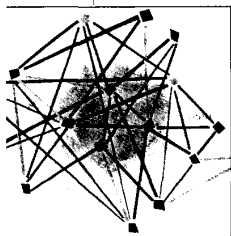


# E-mail at work

*Electronic mail has removed the barriers of time and place between engineers collaborating on complex design projects*



Recently, 53 engineers at Digital Equipment Corp.—spread across Massachusetts, Arizona, Colorado, Singapore, and Germany—collaborated on the design of a new disk drive. Most had never met and phoned each other rarely. Yet Digital estimates that this dispersed group finished its project one year sooner and needed 40 percent fewer people than would have a team assembled in one building. Another recent project at DEC, the Alpha chip, an integrated-circuit design, also made effective use of e-mail by calling on engineers in Israel, Massachusetts, and Scotland.

Tandem Computers Inc., Cupertino, Calif., has a similar tale. In June the company announced a central office switching system for use with the SS7 telephone network. The 40-some engineers on that project were scattered among five buildings in California and two in Texas. The project manager called the lead engineers at each location only once a week and visited those sites only a few times a year; yet the scattered designers worked as a cohesive unit.

Electronic mail networks that reach virtually every employee make such geographically distributed work teams commonplace at DEC, Maynard, Mass., and Tandem as well as at other engineering companies.

“Every new employee at Tandem gets an ID card and a mail access code,” said David Foley, network architect there. “And they may have the mail access several days before the ID card.”

At DEC, said Peter E. Brown, corporate telecommunications manager, “the first thing we all do when we get to work in the morning is check our electronic mail.”

Companies that have come to rely on electronic mail have huge international networks. Palo Alto, Calif.-based Hewlett-

Packard Co. has a network of 94 000 mailboxes (some dedicated to groups, others to individual subscribers), which delivers over 350 million messages every year to its 90 000 employees. DEC’s network sends 110 000 employees around 50 million messages annually between sites (intrasite mail is not included in this tally).

Tandem’s net links 11 000 employees and delivers about 60 million messages a year. At Sun Microsystems Inc., Mountain View, Calif., the network has 12 500 users.

These systems support different flavors of electronic mail. Private e-mail is person to person, and can comprise computer-aided design files and digitized images as well as text. Wide-distribution e-mail originates with one person but is sent to many and replaces interoffice memos. Electronic conferencing allows users to identify topics—often technical, but in some cases with as little connection to work as movie reviews or softball scheduling. Anyone may review a running transcript of a conference and append a comment.

Engineering managers interviewed by *IEEE Spectrum*, an admittedly unscientific sample, typically receive about 25 messages daily; engineers receive more or less, depending on the intensity of projects they are working on and how many interest groups they belong to.

So far, though engineering organizations like these large corporations are at the lead-

A person . . . can say ‘Help’ to 10 000 people. . . The next morning he may have 15 answers to the problem

ing edge of e-mail usage, others, particularly small companies, have decided that they have little need for electronic mail.

Electronic mail is also in less use in some fields, noted Rob Kling, professor of information and computer science at the University of California at Irvine. For example, aerospace engineers are seldom network users.

However, engineers and scientists are pioneers in electronic mail use, and profes-

sionals in other industries are following suit in growing numbers: at the Fortune 2000 corporations, some 11.7 million workers are e-mail users, and that figure is expected to grow to 27 million by 1995, according to a recent study by the Electronic Mail Association, Arlington, Va.

**COMPETITIVE EDGE.** The advantages of electronic mail are many. Besides the obvious boon of avoiding telephone tag and time zone dissonance, e-mail gives companies unprecedented flexibility. Managers can assemble engineering teams by tapping the best people for the project without concern for their location, then disband them as soon as the project is done. Electronic mail also eliminates the need for stressful transfers or expensive temporary assignments.

In fact, some companies have discovered that the time-honored method of assembling a multifunctional team either from employees at one site or by means of transfers or regular meetings is no longer practical. According to a study conducted last year by David Cedrone, DEC’s corporate voice and video manager, and Edward McDonough, a professor from Northeastern University in Boston: “As projects become increasingly complex and greater numbers of uniquely skilled people are needed on project teams, more and more time will be needed to gather them together in a common location.”

