14. CONCLUSIONS

"Inevitable" best describes coming changes in which industry, and Government, will be handling information in the coming micro-decade. Already the US economy is approaching an information-based economy as the ratio of information workers to service/industrial workers exceeds 47:48 (Figure 28).

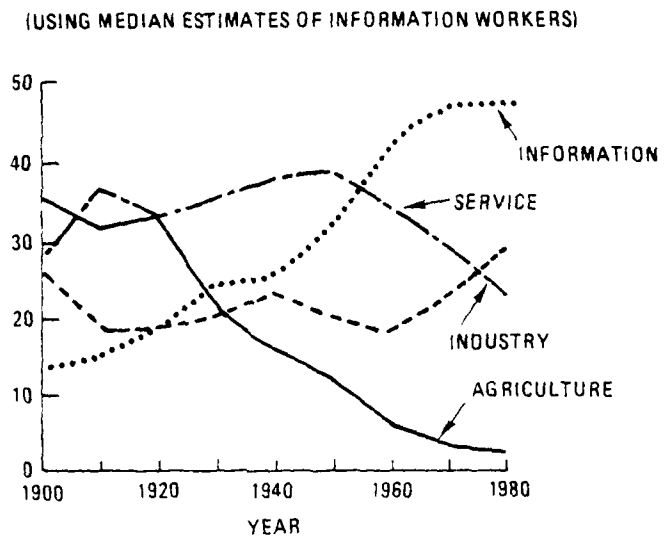


Figure 28. Four Sector Aggregation of the U.S. Work Force by Percent 1900-1980

And the economic stakes are enormous. In 1979, AT&T's gross revenues were over $38 billion, surpassing the GNP of 118 of 145 nations in the United Nations. More significantly, two of the three most profitable US corporations were in the information business (AT&T, IBM).

The impact of such developments on DoD administrative developments should not be underestimated as the magnitude of resultant data traffic about to descend upon DoD networks could well swamp their capacity rapidly. It should also be remembered that the emergence of new DoD office capabilities is a global matter from a telecommunications point of view and that the baggage of decisions in this field will accompany us far into the future.

Certain conclusions concerning the future of automated information processing and handling systems may be drawn from, and trends perceived in, the literature which served as a base for this report. Those conclusions and trends, evaluated in light of the author's experience, are discussed briefly in the following paragraphs. A general discussion of aspects pertaining to the automated office and personnel is included.

14.1 Electronic mail.

14.1.1 Key issues. Electronic mail, while not truly a technology in itself, uses one or more of the several technologies discussed in this report to automate information processing and distribution functions in support of the office of the future. The decision making process leading to the adoption of an electronic mail system should consider the following questions:

(a) Which, if any, of the media are currently in use or planned for procurement at the site in question? For instance: Is the site using stand-alone word processors which can be adapted to on-line use; does the site have access to a large main frame computer which could accommodate their mail requirements; would a centralized operational facsimile mail room providing over-the-counter service be sufficient?

(b) What is available or planned at the sites which will be major participants in the electronic mail system?

(c) What level of communications support will be required? Are new circuits required or can electronic mail be piggy-backed on an existing data communications link without degrading that service?

(d) Are all potential users in agreement about the type of service which will fulfill their requirements? Will potential users be comfortable with the proposed system (i.e., if executives

and managers are to be provided cathode ray tube terminals, for instance, will they actually use the terminals)?

14.1.2 Trends. Electronic mail, in one form or another, has already arrived on the scene and is viable and growing. Rising postal costs and decreasing electronic mail costs coupled with the speed of electronic mail delivery assures the continuing growth and success of electronic mail. At least one third of all First Class mail is computer generated and lends itself very well to being processed electronically. Proliferation of communicating word processors, facsimile, intelligent copiers, computer output microfilm, and computer graphics will place greater demands on electronic mail systems and will encourage their development.

