Electronic Mail: A Comparative Evaluation

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SUMMARY

The purpose of this report is threefold. We define electronic mail and describe its characteristics. We compare electronic mail to telephones and the U.S. Postal Service (USPS). We conduct an economic analysis of these alternate forms of communication.

While we start with the most general definition of electronic mail (EM) as "the delivery of messages by electronic means," we trace the evolution of an operational definition by discussing three successive stages of EM. First, EM is an alternate to physical and verbal message delivery. Second, EM involves the capabilities of directly receiving and sending messages at a terminal and directly obtaining a printed copy of both messages, where "directly" means without the use of an intermediary. Third, EM necessarily involves computers and computer-related technologies to allow for the processing and handling of messages before and after transmission. We conclude by recognizing the impact of new and existing technologies on this operational definition.

The cost justification analysis for electronic mail is approached in terms of hardware and investment costs, direct out-of-pocket costs, and qualitative or "soft" factors. The initial investment for a dedicated, EM-only system can be substantial and is often difficult to justify. Consequently, and based on current trends in office automation, we assume that electronic mail is acquired as an addition to a system with some other "backbone" application. When amortized over time, this marginal cost is negligible relative to the dedicated alternative.

For direct and qualitative benefits and costs, we compare electronic mail to its major established alternatives, postal services and telephones. EM will soon be or is already cost competitive when considering direct costs. Qualitative factors are divided into six time factor and seven general characteristics. The telephone and EM are rated equally when connect, delivery, and reply time are considered, while the former is better in terms of convenience. The USPS had a top rating in only one time category, the interruption factor, which it shared with EM. Electronic mail is rated highest in geographic freedom, records, filing, and one-to-many considerations; the USPS in records and integrity/validity; and the telephone in tone of voice. However, these ratings cannot be compared without using value judgements of the end user.

In sum, EM has many of the advantages of telephones and the U.S. Postal Service with fewer of their disadvantages. The major weaknesses of EM stem from its relatively recent introduction and consequent unproven cost effectiveness and lack of standards. Most, if not all, of these problems are expected to improve with greater use and acceptance. Overall, the three alternatives are viewed as complements, since each has advantages and disadvantages that make it better suited for an individual user's needs. No single service will replace the other two; instead, each will to serve a particular market segment.

INTRODUCTION

The objectives of this report are: (1) to provide a definition of electronic mail, including a description of its characteristics, (2) to compare electronic mail to the telephone and the U.S. Postal Service and, in doing so, (3) to conduct an economic analysis of these alternate forms of communication.

Office automation has recently been the focus of much attention. This movement has centered on efforts to increase productivity of managers, professionals, secretaries, and other white collar workers. For instance, word processors can reduce a secretary's work time by over 30 percent (Konishi). Office costs are rising faster than costs in any other sector of business operations (Connell), yet less than $0.05 is spent on office automation technology for every dollar of the $600 billion spent annually on knowledge-worker salaries and internal support costs (Ross). Further, 53 percent of all workers are white collar, and past emphasis on their blue collar counterparts leaves little leeway for productivity improvements in that area (Goldfield). Attention is thus being placed on increasing professional productivity to reduce escalating costs and, in doing so, to improve corporate profits. In the nonprofit arena, costs can similarly be reduced to provide a given level of service, or greater output might be obtained for a given level of costs.

A defining characteristic of white collar workers is that they often deal with information instead of physical products. The effective management of information is essential to decision making in both the private and government or nonprofit sectors. Information is of no value in itself, but the timely transfer of the right information to the right people can provide not only a competitive edge, but the critical ability of keeping one step ahead of a rapidly moving environment. At the firm or industry level, organizations are

also larger and more geographically dispersed. Subsequently, typical decision makers require better and increased communications with more persons situated over a broader area to meet their information needs.

Messages and their informational content are conveyed via a gamut of methods and technologies but two modes, telephones and mail/postal services, are predominant. More recently, electronic mail (EM) has appeared as an up-and-coming third mode. It can be considered a totally new medium of communication, but to call it an alternative to the telephone, the U.S. Postal Service, or even carrier pigeons may be totally missing the point. Although a viable substitute, the real strength of electronic mail "lies in its ability to provide management with all the information it needs about everything that is happening everywhere, the direction in which other members of management are thinking and blow-by-blow accounts of decision-making processes, all without recourse to the telephone or interminable meetings" (Sharp).

Electronic mail is cited by Connell as a good example of the impact of computer networks on information technologies and of how the distinctions are blurring as word processing, telecommunications, data processing, and computerized storage are integrated. Four factors were cited as driving forces for the growth of electronic mail in the United States during the Seventies (Callahan & Norris)[1] and concurrently, the improvement of white collar productivity:

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[1]Canada, England, France, Germany, Austria, Italy, Holland, Brazil, Japan, Singapore, and others are also listed as having electronic mail (Hindin).

1) The technology making large EM networks possible.

2) Large-Scale Integration (LSI) made it economically feasible to produce the components that were technically possible. Examples are processors, terminals, and communications interfaces.

3) The belief that organizations must communicate more effectively to compete, coupled with the growth of larger and more geographically dispersed organizations and operations.

4) The advantage of communications speed in competition.

In the late Seventies and early Eighties electronic mail has attained a point where "a rash of transmission services have been developed to support it" (Edwards).

Thus, although part of a larger overall effort towards office automation, electronic mail has grown to a separate technology in itself and will apparently continue to grow and be an integral part of the modern world. But what is "electronic mail"? How does it compare to conventional communications media? What costs and benefits are involved? Does EM in fact improve productivity? This report addresses these and similar concerns.

ELECTRONIC MAIL DEFINED

The term "electronic mail" has been used by different authors at various times to describe a number of systems including Telex-TWX, facsimile, computer based message systems, Electronic Computer-Originated Mail (ECOM), communicating word processors, voice-store-and-forward systems, personal message services, electronic message services, and computer teleconferencing systems. Depending on the particular definition and usage, each is electronic mail in its own right. Each might also be viewed as an evolutionary branch or stage of EM. Some are competitors, some novelties, and some different variations of electronic mail today. Still others may be prototypes of future systems. Nevertheless, this section presents an evolutionary definition of modern electronic mail by following the historical trends in EM. Its purpose is to review the technologies that have historically been called "electronic mail" and concurrently, to work from this broad base to a more concise definition applicable to electronic mail today and suitable for the analyses in this report.

A sweeping definition of electronic mail is "the delivery of messages by electronic means." Since even the telephone, radio, and television qualify by this standard, we must refine this definition. We do so in three stages.

Definition Stage 1

Electronic mail is initially defined as the delivery, via electronic means, of messages that would otherwise be physically or verbally transmitted. This explicitly excludes postal services and the telephone although we do not imply that either will be replaced by electronic mail. EM will more likely be a complement by substituting in areas like information management in which the world has very little prior experience, i.e., where other communications media

are inadequate. Two types of "electronic mail" included under this definition
are teletypes and telecopiers.

Teletypes. The technology for electronic mail in the sense of
definition stage 1 has existed ever since the telegraph was used to deliver a
message between Washington and Baltimore in 1844. The more modern version of
telegraphy is the teletypewriter, which transmits messages between locations,
or point to point, as strings of characters. Teletypewriter terminals were
first made available on the customers' premises by AT&T in 1931 under the
tradename TWX (Panko, 1979). In 1959 the Western Union Telegraph Company
entered the market with the European development called Telex (Teleprinter
Exchange Service). Both services were combined in 1971, when the Federal
Government forced AT&T to sell TWX to Western Union.[1]

Today, teletypewriters are widely used in private teletypewriter networks
(PTNs) for intracompany communications and for Western Union's message
services, including Telex-TWX, telegrams, Mailgrams, Money Orders (electronic
funds transfer), and Cablegrams (international telegrams). Telex alone has
140,000 subscribers in the United States (including 483 of the Fortune 500
companies[2]) and 1.5 million in 154 countries around the world (Western
Union Telex), yet the demand for PTNs is considerably greater than the demand
for Western Union's public common carrier services (Panko, 1979). One PTN

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[1]Despite the sale, AT&T (at least in 1979) remained the dominant company in
the teletypewriter market due to its positions in the transmission, terminal,
switching, and other segments of the large private teletypewriter network (PTN)
market for business & government.