This flexibility may let companies operate with a smaller workforce—a specialist, say, may work part-time with two project teams many hundreds of kilometers away. Also, interdisciplinary teams may crop up more—a group might not need a full-time cabinet designer for its project, but would jump at the opportunity to bring one onto the team part-time, instead of tossing a finalized design to the cabinet department. “Many individuals are required in ‘bursts,’” Cedrone and McDonough concluded in their study. “Full-time assignment of individuals rarely matches the real resource demands of a project.”

Electronic mail can also uncover hidden expertise in a company. When a design team at a networked company runs into a problem that stumps all team members, it broadcasts a “does anybody know?” request throughout the network, and suggested solutions often appear in a matter of hours. James Treybig, president of Tandem, has said that “a person in Switzerland on electronic mail can say ‘Help’ to 10 000 people (which a person cannot do on the telephone).

Tekla S. Perry Senior Editor

The next morning he may have 15 answers to the problem, of which 13 are wrong. But he has answers."

A study at Tandem by researchers Sara Kiesler, Lee Sproull, and David Constant of Carnegie Mellon University in Pittsburgh found that during a six-week period, employees broadcast about seven questions a day that elicited about eight replies each. The great majority had first tried and failed to find solutions using other sources. Some of these replies went into open reply files that could be accessed by other employees with similar questions.

Another Tandem study done by Tom Finholt, now assistant professor of organizational psychology at the University of Michigan, Ann Arbor, found that the reply files were accessed more than a thousand times a month. The engineers who used this database most were those farthest from Tandem's California headquarters.

For some companies, electronic mail has meant the ability to tap into expertise that would have been completely inaccessible without it. Report Cedrone and McDonough in their study: "Pockets of expertise and specialization exist throughout the world."

At Sun Microsystems, engineers are collaborating with a team of 33 former super-computer designers in Moscow, St. Petersburg, and Novosibirsk to develop compiler software for Sparc workstations, to be marketed in the United States, Europe, and Japan. Because the telephone network in Russia is unreliable, and most of the Russian designers have difficulty with spoken English, electronic mail is for many project workers the sole means of transatlantic communication. It is used to debate complex technical issues as well as deal with more mundane problems. (The California engineers helped their Russian counterparts network their workstations after the Russians e-mailed a file in PostScript, a printer language, that contained the floor plan of their office building.)

Project teams that span time zones may speed development by working round the clock. Hewlett-Packard has research laboratories in Bristol, England, and Tokyo, as well as in Palo Alto, and joint projects are becoming common. "The time difference means [the overseas] engineers are going home as we are going to work and vice versa," said David Ricci, director of research services at Hewlett-Packard Laboratories in Palo Alto. "So we can leave them a message at the end of our day, and they can pick up and work where we left off, then hand it back to us in our morning."

"Electronic mail gives us about a 30 percent gain in productivity," estimated David Ditzel, director of advanced development at Sun.

In discussing a study of electronic mail usage in a number of software design organizations, Carnegie Mellon researchers Sproull and Kiesler write in their book *Connections: New Ways of Working in the Net-*

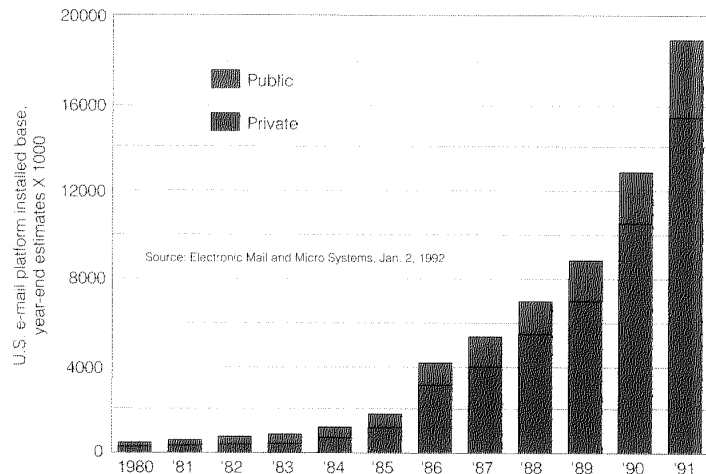
*worked Organization*: "We discovered a very high correlation between use of electronic mail and group productivity."