14.2 Teleconferencing.

14.2.1 Key issues. As with electronic mail, teleconferencing is not truly a technology but utilizes some of the technologies under consideration in performing its function. The issues associated with each of the teleconferencing modes discussed in this report may be found in the paragraphs indicated:

(a) Audio conferencing. Paragraph 4.3.2.

(b) Video conferencing. Paragraph 4.4.3.

(c) Computer conferencing. Paragraph 4.5.3.

14.2.2 Trends. Indepth discussions of the trends associated with the three teleconferencing modes may be found in the indicated paragraphs:

(a) Audio conferencing. Paragraph 4.3.3.

(b) Video conferencing. Paragraph 4.4.4.

(c) Computer conferencing. Paragraph 4.5.4.

14.3 Facsimile.

14.3.1 Key issues. The selection of the appropriate application category is the first consideration when anticipating the use of facsimile in support of office automation. The choice of either a convenience or operational facsimile terminal and further choices as to terminal location and manning will be dependent upon the expected traffic loading. Exercising the above choices and considering the communications requirements of available

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machines versus the communications networking available will determine whether the selected terminal should be analog or digital in its output/input.

14.3.2 Trends. A discussion of facsimile trends is contained in paragraph 5.8.

14.4 Word processors

14.4.1 Key issues. Large numbers of word processors are being procured by business and government but few of them are capable of communicating and even fewer are actually used to communicate. Capabilities of word processors are being expanded almost daily as vendors try to include the latest innovation or gimmick in order to meet competition. Some of the fancy frills are not really necessary for most applications but may be played up by the salesman in order to enhance the prestige of his machine or company. A serious evaluation of needs versus capabilities is indicated during the procurement process.

14.4.2 Trends. Communicating word processors are incorporating hardware and software options which closely resemble computer capabilities, including the ability to process data, access remote data bases and libraries, and create graphics. Some may be interfaced to computers, facsimile machines, optical character readers and other peripheral devices designed to extend their capabilities. Several computer vendors and software vendors are offering packages which allow word processing to be performed on mainframe and mini computers.

14.5 Intelligent copiers.

14.5.1 Key issues. The intelligent copier is a very new technology, just entering the marketplace and still searching for its niche. The intelligent copier processes digital information received either directly from a computer, from a magnetic tape input peripheral, or from a communications line and outputs hard copy at high speeds. Their main application is production of large volumes of printed material which may include text, forms, graphic, or combinations of these.

14.5.2 Trends. As a result of high costs involved in purchasing or renting machines and the large output capabilities which must be fully utilized in order to achieve copy cost effectiveness these devices are getting off to a slow start. Many potential users are adopting a wait and see attitude while waiting for prices to come down and for system de-bugging to be completed.

14.6 Electronic funds transfer.

14.6.1 Key issues. Of the five basic types of electronic funds transfer (EFT) systems now in use (i.e., preauthorized banking services; customer directed payment; point-of-sale; credit verification/authorization; automated banking) only one, preauthorized banking services, has found wide spread application in government usage. Treasury funds for payment of federal salaries and wages, retirement benefits, social security payments, welfare, and payments to other governmental agencies are disbursed via EFT.

14.6.2 Trends. All forms of EFT are expanding in the business environment. Continuing utilization and expansion of preauthorized banking services by government is expected. Requirements for applications of the other four described EFT types within DoD is not clearly indicated. Possibilities do exist for application of some EFT principles but those will probably not require extensive communications support.

14.7 Computer aided instruction.

14.7.1 Key issues. Computer aided instruction (CAI) refers to any of a wide range of educational techniques that rely on a computer to assist in presentation of learning material. Applications may be as simple as a single student studying with the aid of a desktop personal type minicomputer or may involve many students, a large main frame computer, and an extensive communications network. Curricula may range from basic education through post-graduate studies to specialized technical training and war gaming.