[2]Edwards estimates that 70% of the Fortune 500 will have EM by the early
Eighties, perhaps reflecting a difference in definitions of electronic mail.

example is Hewlett-Packard's internal forms processing system. In 1977 it linked 74 locations in the United States, Europe, Japan, Singapore, and other locations with a volume of 23 million messages (85 percent forms, 15 percent narrative). The approximate cost per message, including hardware amortization, was $0.05[1] (Panko, 1979). As for Western Union, over $500 million, or 85 percent of its 1977 revenues, came from electronic mail services. A more detailed breakdown shows Telex-TWX to have contributed 40 percent of total revenues, telegrams 11 percent, Mailgrams 9 percent, and Money Orders 8 percent (Washburn).

Two more recent entries with some similarities to Mailgram are the U.S. Postal Service's INTELPOST and ECOM (Electronic Computer-Originated Mail) systems. The first uses electronic means to transmit messages internationally, with next day delivery by hand. ECOM messages must be delivered to one of 25 domestic serving post offices (SPOs) where a computer assembles, addresses, sorts, and electronically transmits mail to the destination SPO. There, messages are printed, collated, folded, and stuffed into envelopes. Mail then enters the first class system for next day delivery, and almost always within two days of receiving the messages. However, the service is aimed at bulk mailings. Although costing as little as $0.26 per message (depending on volume and with a two page maximum), a minimum of 200 letters is required per mailing. Prices can easily rise to $1.10 per piece (Edwards; Anon., 1982b; Gordon; Anon., 1981b; Washburn).

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[1] It is not clear whether HP later upgraded this system. Panko later refers to the COMSYS mail system (marketed commercially as the HP2060) with a hardware cost, including terminals, of $0.50/message (Panko, 1981). Garcia Luna Aceves, in referring to a HP2026 network connecting 200 HP centers in over 15 countries, cites average transmission costs of $0.01 for domestic messages and $0.08 for international messages with an average message length of 600 characters.

Telecopiers. While teleprinters transmit just characters, telecopiers, also called facsimile or fax, reproduce the entire page by optically scanning the document, converting the image to an electrical impulse, and transmitting the information via telephone line to be reproduced on a similar machine at another location. Facsimile might be viewed as being essentially two photocopiers, where the copy is produced at a remote location connected by phone line to the originating machine. Like a photocopier, material for facsimile can include pictures, graphics, handwritting, and text in any alphabet, providing for operator convenience and enhanced throughput capability (Raag).

Although facsimile in a crude form was invented in 1842, it was limited to special applications prior to the late Sixties because of its slow speed and high cost. For transmission alone, users paid long distance rates at four to six minutes per page. With new technology like computerized data compression and wideband transmission, this time was reduced to the neighborhood of 10 seconds per page. High-speed fax subsequently experienced rapid growth, primarily as a replacement service for private teletypewriter networks (Edwards; Panko, 1979).

Definition Stage 2

Many of the EM candidates listed above are eliminated by definition stage 2: electronic mail involves the capabilities of directly receiving communications at a terminal, using the terminal to directly respond, and being able to directly obtain a printed copy of both messages. Communication should flow directly from sender to receiver without being handled by a human intermediary, implying that terminals be physically located in the immediate vicinity of EM end-users. Teletypes and fax thus may or may not represent electronic mail, in the sense of definition stage 2, depending on the physical location of the terminal. Machines located in a central mailroom or "communications center" are not EM, since access by end-users is via indirect means—the center staff. Conversely, terminals located in the end-users' offices are EM. Although the end-user may delegate actual access to a subordinate, the capability of direct use still exists.

Stages one and two are traditional definitions that focus on electronic mail being just a transmission medium, although transmission can now represent only a fraction of the total cost of a message. EM uses today require that the concept be extended to include the processing of communications (Panko, 1979). This limits EM to two forms: the systems discussed to this point, involving dedicated machines like Telex and facsimile whose sole function is transmitting and receiving messages, or nondedicated machines where transmission is just one of several integrated capabilities of a system.

Definition Stage 3

The position taken in this report is that the nondedicated, multipurpose, computer based system represents the electronic mail that will better serve the information needs of the modern world. The third stage of our definition therefore explicitly recognizes (1) the role of computers and

computer-related technologies in electronic mail, and (2) that EM also involves the handling of messages before and after actual transmission.

This definition reflects trends within the office for increased use of computer technologies and for integration of all information-related machines. A typical workstation for electronic mail may therefore be a stand-alone microcomputer or a dumb terminal used to access a central computer. Besides EM, both may also be used for writing manuscripts, producing form letters and mailing labels, accessing data bases, and performing statistical or financial analyses. Several examples of nondedicated systems have been referred to in the literature, including communicating word processors, computer based message systems (CBMS), electronic message services (EMS), and personal message services (PMS).

Communicating Word Processors. Communicating word processors are exemplary of the evolution from dedicated to multipurpose systems. Communications modules have been offered as an option on dedicated word processing systems since 1973. Although such modules originally cost as much as facsimile terminals, they offered the ability to transmit long documents quickly and easily from one machine to another. In comparison, multipage reports are prohibitively expensive to retype on teletypewriters and can be tedious with facsimile (Panko, 1979). Manufacturers also offer the capability of using other software like spreadsheets or data base managers. The effects of technological advances, especially in microprocessors, are such that it is perhaps just as likely today to find a mini- or microcomputer dedicated to word processing as it is to have a word processor with optional capabilities. Either offers electronic mail capabilities, but a major problem with both is the lack of standards leading to incompatibility between machines. Consequently, communications until recently have generally been limited to

equipment of the same manufacturer.

Computer Based Electronic Mail. Communicating word processors add text writing/editing and local file storage capabilities to the transmission function. As point-to-point (user to user) systems, communicating word processors are, at best, crude examples of EM under definition stage 3. A more advanced step involves the group of related systems with names like CBMS, EMS, PMS, computer message services, mailbox services, electronic bulletin boards, and computer mail. Unlike previous forms that generally involve transmission from point to point, these systems are characterized by interactions between users and a central computer or a network of several computers. Access from remote terminals is usually accomplished via modems (modulator-demodulators) over telephone lines. Anyone with a telephone, an access code, either a dumb or intelligent terminal, and a modem can have electronic mail. Thus, communicating word processors and microcomputers linked to "talk" to one another are treated as special subsets of this group.

Each electronic mail user is assigned an "address" in the central computer's memory, analogous to a post office box or pigeonhole. Instead of a mail clerk, the computer sorts mail and deposits it in the box for each addressee. The patron can then log on to the computer and access the mailbox at his or her convenience in terms of both time and location (further discussed below). Any text processing and file storage can be done either offline by utilizing the capabilities of the remote terminal-workstation, or online by using the services of the central unit.