Electronic mail also leads to increased communications by engineers in the same building, even in adjoining offices. The reason, pointed out Jan Walker, a member of the research staff at DEC's Cambridge Research Laboratory, is that electronic mail is not as intrusive as a phone call. It does not interrupt the recipient, and for the sender, takes less time since he or she need not run through the social amenities. "Getting eight phone calls would be disruptive when you are in the midst of something, but receiving eight e-mail messages is not, and often you can answer with just a yes or a no," Walker told *Spectrum*.

A fringe benefit of communicating electronically is that a record is kept of all con-

And engineers still subscribe to technical journals to track developments in their fields. In fact, according to research by Starr Roxanne Hiltz, professor of sociology at Uppsala College, East Orange, N.J., e-mail users tend to read more, rather than less, probably because associates send e-mail messages referring to published articles.

But does e-mail really allow distant colleagues to work as closely together as they would if they were not geographically separated? The engineers who use it say it does, though sometimes it takes a little creativity to communicate clearly. At DEC recently, engineers were trying to launch the manufacturing in Augusta, Maine, of a new digital router (a dedicated device for directing data communications traffic) but were stymied by defects, so they sent an oscilloscope trace to peers in Clonmel, Ireland.



The number of private U.S. electronic mail networks installed by corporations, nonprofit associations, and universities [blue] has grown much faster than their public counterparts [red].

versations. Meeting "notes" can be distributed to interested parties outside the core team, new team members can easily review past discussions and get up to speed, managers can review the reasoning behind a decision, and a message received by one person can be forwarded easily to others.

"We go back quite often and refer to old messages for part numbers or specs," said Glenn Rankin, a development engineer at HP. "It doesn't require writing things down and putting them in a notebook somewhere."

Finally, perhaps least in importance, though not trivial, e-mail is a bargain. According to Hewlett-Packard's calculations, a two-page electronic mail message between any two HP employees worldwide averages US \$0.22; a letter averages \$0.51, and a fax averages \$1.66.

Studies have shown, however, that e-mail does not reduce travel very much. Robert Lucky, executive director of research at AT&T Bell Laboratories, Murray Hill, N.J., noted that e-mail makes it even easier to go on the road because the traveler does not risk losing touch with his or her colleagues.

The Irish engineers responded the next day: you must be using capacitors from such and such a vendor, replace them and your problem is solved. It was.

**ENDING ISOLATION.** The earliest users of electronic mail were researchers at universities. Since the Advanced Research Projects Agency Network (Arpanet) provided the first reliable electronic highway in 1969, communication over the net has accelerated the process of research.

Researchers thousands of kilometers apart meet in on-line discussion groups devoted to their specialties, and communicate regularly on the net with peers whom they may never have met.

"One of the facts about being an expert in something and working at a university is that a typical university can't afford to maintain more than one or two experts in a field on staff; therefore, experts tend to be spread all across the globe," said psychologist John Condry, a professor at Cornell University in Ithaca, N.Y. "But with e-mail, I talk regularly to a dozen people who are doing the same research I am, communicating as ef-

fortlessly with people in France, Sweden, and Israel as next door. By forming nodes of interaction, e-mail may well speed up the process of science."

Sociologist Hiltz's research on the use of electronic mail by scientists confirms this conclusion. "Perhaps [electronic communication] is like an intellectual lonely minds club," she writes, and indicates it has probably had its biggest impact on those at the smaller universities. The scientists in her study reported more communication with both people in their fields and those in other disciplines that resulted in productivity gains by "increasing the stock of ideas and providing leads, references, and other information."

"Subjectively experienced effects of the increased communication with a larger network of scientists include the ability to get 'instant feedback' on ideas and to 'kick ideas around' with others when a piece of work is in its formative stage," Hiltz writes.

With e-mail, months or years no longer pass between a researcher's completion of experiments and the dissemination of results. Now, scientific papers are "published" on the network, commented on, and

## By forming nodes of interaction, e-mail may well speed up the process of science

often revised and "republished" several times before they appear in traditional journals or are delivered at conferences.

Sometimes the pace of net vs. journal publication trips over itself. A paper finally published in a journal in, say, September may reference a paper to be published in the same journal in November, since the electronic forms of both papers had already been widely circulated and seen by both authors.

Some think e-mail may have dramatically sped the response to the purported demonstration of cold fusion claimed by Stanley Pons and Martin Fleischmann in March 1989. Information about their results was distributed on Bitnet, a worldwide academic network, before it was published in a journal; comments by other researchers, from

quick responses to detailed reports of attempts to replicate the experiments, followed on the network and in a flurry of faxes between universities.