14.7.2 Trends. The decreasing costs of computer technology and the increasing complexity and quantity of information to be imparted and assimilated make CAI a very natural tool for helping to solve educational problems. CAI is a growing technology which is just now gaining maturity and which is bound to grow considerably in the next decade.

14.8 Computer output microfilm.

14.8.1 Key issues. The use of computer output microfilm (COM) and computer-assisted retrieval (CAR) in creating, storing, and accessing files and records offers a solution to many of the problems in record management. Virtually anything that can be reduced to paper hard copy form can be stored on microfilm, reducing volume and costs of storage. Use of computers allows

microfilmed material to be retrieved from file in a fraction of the time required for paper based systems. Material stored on microfilm may be digitized and processed by computers or transmitted via digital communications circuits.

14.8.2 Trends. COM is another of the relatively new technologies which is just achieving maturity. One suspects that it has not gained wider application simply because vendors have not been aggressive enough in their sales efforts. Increasing costs of buildings and storage space for paper based files and the virtual explosion of information which must be stored for both short and long terms assures the continuing growth of this technology.

14.9 Computer graphics.

14.9.1 Key issues. The use of computer graphics to present information to management in concentrated and highly useful form is one of the most valuable tools to be derived from computer technology. Much of the information now presented to managers is in the form of masses of numbers on computer printout sheets and is literally overhwelming to the busy executive. Since man doesn't think naturally in strings and arrays of numbers, but rather in images, presentation of information in graphic form allows managers to start their thinking processes quicker and to proceed from a base of greater perception. The ability to display computer graphics on a cathode ray tube and to manipulate inputs provides a capability for playing "what-if" games and performing comparative analysis over very short periods of time.

14.9.2 Trends. Computer graphics in the field of management will probably be the fastest growing of all the technologies considered in this report. Further discussion of trends is contained in paragraph 11.3.

14.10 Portable communications/radio paging.

14.10.1 Key issues. Portable communications and radio paging free the executive from the confines of his office while allowing him to remain in contact and control. He may be connected to his office by a radio link or summoned by a radio pager to make contact by telephone or with a portable terminal on a telephone line. Either way, it may be said that his desk travels with him and the facilities of his office are available electronically. The executive can read the mail in his electronic in tray, receive text and graphics messages, address correspondence to others, send notes to himself for later followup, carry on conversations with anyone who has the appropriate

terminal and communications facilities on a worldwide basis, or perform a full day's work, all via portable terminals. This technology may be viewed as an invasion of privacy and leisure time by the executive who needs some quiet time away form the office, or as a golden opportunity by the workaholic.

14.10.2 Trends. Portable communications and radio paging are growing in the applications and will continue to do so. Executives will increasingly utilize this technology to gain greater mobility. Additionally, portable terminals will be used by those lower echelon personnel who spend their work day away from the office but need access to data bases or libraries in order to carry out their assignments.

14.11 Discussion. Application of many of the technologies discussed in this report has traditionally been in the area of office services in support of administrative functions. This is especially true for word processors, facsimile, office copiers, computer output microfilm and the various forms of teleconferencing. Computer graphics has generally supported technical and design work while electronic funds transfer and computer aided instruction have each resided in their own niche. Communicating, or intelligent copiers are a new technology, just coming onto the scene and are not fitted firmly into any particular slot. The pervading theme of this report is that computers and computer technology are paramount to development of information processing and handling systems of the future. Paragraph 2 discusses and illustrates the concepts involved in bringing about an integrated electronic office through digitizing the input and output of information processing and distribution equipments and then using a controller, a computer, to tie everything together and direct the interface. It soon becomes obvious that if such concepts are to evolve in an orderly fashion and achieve the ultimate goal, an electronic integrated office system which is cost effective and highly productive, then there must be an improved understanding on the part of users of the concepts involved. Likewise, the disciplines currently applied to data processing must be applied to the computer controlled office equipments. The ideal situation would be for the devices to be transparent to the operator but for this to be so there must be an involvement of computer personnel, programmers, systems analyst, and data base managers. Presently, the more sophisticated word processors come with their own software packages, and some hardware features, which are better understood by computer programmers and operators than they