The capability for this type of electronic mail arose from advancements in computers, specifically in timesharing networks. One such network was first developed in 1971 in an effort to use computers in the Delphi and other structured procedures. Users demanded the ability to exchange free form

messages, leading to "computer teleconferencing." Soon after, the ability for network-wide mail delivery was added. In the mid-Seventies, the National Science Foundation funded the development and evaluation of two major computer teleconferencing systems, of which one, FORUM, is now marketed commercially (Panko, 1979). Another pioneering effort was ARPANET, a packet switched computer transmission network created in 1972 by the Defense Advanced Research Projects Agency (DARPA) to interconnect the many computers with software developed under its funding (Panko, 1979). Some of the major networks in operation today include GTE's Telenet, Tymnet, Computer Corporation of America's COMET (COmputer MEssage Transmission system), and DIALCOM. Local Area Networks (LANs), based on the assumption that any kind of input device can be linked to a comprehensive system, are only able to provide EM service to users over limited distances in the range of a few miles, but could be linked to more distant areas via telephone lines (Seaman).[1] Present vendors and their LANs include Wang Laboratories (WangNet), Amdex (Cablenet), and Xerox (Ethernet). Both the major and local networks are typical of the electronic mail capability of multipurpose systems.

From the user's viewpoint, electronic mail has thus been relegated to being "just another program" or software package to be used on a dumb terminal or microcomputer. It must be noted, however, that electronic mail alone is rarely cost-justifiable. Without a "backbone" application like word processing to justify the equipment, "electronic mail is realistically prohibitive in cost and usefulness"[2] (Goldfield). Equipment with multiple

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[1] To have the full capabilities of EM—i.e., message storing, geographical and temporal freedom, and other functions associated with a central system, LANs would require a controlling computer.

[2] These statements will be further challenged when the economics of electronic mail are analyzed not only in terms of direct dollar impacts but also in terms of nonquantifiable or "soft" benefits and the overlying context of an organization's information requirements.

uses is implied, but the argument is even more valid for a dedicated machine. While teletypes and telecopiers serve a specific need in certain organizations, the multipurpose system is more functional and amenable to use by a wider range of organizations and individuals, if only by virtue of its many functions. Further, such terminals have consistently demonstrated an ability to be used enthusiastically after being placed on the desks of line managers (Panko, 1981). With such ready access by managers, professionals, secretaries, and other end users, machines have higher utilization rates compared to devices placed in a centralized "communications center" with its own staff of trained operators. The latter tend to be "psychologically inaccessible" and involve added labor costs (Panko, 1979).

However, it is recognized that electronic mail is a dynamic medium. Examples are ongoing developments to give facsimile document storage capabilities and to establish linkages between fax and word processing equipment. EM today may be obsolete tomorrow as these or other new products and technologies like micrographics, voice systems, fiber optics, light pens, and electronic "mouses" make their impact.

A Working Definition

Figure 1 is a diagram illustrating the process by which we have moved from a general definition of electronic mail encompassing a broad range of technologies to a more refined meaning of EM. To summarize: electronic mail (EM) involves the computerized handling and electronic tranmission of messages that would otherwise be physically or verbally delivered. Users are able to personally check their "mailboxes" for messages, view desired mail at a video terminal, type responses at a keyboard, forward messages to others, and print out and/or electronically store copies of correspondence at their convenience.

New material can be researched, drafted, and edited at the terminal, with the capability for multiple copies being simultaneously sent to different users. Centralized computers, telephone lines, and remote terminals are the basic components of EM. Electronic mail thus integrates the computer technologies of word processing, data processing, and telecommunications into a single use.

General:

Delivery of messages by electronic means

Stage 1:

Substitute for physical or verbal transmission

Stage 2:

Two-way transmission, printed copy; proximity of terminal to end-user

Stage 3:

Include processing of communications and the role of computers
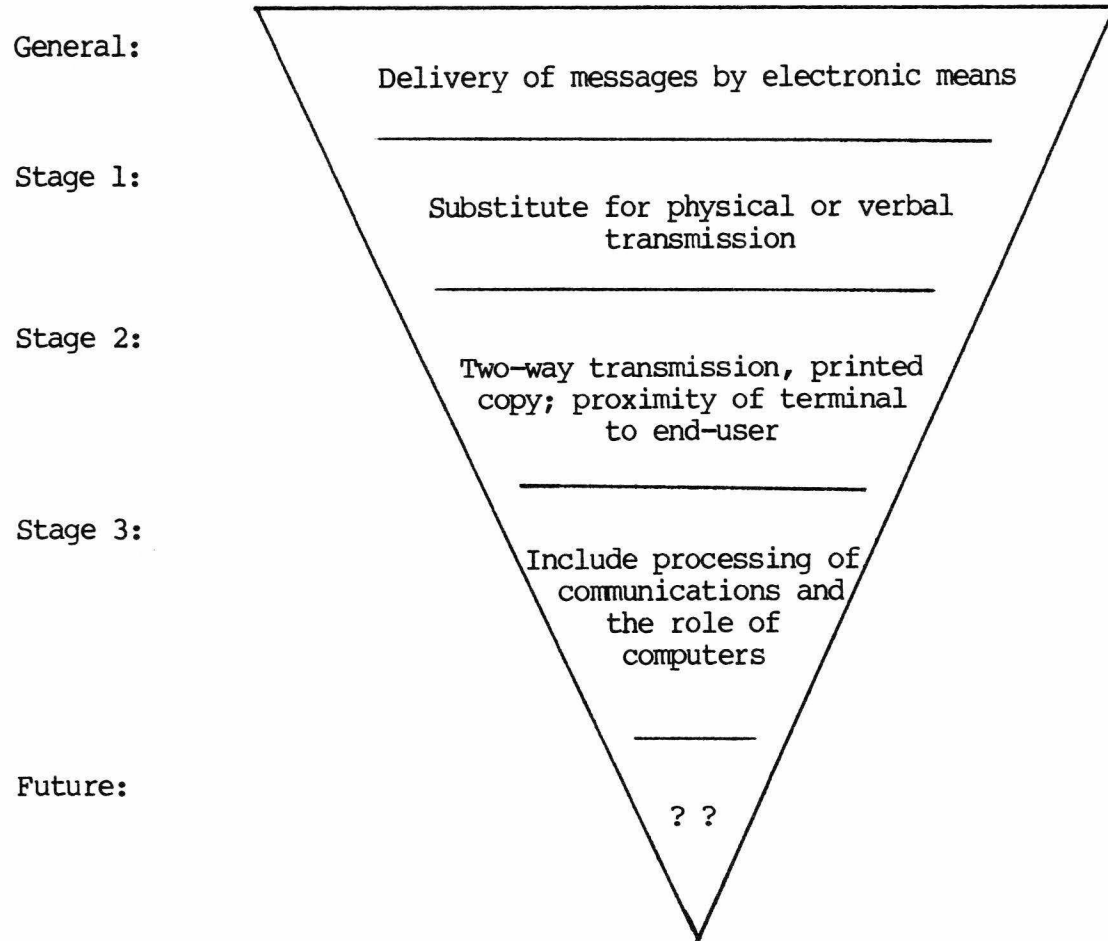
Future:

? ?

Figure 1. An Evolutionary Definition of Electronic Mail

QUANTIFIABLE COSTS

The cost analysis of electronic mail contains three components: hardware and other costs associated with the initial investment in EM, direct out-of-pocket costs incurred in using EM, and soft or qualitative costs associated with EM use. The first two are readily quantifiable: that is, dollar values can be attached to the various items considered. Both are discussed in this section. Soft, or nonquantifiable, benefits and costs are discussed in the following section.

Hardware and Investment Costs

Unlike telephones and conventional mail, the initial investment in electronic mail can be substantial. Besides the hardware or physical components, software needed to operate the equipment may also have to be acquired. Vendors often include software with hardware as part of a package or total system. In other cases, the cost for software is incorporated into hourly use rates. In addition, some EM vendors charge an initial subscription fee that is similar to a hookup charge to initiate telephone service.