Writes Frank Close in *Too Hot to Handle*, an account of the cold fusion announcement and its debunking: "By Monday afternoon [the day after cold fusion was announced in a press conference] information was coming in by phone, fax, and Bitnet. A new genre in scientific communication was being

born. You logged in at any time and read the latest gossip or hard news and sent in any insights you had gathered yourself. . . . The 'paper'—really a set of electrical signals propagating through the air—flashed round the world like an electronic chain letter."

According to Richard Petrasso, a principal physicist at the Massachusetts Institute of Technology (MIT) in Cambridge, electronic mail discussions backed up by preprints of papers and errata transmitted by fax "had a direct impact on our work," leading to the publication of several papers on the topic shortly after the cold fusion experiments were announced.

Nate Lewis, a professor at the California Institute of Technology in Pasadena, said researchers in his cold fusion group "read

### Meta-matrices

"Uncontrollable" is the best way to describe the growth of big networks, said Vinton Cerf, president of the recently formed Internet Society, and a computer scientist at the Corporation for National Research Initiatives located in Reston, Va. No one really knows just how extensive many of these decentralized computing webs of cyberspace are. The indicators are, however, that the proliferation is occurring exponentially.

A half-dozen varieties of wide-area networks exist. Besides the many commercial offerings such as Prodigy and CompuServe [To probe further, p. 33], there are the exchanges for science, technology, and education. The Internet is the largest all-purpose global meta-network supported by governments, while FidoNet represents another class of connection, the kind formed spontaneously by individuals without much investment.

**INTERNATIONAL NET.** The Internet traces its origin to Arpanet, a computer science experiment set up by the Pentagon's Advanced Research Projects Agency in the late 1960s. In the next decade, Arpanet's growth plus a confluence of terrestrial and satellite switching technologies and the development of local-area networks set the stage for wide-area interlinked computer networks.

An additional influence came from the U.S. Department of Defense, which in 1978 endorsed the Transmission Control Protocol/Internet Protocol (TCP/IP) as a data communications standard. Devised in part by Cerf, then at California's Stanford University, TCP/IP in 1983 was made a requirement on Arpanet and Milnet, a Government military network, by the Defense Communications Agency.

After that, companies responded by making

TCP/IP-compatible products, like routers and modems. "That was the beginning of the explosive period of growth," Cerf told *IEEE Spectrum*.

The Internet protocol suite, now widely accepted internationally, is designed for decentralized use and to link heterogeneous systems. The collection of networks that share this protocol is known as the Internet.

Once hooked on to the Internet, most users pay no more to send 1000 messages to Tokyo than to send 10 to Boston. Lower-echelon users are generally charged a one-time installation fee of several thousand dollars for a dedicated phone line and telecommunications gear. Cyndi Mills, manager of NSF Network Services (NSFnet), Cambridge, Mass., and head of the Internet Engineering Task Force's accounting working group, said rates vary from \$25 to thousands of dollars a month, according to how much bandwidth is rented and the size of the organization.

**FLOWING TRAFFIC.** The Internet is analogous to a highway system, with dedicated communications links—copper and glass fiber cables as well as satellites—functioning as the concrete and asphalt. Leased phone lines of 56 kilobits to 1.5 megabits per second often serve as the on-ramps, connecting to regional networks. The capacity of the T1 highways is 1.5 Mb/s; that of the T3 routes is 45 Mb/s. These latter are currently being installed by a non-profit joint venture by IBM, MCI, and Merit Network called Advanced Network and Services Inc., located in Elmsford, N.Y.

Breaking messages into various sizes of packets, which are then sent along optimum routes, helps to keep traffic flowing and to make efficient use of

the expensive high-capacity links. Though gigabit-per-second superhighways are still in the research stage, they will be essential for bandwidth-intensive imagery. (Recently the MIME Internet standard for sending multimedia e-mail was completed. In July, during a technical conference, voice and images using the MIME standard were sent over the Internet to several countries.)

About 17 000 networks now plug into the Internet, and its users number in the millions. According to a quarterly survey done in July by Mark K. Lottor, a consultant for the network information systems center of SRI International, Menlo Park, Calif., the Internet has 992 000 host computers, up by 100 000 since April.