are by the usual word processor operator. The initial incorporation of an electronic mail system into an existing main frame computer requires an understanding of office workflow which is not generally posessed by the computer programmer or perhaps even by a systems analyst who is prone to think in terms of data processing applications. The same may be said of the data base manager who is faced with accommodating word processing in what heretofore has been a data oriented world. When the requirement for communications between various nodes of the office system (remote libraries, microfiche files, dispersed processing terminals, etc.) are added to the picture then there must also be an understanding between the administrative office manager, the data base manager, and the telecommunications manager. Vendors are already producing terminals which are designed to interface with several of the technologies discussed, with the full expectation that this is the way of the future.

14.11.1 The integrated electronic office.

14.11.1.1 Conclusions. The development of the integrated electronic office will occur in an evolutionary process as a need is perceived to apply the technologies and as funds are made available for procurement of necessary hardware, software, communications networks, and specially trained personnel. The movement towards automation of information processing and handling systems will be dictated by the necessity to reduce travel, cut information transfer costs associated with traditional processing and delivery methods, and to reduce transfer delays of important and perishable information.

14.11.1.2 Trends. The move towards office automation has already started in both industry and government. It will accelerate as the costs associated with personnel continue to increase while those associated with hardware and communications continue to decrease.

14.11.1.3 Personnel considerations. Personnel, both the manager-user's of the integrated electronic office and the system operators will be a major factor in the speed with which the new technologies are acquired and the success of the systems after they are in place.

(a) Management personnel. Management oriented personnel who enter the field of office administration and the chain leading to top management positions in the field of administration usually have certain basic skills which they have acquired on

colleges and universities. They have been taught the state-of-the-art in their particular discipline and are ready to go to work under the supervision of senior and more experienced people. Future managers who are in school today are being given some familiarity with computers and certain other of the automation technologies discussed in the report. Those individuals will undoubtedly find it easier to adapt to the fully automated office than will the older, perhaps more set in their ways, manager and executive who is in business and government today. Some executives feel that typing on a keyboard, even if it is connected to their own computer based message system which will give them near instant access to vast amounts of information and communications with the entire world, is something that is not in keeping with the dignity of their positions. Others simply can't type. Many executive and managers are so "people" oriented that they are unable to relate to dealing directly with a machine. Their usual mode of operation, long tried, tested, and true, is to deal with a few select individuals who make up their staff, and for the staff to deal with the rest of the organization. At a lower level, some managers are greatly intimidated by knowledge that their boss has a computer which will automatically remind both him and them when a report is due, or past due. If the report is to be a day late they would like to sneak it in on the old man's desk while he is out of the office and hope he accepts it that way. If the boss happens to be out of the office and has his portable communications terminal along then he can provide new work directions to his staff and receive reports at any time of the day or night. There is also a problem about "junk mail" in the manager's electronic in tray. Once people discover that by pushing a few buttons they can put a copy of anything in the system into his electronic in tray they tend to overwhelm the manager with trivia, involving him in minor matters to a degree which is beyond his capability to contend with. Junior

managers are deprived of the opportunity to deal with problems before they get kicked upstairs and therefore develop a fear and disliking for the electronic monster which they were told was there just to help them and improve efficiency. Some managers will find it necessary to restructure the way in which they use their time in the office. They are used to dealing with a single problem for only a few minutes before being interrupted by a telephone call or other urgent business. If their incoming information arrives in the form of messages stored in their personal communications terminal, to be looked at and dealt with at their choice of times, then they will have to set aside time for this.