Several other considerations add to the problem of high investment cost. First, a generalized analysis is difficult because of the variability in the costs and types of equipment and EM services available. Even if only dumb terminals are purchased to tie into a commercial network, their cost can range from several hundred to several thousand dollars per terminal. Supporting products like tables or communications software may need to be purchased. Some systems can operate on existing phone lines, while others might require special wiring. The total could easily exceed $500,000 if an in-house minicomputer or mainframe is involved. As noted, some vendors charge an initial subscription fee, while many do not. Similar electronic mail

capabilities can be provided by different manufacturers at significantly different prices. Thus, the total cost is not only substantial but highly case-specific. It varies widely with the number and type of terminals, the configuration of the equipment, the manufacturer, installation costs, any commercial EM networks used, and so on.

Further, although it decreases continuously with use, fixed cost per unit of use varies with the amount of utilization and the magnitude of the initial charge. If amortized over time, the assumed use life, time period increment, discount rate, and tax considerations are also important factors in cost justification.

Consequently, and despite technological improvements and decreasing hardware costs from large-scale integration, an investment dedicated to electronic mail will be difficult to justify on a cost-benefit basis. It is a general conclusion that either the lease or the initial purchase costs are prohibitive for a dedicated system. This is especially true when the probability of technological obsolescence and the possible business failures of manufacturers and vendors in the rapidly changing computer industry are considered.

Acquisition costs are lower, however, if electronic mail capabilities are added to an existing system. This paper assumes that EM is obtained subsequent to a primary application like word processing or data base management. This is a valid assumption given the current trends toward office automation, computerization, and the greater use of microcomputers in the home and office. Electronic mail is thus acquired with relatively inexpensive additions or modifications to existing equipment. Relative to a dedicated system, the amortized cost is negligible.

Comparative Direct Costs

This subsection presents an out-of-pocket cost comparison between electronic mail and regular mail, express mail, telephone, and electronic alternatives (teletype and facsimile services). Table 1 contains a summary of the charges for using various communications media. These are basically transmission costs only.

U.S. Post Office rates vary according to the weight and size of the item being mailed and the particular service. First class mail costs $0.20 per letter up to one ounce, and $0.17 for each ounce thereafter. Messages on postcards can be sent for $0.13, while special delivery adds $2.10 to first class mail under two pounds. USPS Express Mail is advertised at $9.35 for up to two pounds. Federal Express costs $10.50 for its Overnite Letter services for letters up to two ounces, and $21.00 for its Courier Pak (up to two pounds). The cost for up to two pounds on Purolator is $20.00.

Telephone rates are highly variable, depending on the rate schedule of the company, distance, time of day, and whether or not operator assistance or other services are used. Local calls generally can be made at no direct cost. A recent advertisement by Western Union claims the average long-distance call lasts seven minutes. From New York to Los Angeles, this average call costs $3.69 at station-to-station rates during business hours. Based on the rate schedule printed in the Oahu Telephone Directory, the cost of a seven-minute call originating in Hawaii can range from $0.90 (direct dial, night rate to Neighbor Islands) to $17.70 (person-to-person, business hour rate to Alaska). Charges to the U.S. Mainland other than Alaska range from $1.61 to $8.74. International calls are even higher (Hawaiian Telephone Company). Systems like WATS lines, NU-TEL or GTE's SPRINT offer cost savings in the neighborhood of 18 percent to 56 percent over regular phones (SPRINT and NU-TEL brochures).

For Telex and facsimile, the Western Union advertisement cited above offers Telex at a cost of $0.3475 for a 66-word message to anywhere in the contiguous United States. Telex II is 50 percent faster and costs $0.43 per minute. It also states that the most common fax units would take four minutes to transmit a single page and cost $2.21 during business hours (Western Union). In general, older, low-speed fax units transmit at a rate of four to six minutes per page at long distance phone rates, averaging $2.50 per page. Medium-speed units (two to six minutes per page) average $1.75 per page and high-speed units (up to 20 seconds per page), $0.60 per page (International Resource Development). Faxpak, a network of computers and fax machines developed by ITT in 1977, offers transmission for as low as $0.12 per page (Howard) and Q-Mail, offered by National IMS Corp, uses facsimile to deliver messages at $1.50 per page (Anon., 1981b). INTELPOST, offered by the USPS, used high-speed facsimile with test period costs of $5.00 per page (Much).

The costs of "public" electronic mail systems vary but are decreasing at a projected rate of 15 to 25 percent per year (Panko, 1981). Contributing factors are technological advances that make lower cost equipment available. Further, many electronic mail systems to date operate at relatively slow speeds. As evidenced by low- to high-speed facsimile, costs can be reduced significantly as faster transmission rates are used. According to Howard Anderson (president of The Yankee Group, a telecommunications consulting company in Cambridge, Mass.), the per message cost of electronic mail has gone from $1.50 in 1977 to $0.75 in 1980 to a projected $0.50 in 1983 (Miller). Panko (1981) found EM costs of $0.50 to $3.00 per message (average $1.00), with expected transmission costs falling to less than $0.05 per message by 1989 (Panko, 1979).

As for specific systems, Edwards found GTE Telenet's Telemail to cost $0.05 per minute during off hours and $0.22 per minute during business hours. The cost of Dialcom over a 10-month period in 1982 by the Hawaii Institute of Tropical Agriculture and Human Resources (HITAHR) at the University of Hawaii averaged $0.142 per minute. Each call, often involving sending and retrieving several messages, averaged almost seven minutes in length and cost $0.95. Seaman cites a Comet internal report that found an average message to cost $1.11. He also quotes Tony Mallia, application product line director for Wang Laboratories, who placed Wang's Mailway costs at $0.62 per thousand characters for transmission only, or $1.50 per thousand if hardware, software, and staffing are included (Seaman).

Lind lists the costs of accessing several systems from Hawaii. Although largely information/data base services, both cited here also offer electronic mail. The Source charges a $100.00 initial fee and costs $18.00 per hour ($0.30 per minute) for day use and $10.00 per hour ($0.167 per minute) during evenings and weekends, with a $10.00 minimum charge per month. Lind notes that The Source's day rates are compatible with those in the continental United States, but that a $5.00 per hour premium is being charged for off-hour use. A $35.00 initial fee, including two hours of "free" use, is charged by Dialog. Subsequent use costs $24.00 per hour ($0.40 per minute) with no minimum, but only during restricted hours. Charges for both services include Telenet fees.

Table 2 contains a ranking of the various communications media according to estimated cost per message. It assumes a two-page letter is equivalent to a seven-minute telephone call or to three minutes on electronic mail. Only direct, out-of-pocket (variable) expenses are considered.

Table 1. Costs of Different Communications Media

U.S. Postal Service
   Postcards $0.13
   First Class $0.20 + 0.17/add'l oz.
     special delivery   add $2.10

Overnight mail
   USPS Express Mail $ 9.35 <2 lbs.
   Federal Express
     Overnite Letter $10.50 <2 oz.
     Courier Pak $21.00 <2 lbs.
   Purolator $20.00 <2 lbs.