Data on the NSFnet from Merit Network Inc., Ann Arbor, Mich., show how the largest backbone of the Internet is used. In June, 15.7 billion packets were transmitted on NSFnet, more than double the number of June 1991 and five times that of June 1990. File exchanges accounted for 31 percent of the usage; electronic mail, for 21 percent; and interactive computing such as telnet (where a user logs in remotely to operate, say, a supercomputer), for 13 percent.

NSFnet is truly international. Over and above the 3898 networks in the United States linked to it, as of July 1992 NSFnet had a total of 30 networks in Brazil, 3 in Estonia, 10 in Poland, 119 in Japan, 187 in the United Kingdom, 287 in Germany, 243 in France, and 253 in Canada.

Like postal and highway systems, Internet receives subsidies from assorted government agencies for research, installation, maintenance, and service help. Consequently, the cost of a single message is "vir-

the latest gossip" on the networks every day. "It propagated rumors, but it also kept close track on the facts."

A drawback of electronic mail, though, is that the ability to move fast is not always positive. "Anytime there is a rush, there is less time to contemplate your results," said Petrasso at MIT. "A scientist needs time to cogitate about his paper. We all make mistakes, and the increased rapidity in communications is depriving the scientist of the time to think, and talk to colleagues, and change things before they are made public. As a consequence, there will be more mistakes committed by scientists; maybe because of e-mail the mistakes will be discovered more quickly by others, but it doesn't make it a happier environment."

These days, however, said Lynn Conway, associate dean of the college of engineering at the University of Michigan, Ann Arbor, it is hard to imagine coordinating university researchers without e-mail, because their varied class, research, and travel schedules makes them especially hard to track down. **ENGINEERING TOOL.** Electronic mail entered the engineering workplace in the late 1960s, when corporate engineering research organizations began communicating with each

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and there are times when  
inertia is a good thing

other and universities over the Arpanet. By the mid-1970s, it was already being viewed by engineers as a powerful tool.

At the Xerox Palo Alto Research Center (PARC) in the 1970s, collaboration by means of electronic mail allowed then PARC researcher Conway and California Institute of Technology professor Carver Mead to develop their ground-breaking methodology for structured very large-scale integration (VLSI) design. At first they exchanged only text messages between Palo Alto and Pasadena, but soon they were shipping actual instructions for IC layouts electronically over Xerox Corp.'s companywide mail system.

By tapping into the Arpanet, students across the nation could submit design files

to an automated file server at PARC. The server would extract chip designs from the e-mail messages, collect designs into manufacturable groups, and convert the data into the appropriate format for semiconductor mask-making.

E-mail is particularly important in making crash projects successful, Conway told *Spectrum*. "It is a powerful medium for small group coordination round the clock," she said. "Because the VLSI design project was intense, e-mail was suitable."

E-mail was also used at Xerox PARC in the late 1970s and early 1980s for the development of Interpress, a printing protocol that has evolved into today's PostScript language. John Warnock, an Interpress designer and now chairman and chief executive officer of Adobe Systems Inc., Mountain View, Calif., has recalled that Interpress designers were scattered among Palo Alto and El Segundo in California and Pittsburgh and Philadelphia in Pennsylvania.

In the early 1980s, Common Lisp, a computer language for artificial intelligence, was designed by a group of some 60 people at numerous organizations collaborating over the Arpanet. The group met just twice in three years, and has indicated that the language development would not have been possible without the Arpanet's e-mail capability.

**DOWN SIDE.** Electronic mail has its limitations, nonetheless. According to Walker of the DEC Cambridge Research Laboratory, "It is very hard to reach a decision about something that is complex and multifaceted." Walker told *Spectrum* that she has participated in a number of lengthy and deep technical discussions carried on by means of e-mail, but has found that, in the absence of a structured, face-to-face meeting, a participant rarely takes charge, summarizes the data presented, and guides the group toward a solution. "It is great for collecting information, but it is tough to reach closure, because people just haven't worked out the processes yet," she said.

Sociologist Hiltz noted a similar phenomenon in her study of scientists—that half the users felt that theoretical controversies in their fields were clarified by the use of electronic communication, but none felt it helped resolve them.

Engineers who spend too much time reading e-mail lose sight of the forest for the trees, Conway has noticed. "Your point of view becomes skewed to the present, and you lose the ability to manage subtle things that take time to build and grow," she said.