(b) Systems operators. Office personnel who operate the machines and systems in current use throughout business and government generally enter the work force possessing the basic skill requirements of their trade (i.e., typing, filing, shorthand, bookkeeping, keypunch operator, computer terminal operator) which was initially acquired from a high school, trade school, or college and often enhanced by some amount of practical experience. The operator's acquaintance with newer technologies such as word processors, copying machines, and facsimile is generally acquired by on-the-job training or from vendor's representatives, either on-site or at some off-site training facility. Skill levels acquired through on-the-job training are dependent upon the capabilities of the instructor and the time devoted to training. Training by vendor's representatives may offer a better chance of professionalism but again may be limited by time constraints or the necessity to travel to the vendor's facilities. Retraining of on-board personnel when a major new technology is moved into the office may be unsuccessful if they are unable to assimilate it or are unwilling to accept it. On-the-job training for a typist learning to operate a word processor is a relatively simple procedure when compared to teaching a secretary versed in present day office procedures to become proficient in dealing with the integrated office system.

Mastering an office which has a communicating word processor, a high speed digital facsimile terminal, a microfiche library, computer conferencing for her supervisor and an electronic mail system - with very little paper in sight - is not a thing that will be achieved overnight or through the process of intuition. Training of system and equipment operators (and education of management personnel) will probably come a little easier to those people who have grown up with a calculator in hand, cable TV, instant replays, an instant camera, microwave ovens, and electric typewriters. They are familiar with the idea of "instant everything". So much the better if they have seen "Star Wars" and its follow-on movies and relate to those futuristic concepts. Even so, a grasp of the overall concepts of the integrated office system will not be automatic or even easy for every one. The continuing problem of declining ability on the part of high school and college graduates to read and comprehend and to write effectively will play some part in limiting the usefullness and performance of the integrated electronic office as well as the time table for its full implementation. The point is that technology is proceeding at a faster pace than is the supply of people who can fully utilize and deal with it. On-site formal training, perhaps computer assisted, can solve some of the potential training problems but a need for integrated systems training in the traditional school system prior to entering the business or government office world is indicated. The system operators can perhaps be trained easier than can the system users, the managers who will benefit most from the systems. Before they can be trained in the system details the managers must be convinced of the benefits to be obtained therefrom.

(c) New personnel relationships. It is to be expected that new personnel job descriptions will be added to those which now exist for office managers and system operators. When word processing and data processing are combined in an organization there will be a need for a manager who understands both

technologies and is able to direct them in a manner to take full advantage of all available resources. Information Systems Managers or Information Processing Managers are likely to be the senior manager in such offices with data processing and administrative managers still existing but performing their duties under the guidance of this new super-manager. In many large corporations today the data processing and word processing managers never communicate and sometimes don't even know each other's name. This is a situation which clearly cannot exist in the fully integrated electronic office of the future. There must be an agreement as to the division of responibilities between managers but such division must not separate the managers so far from each other that they are not only up to date on the trends and requirements of their own area of responsibility, but also of their counterparts in other parts of the organization.

(d) Personnel availability and costs. Some attention has been given in the paragraphs above to the training of operators and the education of managers but there are some further points worth making. Even though office automation, if correctly done, will permit the same amount of work to be done by fewer people or more work to be done by the same number of people, those people are going to be more expensive - their training will cost more and their level of expertise will demand a higher price in the job market. Competition for trained and experienced data processing personnel is very high right now. When office automation is added to the demand for computer oriented personnel the situation will only get worse. Even though the costs of hardware are steadily declining the costs of computer operation overall are going up, primarily because of software costs, software being highly labor intensive. There is now and will continue to be a shortage of maintenance personnel in the fields of technology herein discussed and those who are available are in the high-pay category. Systems analyst and data base managers have not previously been considered in the

costs of operating administrative functions but their employment in this area will require that their costs be at least prorated among all departments who use their services. The salary for data base managers is in the area of $50,000 and up, sometimes way up.