Long distance telephone, 7-minute call
   New York to Los Angeles $ 3.69
   from Hawaii
     interisland night rate $ 0.90
     person-to-person, Alaska $17.70
     to contiguous U.S. $1.61 - 8.74
   WATS, SPRINT, NU-TEL   18% - 56% savings

Teletype and telecopiers
   Telex, 66 words $0.35
   Telex II $0.43/min
   Facsimile
     lo-speed fax $2.21 - 2.50/page
     med-speed fax $1.75/page
     hi-speed fax $0.60 - 1.50/page

Electronic mail
   Panko's study $0.50 - 3.00/message
   Telemail $0.05 - 0.22/min
   Dialcom (HITAHR) $0.14/min
                 $0.95/7-min call
   Comet $1.11/message
   Mailway
    transmission only $0.62/1000 characters
    total $1.50/1000 characters
   The Source $10.00 - 18.00/hour
              = $0.167 - 0.30/min
   Dialog $24.00/hour
              = $0.40/min

Table 2. Communications Media Ranked by Out-of-Pocket Cost

(Postcard $0.13)

USPS, first class	$0.20 + stationery
Telemail	$0.15 - 0.66/message
Dialcom	$0.42/message
The Source	$0.50 - 0.91/message
Panko's study	$1.00 ave/message
Comet	$1.11/message
Dialog	$1.20/message
Telex II	$1.29/3 min
hi-speed fax	$1.20 - 3.00/2 pages
med-speed fax	$3.50 ave/2 pages
lo-speed fax	$4.41 - 5.00/2 pages
NU-TEL, SPRINT	$1.19 - 7.17
long distance phone	$1.61 - 8.74
Overnight mail	$9.35 - 20.00

Assumed message equivalents:

    2-page letter = 7-minute telephone call
                  = 3-minute electronic mail message

The least expensive medium for out-of-pocket costs is first class mail at $0.20 per message plus supplies, although GTE Telenet's Telemail may cost $0.05 less for off-hour use. Electronic mail represented by public systems is second with costs ranging from $0.15 to $1.20 per message, followed by Telex II. Facsimile and telephone services are almost a toss-up, depending on the transmission speed of the fax machine and the distance of the call. Overnight mail services are the most expensive, costing as much as $20.00 for a single letter (not including pickup charges). Ironically, mail can cost as little as $0.13 if the message can be placed on a postcard and if privacy is not a concern. The services depending on telephone lines, i.e., everything other than mail, have a range of costs depending on the transmission distance and the time of day.

Assuming that the relationships shown remain unchanged over varying message lengths, Table 2 would seem to indicate that the cheapest method of delivering a message is via the U.S. Postal Service, and preferably on postcards. However, these figures do not consider the labor costs in writing or dictating and typing a letter, or delivering the letter to a mailbox, etc. Konishi found the average business letter to cost in excess of $10.00 for typing, copying, intracompany delivery, and filing (Konishi). Others found letters or memos to cost from $4.47 to $18.00 (Holden). Further, labor costs have been increasing: one estimate is 6 percent annually (Konishi). Others found the cost of a 250-word business letter from dictation to mailing to have increased from $1.17 in 1953 to $2.32 in 1964 to $3.31 in 1973. In addition, the 1973 figure was based on a secretarial wage of $572.00 per month, despite a range of $555.00 to $725.00 and the fact that most make in excess of $660.00 (Costello). Thus, the addition of labor charges alone will push the cost of a

Table 3. Comparative Costs of a 150-Word Business Letter
and a 6-Minute Telephone Call

Method	Labor	Out-of-Pocket[a] Expense	Total[b]
Machine dictation, power typewriter	$1.03	$0.17	$1.35
Machine dictation, standard typewriter	$1.31	$0.16	$1.48
WATS telephone call	$1.14	$0.61-1.44	$1.75-2.58
Secretary dictation, power typewriter	$2.24	$0.17	$2.61
Secretary dictation, standard typewriter	$2.61	$0.16	$2.77
Longhand, power typewriter	$2.64	$0.17	$3.01
Longhand, standard typewriter	$3.00	$0.16	$3.17
Toll telephone call	$1.14	$2.01-3.23	$3.15-4.37

[a]Supplies, postage, and telephone charges

[b]Labor, equipment, supplies, postage, and telephone costs

letter well above the $0.20 paid for postage. Similarly, labor and other factors must be included in the costs of different communications media.

The results of a study at the Eastman Kodak Company during the mid-Seventies are summarized in Table 3. Fugler found the labor, equipment, postage ($0.13 at the time of his study), and supplies cost of preparing a one page, 150-word letter with two carbon copies to range from $1.35 with dictation to a machine and using Mag Card II ("power") typewriters, to $3.17 for a longhand manuscript with a standard typewriter. He found the total cost of a machine-dictated letter on either a standard or power typewriter, $1.35 and $1.48 respectively, to be less than either a six-minute WATS call ($1.75 to $2.58) or regular toll call ($3.15 to $4.37). The way letters were prepared made a difference as nonmachine-dictated letters cost from $2.61 to $3.17, which was more than WATS but still less than toll calls (Fugler). When considering more than delivery charges, Fugler found letters were not necessarily the least expensive medium. However, when only out-of-pocket expenses (postage, supplies, and telephone charges) were considered, letters were found to be always less expensive than WATS or toll calls (respectively $0.16 to $0.17, $0.61 to $1.44, and $2.01 to $3.23). Since the labor and equipment costs can rarely be recovered—e.g., secretarial staff will still be paid whether or not letters are typed, office equipment payments must still be made regardless of their level of use—Fugler concluded that the advice "Write when possible . . . phone only when imperative" was still valid.

But what of electronic mail? As discussed below, electronic mail is expected to reduce the labor costs in preparing a message, in some cases to the point of eliminating all secretarial work. Fugler's labor costs additionally do not consider other time costs like locating a person by phone, interruptions, or the speed of postal delivery. A total cost comparable to

the analysis in Table 3 would also depend on the volume of electronic mail, other uses for the equipment, and the relative prices of labor and hardware. Given the trends toward more office automation, lower prices in equipment, increasing labor costs, and greater productivity from the use of EM, it is expected that electronic mail, if not already, will soon be cost-competitive with regular mail. As opposed to the hard figures obtained from direct out-of-pocket expenses, many of these and other factors are described as "soft" benefits and costs. The following section extends the direct cost analysis to consider these soft factors.

QUALITATIVE BENEFITS AND COSTS: COMPARATIVE STRENGTHS AND WEAKNESSES

Electronic mail has been and will continue to be evaluated relative to

its opportunity costs—i.e., telephones and conventional mail as alternatives.

The analysis above accomplished this using the dollar as a known standard.

This measure is not presently applicable to soft benefits and costs, yet

although a characteristic may not be quantifiable, its intensity or magnitude

can be conveyed via comparisons with established norms. Texture, for

instance, can be described relative to silk, denim, burlap, or sandpaper. In

comparing the items silk could be given a "1," denim a "2," etc., to indicate

relative softness. This section uses such an approach to develop rankings

among the three alternatives for the various factors considered.

The literature describes a number of strengths and weaknesses for each

communications mode. These are grouped into the following categories for

comparative purposes:

1) time requirements
2) geographical freedom
3) convenience vs. the interruption factor
4) records and file copies
5) one-to-many considerations
6) security and related factors

The section concludes with some notes on user acceptance.

Time Requirements

The time involved in using any communication mode is further divided into

three parts: (1) connect/preparation time, (2) delivery time, and (3) reply

time. The connect/preparation time is the period required to initiate the

service. For the telephone, little preparation is involved. Both parties

must be available for a connection. Consequently, the caller often encounters

a busy signal, or may find the other party out of the office or "in a

meeting." The caller may be put on interminable hold (sometimes spiced with Muzak), but more often engages in the game called "telephone tag" where a message is left to return a call, but the replier in turn must leave a message, and the process continues indefinitely. One study found a success rate for getting through on initial calls of only 26 percent (Holden). Another estimated that more than 30 percent of calls are not completed by the third try, and that one-third of all telephone time is wasted becouse the intended communication was not accomplished (Tellefsen). Connect problems are further compounded by time zone differences. For example, calls between Hawaii and the U.S. East Coast during an 8-to-5 workday are limited to a "window" of three or four hours when both parties are in their offices. For the same reason, calls to certain foreign countries are impossible during conventional office hours.