"There is no inertia in the system anymore," said Robert H. Anderson, senior information scientist at the Rand Corp., Santa Monica, Calif., "and there

usually impossible to figure out," said Larry Landweber, vice president of the Internet Society. Institutions share costs by renting capacity, unlike on Milnet, where users are charged according to the number of packets sent.

In the United States, Government-funded backbones such as NSFnet are ostensibly used for educational and research purposes only. There are also commercial backbones on the Internet, which can sell software or services and offer games with the meter running.

**CALLING FIDONET.** Unlike the Internet, FidoNet is a telephone-based relay network, requiring people to make calls using existing public phone lines, ideally at regular intervals, to forward e-mail. FidoNet is acknowledged to be in more than 60 countries, including the United States.

Since it does not require much infrastructure, it is easily installed and is therefore common in developing countries, noted Landweber, a professor of computer sciences and a specialist in international networking at the University of Wisconsin in Madison. Because the FidoNet is financed almost entirely by individuals, reducing modem-telephone time has been the priority of the protocols, which now use Zmodem-based transports.

Since November 1991, an experimental system that uses Internet to exchange mail and news between Europe and North America has saved FidoNet operators thousands of dollars a month, according to Randy Bush, Pacific Systems Group, Portland, Ore. FidoNet has tens of thousands of public and private nodes and more than a million users, Bush estimated. The daily volume of compressed electronic news on FidoNet is about 5 Mb.

Another problem with e-mail is the maze of address names. Some business cards display three or more e-mail addresses. An Internet address might look like: jadam@eee.org; but to pass to FidoNet from the Internet, the address might be: john.adam@p0.f42.n105.z1.fidonet.org. Still other e-mail addresses use ! or % symbols and are even longer.

In contrast, the labyrinth of protocols causes no big hassles for electronic mail. It is relatively easy at a gateway between networks to translate the header from one recognized mail application protocol to another (such as the Open System Interconnection's X.400 to that used on the Internet, SMTP and RFC822).

"We will always see multiple standards out there," said Cerf, because of the installed base, different priorities, and new technology. Even proprietary protocols such as Appletalk and Decnet may be encapsulated and sent across the Internet.

The long-awaited privacy-enhanced electronic mail is just becoming available to Internet users. As companies use networks to send proprietary information, privacy and authenticity become essential. But U.S. export restrictions on certain cryptography techniques may create special islands of users.

Cerf also acknowledged that the system is not friendly to neophytes but rather "is designed and used by people who are comfortable in the arcane world of software." However, this culture is changing, he noted. The growing number of commercial users will surely not put up with difficult user interfaces and, just as important, will spend a lot of money to spur the market for easy-to-use systems.

—J.A.A.

are times when inertia is a good thing."

For those who are new to electronic mail or who use it seldom, the lack of nuance in keyboarded comments poses hazards. Write Anderson and Norman Z. Shapiro in a Rand report: "Perhaps the most important phenomenon in electronic mail systems is the likelihood that the recipient will react negatively or inappropriately in reading material that might well have been misinterpreted."

An informal system of "inflecting" e-mail, called "smilies" has developed, but it does not always register with the recipient. In an electronic mail debate on the risks of the computer revolution, published in the *Wall Street Journal* on April 6, Mitchell Kapor, founder and former chief executive of Lotus Development Corp., Cambridge, Mass., commented: "Risks, what risks? Computers are here to benefit all personkind.:-)"

But debate participants who did not notice the smile :- ) got into a heated debate over his remark. It was interrupted only when Kapor revisited the conversation three days later and said, "The typographic glyph :- ) which I included at the end of my comment is the on-line equivalent of an ironic or sarcastic tone of voice. It is intended to convey that the writer really means the opposite of the literal meaning of what preceded. . .What I was saying was that there are risks in computers."

Even when understood, smilies do not eliminate another hazard of e-mail communication—the temptation to "flame." With e-mail it is all too easy to dash off an angry and ill-considered reply to a message—much easier than when responding orally or in a formal letter.

Some electronic users are not aware or forget that "private" e-mail is not really private; a record of the messages exists on a file server somewhere, is sometimes archived onto tape and stored for years, and can be retrieved by others in a company (Federal law prohibits outsiders from snooping into electronic communications, but employers can tap in at will. Other legal protection surrounding e-mail are hazy and are currently the subject of much debate.)