14.11.1.4 Machine interfaces. The research conducted has led to the conclusion that there are, for the most part, no industry wide standards for protocols to be applied within the interfaces between equipments. It is understandable that such diverse technologies as word processing and facsimile, each of which developed as stand-alone technologies, have given little or no thought to the interfacing of those technologies which is now taking place. However, even within a single technology the same interface problems exist. Front-end or in-line processors have been developed to overcome some of the problems but not all. Some pretty strange things still happen when a word processor which uses one algorithm to perform word underlining is interfaced to a machine which uses a vastly different algorithm. Continuing development of microprocessors and their incorporation into equipment communications interfaces to overcome these incompatibility problems is bound to help, but greater attention is needed in this area. If universal communications compatibility is not achieved between every model of each of the represented technologies, then consideration must be given at time of systems procurement to acquiring systems and equipments which <u>are</u> compatible. Close coordination between those individuals who acquire systems and experts in the field of telecommunications is strongly indicated.

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Systems: PRIMACS-1, PRIMACS-2.

Wiltek, Inc., 542 Westport Avenue, Norwalk, CT 06851
System: The WILTEK Electronic Mail System.

Wang Laboratories, Inc., One Industrial Avenue, Lowell, MA 01851
System: Mailway.

TYMNET, Inc., 20665 Valley Green Drive, Cupertino, CA 95014
Systems: OnTyme-II, TYMNET Private Networks.

IBM General System Division, Atlanta, GA
System: IBM 5520 Administrative System.

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International Business Machines Corporation, General Systems Division, 4111 Northside Parkway, P.O. Box 2150, Atlanta, Georgia 30301

International Business Machines Corporation, Office Product Division Branch Office, 1550 Hotel Circle North, San Diego, CA 92108

Lexitron Corporation, 9600 DeSoto Avenue, Chatsworth, CA 91311

A.B. Dick Company, 5700 West Touhy Avenue, Chicago, Illinois 60648

Digital Equipment Corporation, Word Processing Computer Systems, Merrimack, New Hampshire 03054

Jacquard Systems, 1639 11th Street, Santa Monica, CA 90404

Burroughs Corporation, 95 Horse Block Road, Yaphank, NY 11980

NBI Inc., 1695 38th Street, Boulder, CO 80301

CYBERTEK, 6133 Bristol Parkway, Culver City, CA 90230

Lanier Business Products, Inc., 1700 Chantilly Drive N.E., Atlanta, Georgia 30324

Exxon Information Systems, 9 Vreeland Road, Florham Park, NJ 07932

Wang Laboratories, Inc., One Industrial Avenue, Lowell, Massachusetts 01851

Bowne Information Systems, 160 Water Street, New York, NY 10038

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DatagraphiX, P.O. Box 82449, San Diego, CA 92138

Infodetics Corporation, 1341 South Claudina Street, Anaheim, CA 92805

Dunn Instruments, 52 Colin P. Kelly Jr. Street, P.O. Box 77172, San Francisco, CA 94107

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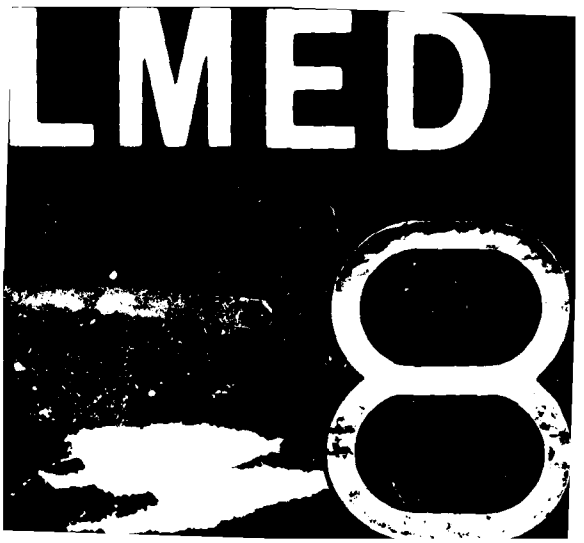
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