With regular or electronic mail the preparation aspect is more relevant, and is defined to include any activities between composing a message and either dropping the letter in a mailbox or dialing up the electronic mail system. Mutual availability is not a problem since the sender can write or dial up at any time and since the receiver can check his mailbox and read letters at his convenience. For regular office letters the writing process often involves a longhand draft or dictation to a secretary who types the document, sends it back for review, and makes corrections. Mail then enters the "out" box to begin the process of getting finished letters into the postal system. Conventional letter writing therefore could involve a number of persons over a fairly lengthy period.

In contrast to formal letters and memos, casual users of electronic mail tend to send terse messages only one or two lines in length (Ross). Unlike errors in regular mail, typos are perceived as being acceptable (Holden) but

can be easily corrected using the workstation's word processing or editing capabilities. Consequently, many users have developed a habit of doing as much "easy" work as possible at their own terminals while delegating work to secretaries only when it takes more than a few minutes of time (Holden; Panko, 1979). The option still remains for the end user to delegate terminal work to someone else. The writing process and connect time is nevertheless considerably shortened and has led to faster communication and increased productivity.

Delivery time deals with the period between establishing a connection and the other party receiving the message while, as implied by its name, reply time refers to the period required for the sender to get a reply to his original message. Telephone messages can be delivered and replies received almost instantaneously once both parties are on the line. Questions can be answered, points clarified, and previously undiscovered avenues explored without a protracted exchange of messages. This timeliness is perhaps the greatest <u>potential</u> advantage of verbal communication via telephone. However, in addition to the connect time, social decorum dictates that certain pleasantries be exchanged, be it the health of the family or the state of the weather. Telephone conversations are therefore longer than necessary. Some callers also tend to be verbose. One study found telephone calls to average 4.8 minutes each (Holden). Another estimated at least 30 minutes per day to be wasted (Edwards). A recent national advertisement claimed the average long distance call to be seven minutes long, even though most messages could be conveyed in no more than 75 to 100 words (Western Union).

Delivery time by the postal service has gained notoriety by being unreliable and the slowest of the three, usually requiring a number of days.

With the connect and delivery times of the receiver, it can easily be a week before the sender gets a reply. In response to this lag, a number of overnight and express mail services that promise next day delivery have been initiated, but for limited sizes of mail and at price premiums.

Delivery of a message to the receiver's mailbox with electronic mail is the fastest of the three. The low information density of speech leads to inefficient electronic transmission of messages (Holden). Speech requires a transmission rate of about 60,000 (60K) bits per second, but 60K bits of speech is equivalent to 15 characters of written text; i.e., a person can read aloud a passage of about 15 characters in one second. In contrast, the electronic transmission of 15 text characters requires only 120 bits. Without even counting telephone pleasantries, verbal communication is transmitting 500 times too many bits: in other words, it takes much longer to transmit the same message. However, the ensuing period until the receiver actually checks the mailbox and reads the message can be highly variable. The total delivery time is therefore expected to be somewhere between the telephone and regular mail times.

As noted, the reply time for telephones can be within seconds and for mail a matter of days. Electronic mail replies are facilitated by the characteristics of EM, so users often send off an answer right after reading a message. Like the delivery time, the total period until the original sender obtains a reply depends on when both check and read their mail.

In sum, the time requirements of the three media are ranked as follows (from fastest to slowest):

```
Connect/
    preparation:    1-EM, 2-telephone, mail (toss-up)
Delivery:           1-telephone, 2-EM, 3-mail
Reply:              1-telephone, 2-EM, 3-mail
```

The connect/preparation time between telephone and mail was rated a tie, largely depending on luck and perseverance in using the former. The unknown factor of when users access their EM mailboxes is the reason for the lower delivery and reply ratings. Overall, electronic mail is rated faster than its conventional postal counterpart. The time comparison between EM and telephones rests on the connect vs. mailbox access questions. It is expected that electronic mail will better its position as it becomes more accepted and established as a viable communications medium. The final result with respect to time will be a reduction in the "information float," the period between information creation and its reception by the end user (Callahan).

Geographical Freedom

The telephone is universal in the modern world but is a point-to-point service. That is, although nearly everyone has a phone, calls are made to a location instead of to a person. A number is dialed under the assumption that the receiving party will be at the corresponding phone location at the time of the call. As stated in the section on connect time, this is true for only a fourth of all initial calls. Instead of being at his desk, the intended receiver may be in another office, on a plane or driving a car, visiting a client, in the restroom, at lunch, down the hall, and so on. As the world gets more and more mobile, locating a person at a set time and place will be increasingly difficult.

The postal service is also geographically restricted but without a time constraint. Mail is delivered to a given address without the need for anyone to be present. However, the delivery of messages is still contingent on the recipient returning to that location.

In contrast, electronic mail frees users from time and geographic restrictions and capitalizes on the universality of Ma Bell. Because individuals are not directly contacted, messages need not be left at specific physical addresses. A user can receive his messages at any time by checking his mailbox from any location having a telephone line and terminal. Electronic mail thus allows people to effectively be in different locations at the same time, without unduly disturbing the principal activities scheduled for that time (Sharp).

Convenience vs. the Interruption Factor

Compared to letter writing, it is very easy to merely dial someone and verbally deliver a message. Mail requires composing, writing or typing, and for the traditional service, addressing an envelope and locating a stamp and mail drop. Although nearly every home and office has a telephone, finding a person's telephone number is not an overpowering problem, and is greatly facilitated by directories and directory assistance. In comparison, no readily available source exists for mailing addresses except for what is available from telephone directories. Finding a user's mailbox may also be a significant problem as more people use electronic mail (Holden; Panko, 1981). Marill and Holden note that in a group of 100,000 persons, the probability of a name ambiguity exceeds 70 percent, while the problem hardly exists with fewer than 1000 users. With these and related considerations, the telephone emerges as a very convenient mode of communication.

This convenience may be a boon to callers, but results in the telephone being a nuisance to many recipients. Although very few calls require immediate, real-time attention, practically every call involves an interruption of the receiver's activities. Besides the time lost on telephone protocol, even more is spent in recovering disrupted trains of thought. Telephone calls also mean attention is divided between ongoing and new activities, with both ultimately being worse off. Interruptions therefore promote actions like unhooked phones (busy signals), or "in a meeting" instructions to secretaries, which in turn promulgates telephone tag.

Most messages could be more effectively handled in a few periods during the day set aside for that specific purpose. Electronic mail and, to a more limited extent, regular mail allow users this ability to take care of correspondence when convenient. Further, replies are generally clearer and better thought out, having been considered with undivided attention. Electronic mail is fast when need be, but also allows time for reflection. Others can be consulted instead of being pressured to reply "off the top" as with verbal communications.

Records and File Copies

A message printed on a video screen or piece of paper allows both senders and receivers to make optimal use of their time. Correspondence can be prepared and reviewed without the time constraints and pressures of someone waiting for a reply. A file copy on paper or electromagnetic media is also available for future reference, while telephone calls require handwritten notes or other means of obtaining a record of the call. Without such notes, the information content of a telephone call is effectively limited by human memory, but the delays and problems with note taking can negate many time

advantages. Printed material also avoids problems with speech and recall. Consider the examples of obtaining the correct names and addresses for a list of people, or problems with ordering like "Was that four to arrive on the third, or three on the fourth?" or "My order was for 19 'night flashers,' not 99 flashlights."