The good news is that important mail accidentally "deleted" can be retrieved. The bad news is private mail may be misused; people have been fired because of the content of supposedly private messages. In Colorado City, city council members discovered to their dismay that the mayor was able to thwart them on certain issues because he had been regularly reading their "private" communications. And the reappearance of e-mail memos sent and apparently deleted by White House officials was key evidence in the Iran Contra hearings. [Security concerns of computer communications were addressed in the August issue of *Spectrum*, "Data Security," pp. 18-34.]

For its first decades, only a relatively small research community had access to electronic mail. But in the past five years or so, it has become widespread in the biggest corporations, and it will be some more years before it reaches a more general audience. As a result, much electronic mail to date has been of some value to the recipient. Nonetheless junk mail has begun to proliferate, and may threaten e-mail's usefulness. To combat the threat, several electronic-mail systems have introduced "filters" in various versions.

Some filters sort mail into topic folders defined by the user, so that less important mail may be collected and handled at leisure. Others act as "bozo" filters, eliminating messages from certain sources, giving those from key sources high priority, or forwarding some to other recipients for handling. Another type filters out any message sent to more than, say, 20 people, rationalizing that messages with broad distributions either are of little account or will be heard through other means.

Filters, however, are not popular. They prevent people from getting the unexpected message—the new contact, the new information—that is sometimes the most important by-product of electronic mail.

Even nonjunk mail is sometimes overwhelming—25 messages a day can be reviewed and handled in 20 minutes, perhaps, but the several hundreds of messages waiting after a two-week vacation are daunting, keeping some engineers and managers from ever really taking a break; they check their electronic mail daily, no matter where they are or what they are doing.

A solution suggested by sociologist Hiltz in her 1985 book *Online Communities*—but

## Electronic mail cuts across corporations and the hierarchy of organizations, creating a new kind of accessibility

apparently not widely implemented—is a self-destruct capability: senders can tag messages with the last date of their usefulness, after which they erase themselves. For example, Zmail, a mail system used on Symbolics computers, asks for an expiration date in the header of a message, and users choose whether or not to have expired messages automatically deleted.

**RESTRUCTURING THE ORGANIZATION.** By its very nature, electronic mail blasts aside typical corporate hierarchies because the messages are undifferentiated—there is no fancy letterhead or secretary to place a call and ask the person called to hold for president

so-and-so. In an electronic list of messages, a message from a summer intern looks just as important as one from the company president.

Electronic mail, said Lucky at AT&T Bell Laboratories, "has produced a new social fabric for the R&D community that cuts across corporations and the hierarchy of organizations, creating a new kind of accessibility. It is easier to send e-mail to very important people, people whom you would never consider writing or calling."

At Tandem, anybody can, and many do, send messages to president Treybig, an open access policy the company believes is one reason for its success.

Electronic mail also eliminates cues about age, gender, race, and appearance: people are judged only by the value of their ideas, so all ideas can get an equal hearing. Carnegie Mellon researcher Kiesler writes: "When communication lacks dynamic personal information, people focus their attention on the message rather than on each other."

This may lead to better decision-making. Kiesler and Sproull, also at Carnegie Mellon, concluded in their studies that the best solution may not arise from face-to-face group discussions if it is suggested by a low-status person; electronic meetings may find better answers.

And for engineers, Lucky said, e-mail may be a better medium for communication than voice. "I'm shy about talking to people on the telephone that I haven't met in person," Lucky told *Spectrum*. "I would rather deal with a computer. It's easier to think with my fingers, and I don't get tongue-tied."

Electronic mail reduces the tendency of the more outspoken personalities to dominate discussions, and therefore allows more diverse ideas to emerge. As Kiesler and Sproull put it, research laboratories have leapers, who think quickly on their feet and love debate, and plodders, who like to work through implications of ideas in detail before sharing their analysis. With electronic mail, both types of scientists get their ideas heard; without it, the leapers dominate.

The ability to communicate across the hierarchy, broadcast to peers in various places in an organization, and form *ad hoc* communities to solve problems will reduce the need for middle management and make corporations more efficient, said Rand Corp.'s Anderson. "Corporations can be run with thousands of employees less than before," he told *Spectrum*, "and we are already seeing some layoffs result."

The effect is positive, Anderson indicated, because the talents of individual employees will be able to develop more fully than if they were locked in a traditional physically co-located work group. "A lot of people will have to find new employment," he said, "but somebody always gets hurt in revolutions, and this is a revolution." ♦