However, two features of verbal communication that are not readily available with hard copy are the personal contact and a better "feel" of a conversation. Body language, facial expressions, the tone of voice, and hesitation can convey hidden meanings not found in the written word (many are only available in face-to-face meetings). Conversely, postal services are not limited to letters alone. Widgets or a bouquet of roses cannot be sent by telephone or electronic mail.

A comparison also needs to be made between records stored electromagnetically and in paper files. Electromagnetic media take up far less space than bulky paper files, and computerized processing eliminates a lot of inefficient manual filing and information retrieval. Data processing methods also allow rapid searches and sorts based on different record characteristics like date, subject matter, destination, or author. Such tasks may take days by hand. In addition, computerized records are relatively easy to duplicate, or "back up," as a safekeeping measure. Perhaps the major benefit of paper lies with reading longer documents or when flipping back and forth between pages. Of course, the electronic mail user always has the option of printing a hard copy of any file.

One-to-Many Considerations

Sending the same message to several persons involves a lot of time,
effort, and money with regular mail and the telephone. Witness the xeroxing
or mimeographing and the envelope stuffing, stamping, and addressing that
occur with something like a meeting notice or a newsletter. Witness also the
telephone trees that sprout if the meeting time is changed too late for
another mailing, and the members who are absent because they were not
contacted. With electronic mail, once a file of the membership list is
stored, the meeting notice and update need be typed just once, with a copy
being sent to all persons on the list. A similar EM feature is the electronic
bulletin board. Items of general interest or with no specific audience can be
posted for perusal and comments. The ensuing comments and discussion could
form an electronic forum or even evolve into an electronic conference.

As far as simultaneous communication is concerned, the timeliness of the
postal service realistically eliminates mail by definition, while having more
than three or four persons on a conference call is impractical.
Conventionally, the only viable method for many persons to communicate
simultaneously is in a group meeting, yet maintaining control can be a problem
any time more than one individual tries to speak. The existing and developing
technologies for electronic mail, however, make teleconferencing a viable
alternative to face-to-face discussions (Sharp). It allows a large group to
discuss issues in a manner unattainable in conference-type meetings. More
than one person can "speak" at once because the computer maintains order.
Since minutes are automatically recorded a person can not only leave the
discussion and not miss anything, but also has a record of past arguments to
refer to when the discussion is relevant, not past history. Because people
can participate from their own offices, such an arrangement does not require a

physical presence and thus removes the expense and need for travel. A person
could conceivably participate in several meetings at once. Thus, meetings
become event versus time oriented. Other possibilities on this theme include
the use of video equipment and applications like seminars, auctions, and
advice or instruction from otherwise inaccessible individuals or institutions.

Security and Related Factors

Electronic mail has some security and privacy advantages over telephones
and regular mail. There is less opportunity for eavesdropping, either by
overhearing a conversation or seeing a letter on a desk, or from processing
written documents as when sensitive material passes through the clerical pool
or when calls and mail are screened by a secretary. Periods affording privacy
can be chosen to use EM, and all materials can be left in a computer account
with controlled access.

However, the use of computer technology introduces a number of problems
for electronic mail (Connell). First of all, computerized information is
concentrated, so an unauthorized person could very quickly access a lot of
material. Some maintain that security and privacy can be ensured with a
properly designed system (Carr), but it is instructive to note the recent case
in which a group of teenagers accessed a national defense computer using a
home microcomputer! Of some consolation, no media or method is immune.
Historically, letters have been steamed open, vaults ransacked, telephones
bugged, secret codes broken, offices burglarized, couriers bribed, and so on.
If someone can design a system, someone else with more time, more ingenuity,
and more resources will beat it. For practical purposes, then, as much effort
should be expended in protecting correspondence or records as is warranted by
their informational value. The technology and methods like complex

coding-decoding, scrambling devices, elaborate password schemes, and key-operated terminals are available for those willing and able to make the necessary outlays.

A second question involves integrity. Is a message complete, or were portions deleted or lost? A related concern is validity. Were the contents of a document changed during transmission, storage, or receipt? Like the traditional media, both are obvious in some instances as in a missing page or garbled words. In both telephone and EM, users could get a poor connection. Other cases are unique to electronic mail, like dropped zeros where $5,000,000 is changed to $5,000. These are expected to be less of a problem over time as control techniques, like parity checking and handshaking protocols, and better equipment are developed and put into use.

The final security factor considered is authenticity—whether the message actually came from the person to whom it is attributed. With postal correspondence, authenticity (not accounting for forgery) is provided by signatures and letterheads, and correspondence could further be notarized. With telephones, one may recognize the caller's voice and is at least able to question the other party. Such accouterments are not available to electronic mail. Again, a solution may exist in the future with control techniques and other developments (Connell).

Some Observations on the Acceptance Problem

Telephones and postal services are well-established means of communication in the modern world, yet despite their acceptance, the discussion above has pointed to a number of weaknesses in each. Electronic mail can ameliorate many of these; ironically, a major problem with electronic mail appears to be its acceptance. Much of the acceptance problem

can be traced to the relatively recent introduction of not only EM but many of the other new technologies associated with computers. This is observed on both organizational and user levels.

At the organizational level, two conflicting forces come into play. Firms need to constantly adapt and change not only to grow, but to survive in the business environment. On the other hand, overenthusiasm for a project often results in unrealistic expectations, which in turn can lead to potentially harmful decisions.

Although firms do not want to be at a competitive disadvantage by being too slow in adopting new technology, the new technology itself creates problems. One centers on the lack of standards and the resulting inability of equipment of different manufacturers to "talk" to one another. A related concern is the number of companies offering equipment and services. Still a third is technological obsolescence caused by rapid changes in technology. A company purchasing one system early in the game may find itself literally "locked out" if the industry decides to adopt a different standard. It may find that the supplier is no longer in business, or that the product line is outmoded and no longer supported by the manufacturer. The more conservative majority take a "wait and see" attitude for others to do the experimenting, risk taking and developing of time-proven systems, yet this may leave the organization in a position of never being able to catch up. Consider, for example, that it may take months to incorporate a new system into an organization and that many models are technologically obsolete by the time they appear on store shelves because of advances in the research laboratory. The product life of something like a microcomputer is therefore fairly limited before a new model or replacement product line is introduced. A potential

buyer waiting for a system to be proven or for the improved version to be released will fall farther and farther behind and may end up never making a purchase.

Within the greater context of strategic planning, corporate goal setting, problem solving, etc., a tool that is often used to shed light on dilemmas of this type is some form of benefit-cost analysis. Even a risky project should be undertaken if its expected benefits (discounted for risk and uncertainty) outweigh its costs. Yet, one of the key historical obstacles to electronic mail is cost justification, in particular the meaningful quantification of benefits and costs (Miller). The problem lies in analyses with too rigid a line of thinking and too limited a scope, focusing mainly on factors that can be evaluated by their short-term effects on the pocketbook. Although their effects cannot be easily measured, factors like "increased productivity" and "higher job satisfaction" must be considered. This report has attempted such an incorporation.

At the user level, many humans by nature tend toward stability and familiarity, perhaps even more so as a survival mechanism in the rapidly changing modern world. This tendency to preserve the status quo can have profound effects on electronic mail's success. Users having electronic mail thrust upon them might view EM as a threat and may even go so far as to consciously or subconsciously attempt to sabotage the new system. Like the results of automation in manufacturing, those affected by EM may be concerned with the change in their work content and habits or may fear more radical changes, like the need for retraining or even being displaced by a machine. To a certain extent, there may be some basis to such fears. For instance, Sharp noted that EM makes nonsense of traditional pyramid-type management

structures and, because of its time savings, increases the span of control and associated responsibilities of any one individual. In terms of computers in general, Ross noted that computers may be reducing the need for middle managers in large organizations. He also found that computers may be reducing middle managers' access to higher management. Thus, while case histories show successful electronic mail systems to have a high degree of management use and support (Holden), EM might be hard to accept because it could add to job-related stress and uncertainty.

However, Panko (1981) found that user reactions were very favorable wherever electronic mail had been introduced. In one survey, he found that only a handful of 210 managers, professionals, and secretaries surveyed actually disliked the system. Perceived benefits varied widely by the person's job and whether or not terminals were directly accessed or delegated to a subordinate. Panko found that EM did not revolutionize the lives of managers, but instead produced steady gains.

Holden noted a phenomenon called the "satisfaction curve." New buyers experienced remorse, or a satisfaction dip, when the initial excitement surrounding a brand new system was followed by a realization of the limitations of the system. With more realistic expectations, satisfaction again rose to a stable level. Thus, a successful system needs a reasonable time period for people not only to learn EM but to attain the final satisfaction levels.

It must be noted, however, that electronic mail is far from being as extensive as either the telephone or postal services in terms of numbers of users. A message cannot reach someone if he or she is not an EM user! According to Holden, case histories also show successful EM systems to need a certain "critical mass" of users. Anyone with a terminal and telephone is a

potential user, and the number of persons utilizing this potential is

increasing daily, but in the interim the limited user base may be a barrier to

the acceptance of electronic mail.

CONCLUSIONS: BENEFITS AND COSTS

The telephone is the most convenient mode of communication since it is universal in the modern world and readily accessible. It gives users a "feel" or "mood" of the conversation, and potentially provides the fastest method of delivering a message and receiving a response. Paradoxically, the time element involved is one of its major disadvantages. Because telephone calls require simultaneous access in time and space, there are problems with time zone differences, locating a person, and subsequently, with interrupting the receiver's activities. Besides the cost of user time, other disadvantages are the effective maximum length of a message, the lack of a record of the conversation, eavesdropping, and perhaps most importantly, use charges, especially for long distance toll calls.

The U.S. Postal Service offers the most inexpensive transmission alternative and allows messages to be written and read at the individual's convenience. Mail provides a permanent record and is not limited to short messages of words and numbers alone—books, graphs, photographs, and other items can all be sent by mail. Its major drawback is the time span between composing a message and (one hopes) receiving a reply. In light of this problem, the postal service and several private firms offer "overnight" or "express mail" services, but only by sacrificing cost and size/weight advantages.

Electronic mail combines many of the advantages of telephones and mail with fewer of their disadvantages. The preceding analyses looked at three areas: startup costs, direct costs, and soft/qualitative factors. A generally applicable analysis of startup costs is difficult because of the wide variation in equipment configurations and associated costs. For most cases the initial outlays for a system dedicated to electronic mail are

prohibitive. However, current trends in office practices justify an assumption of minimal investment costs. It is assumed that an EM capability is secondary to applications like word processing or data base management. The cost of the system is justified by these "backbone" functions.

Table 4 contains a summary of the benefits and costs of telephones, postal services, and electronic mail for direct costs and qualitative factors. Again, the numbers represent a relative ranking among the three media for that particular category only. Rankings in general cannot be compared between categories except in a very crude manner. Put another way, rankings cannot be added. For instance, being ranked "1" for lowest price is not necessarily equivalent to the same rank for number of colors available. Neither is a pair of "2's" of equal importance to a "1" and a "3." Any overall comparisons necessarily include value judgements on the relative importance of any one category.

For out-of-pocket expenses postal mail has the lowest transmission and supply costs. Electronic mail is second largely due to its higher transmission speed (information density) relative to telephones. The telephone generally has the lowest direct labor costs for any message delivered. EM is second since it is labor saving over conventional letter writing. Overall, Fugler found conventional mail to be potentially less expensive than telephone calls, depending on the machine/labor combinations used. The position of electronic mail is uncertain, dependent in part on the cost and alternate uses of the hardware and the volume of messages. EM is expected to compare favorably if equipment is acquired for some other primary purpose, given the trends toward office automation, lower costs from technological advances including large-scale integration, and increasing use of electronic mail.

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Table 4. Rankings for Telephones, Postal Services, and Electronic Mail
          Over Various Service Characteristics

	Phone	USPS	EM
Direct Costs			
transmission and			
supply costs	3	1	2
direct labor	1	3	2
total direct costs	2	1	?
Time Factors			
connect time	2	2	1
delivery time	1	3	2
reply time	1	3	2
overall time reqs	1	3	1
convenience	1	3	2
interruption	3	1	1
Other Qualitative Characteristics			
geographic freedom	2	2	1
records	3	1	1
filing	none	2	1
tone of voice	1	none	none
one-to-many	3	2	1
security	?	?	?
integrity/validity	2	1	?

Time factors were divided into several categories, four relating to actual time requirements (connect/preparation, delivery, reply, and overall time) and two others dealing with convenience and interruptions. The best ratings went to the telephone for delivery and reply times and electronic mail for connect/preparation. Although regular mail can often be prepared in less time than to establish a phone connection, its delivery record and subsequent lengthy reply time give it an overall bottom ranking. EM's delivery and reply times are dependent on the habits of EM users. Some may not check their mail for days. On the other hand, others may be logged on when a message is delivered, resulting in a turnaround faster than or comparable to the telephone. This uncertainty resulted in the "2" rating. As EM gains acceptance, delivery and reply times are expected to improve. The faster connect/preparation time compensates for these effects, so electronic mail's overall time requirement rating is the same as for the telephone.

Telephones are the most convenient for the caller, but are most disruptive to the receiver. Regular mail is the least convenient but does not cause an interruption. It is expected that electronic mail's convenience will increase with greater use and acceptance, and users have complete control over interruptions.

Seven other qualitative or "soft" factors were rated. Of these, electronic mail received a "1" in four categories: geographic freedom, records, filing, and one-to-many considerations. The telephone is best for conveying the tone of voice. Postal services share the records category with EM, and are superior to the telephone for message integrity and validity. There are too many unknowns to rate EM in this area. Similarly, security cannot be rated among the three media.

As noted in Table 4, EM rates higher than the telephone in transmission

costs and higher than mail in direct labor costs. Its relative position for overall direct costs is therefore uncertain. The telephone and EM equally share the top rating for overall time requirements, but the lack of interruptions is a major benefit of EM when considering other time factors. In terms of the other qualitative characteristics, electronic mail rates a "1" in the majority of categories. EM has a higher rating than the telephone in four categories, with two uncertain, and an equal or higher rating than postal services in five categories, with the remaining two uncertain. If one could reach a conclusion on these numbers alone, electronic mail would seem to be quite feasible. However, it cannot be overemphasized that these rankings are not directly comparable. The weight or importance that users place on individual characteristics ultimately determines the total value of each medium.

In conclusion, transmission costs of EM, although not as low as regular mail, are lower than those for telephone. When total time requirements are considered, EM may also be just as fast or faster than either alternative. It also provides freedom from geographical and time constraints, has no interruption problem, ends telephone tag, has capabilities for message writing and editing, allows a single message to be sent to multiple receivers, and provides electromagnetic file storage/handling and hard copy options. Electronic mail's major disadvantages stem from its relatively recent introduction and consequent unproven cost effectiveness and lack of EM standards. However, EM is gaining acceptance, and many if not most of its weaknesses are expected to improve with greater use. Successful systems have management's support and use, a critical mass of users, and a time period of sufficient duration for users to learn and accept electronic mail.

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