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THE INTERNET

How it Came About

How it Affects Society

How it Influences Education

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Editorial

Dear Readers:

The current issue of the *American Studies Journal* is the first published under the auspices of the German Association for American Studies. You will not note great changes. The layout and the sources of the articles printed (and reprinted) have remained generally the same.

This indicates that the *ASJ* is still in a period of transition which will come to an end with the publication of the Spring 1997 issue. By then, a GAAS editorial board will have evaluated and redefined editorial policy. Future issues will focus on all aspects of United States Studies and will specifically address problems of classroom methodology and content-based ESL teaching. We see secondary school teachers, students in *Leistungskursen*, and university undergraduates as special target groups.

The new editorial team will consist of Prof. Dr. Hans-Jürgen Grabbe, Center for U.S. Studies, Martin-Luther-Universität Halle-Wittenberg (editor), Prof. Dr. Gerhard Bach, Universität Bremen (associate editor, cultural studies and methodology), Prof. Dr. Peter Freese, Universität -Gesamthochschule- Paderborn (associate editor, literature and cultural studies), Priv.-Doz. Dr. Ursula Lehmkuhl, Ruhr- Universität Bochum (associate editor, political science), and Birgit Plietzsch (editorial assistant).

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The current issue is brought to you free of charge through the usual channels. The first issue of 1997, however, will cost DM 5 if picked up at an Amerika Haus or another cultural institution. Individual subscriptions require prepayment of DM 15 for two issues, each comprising approximately 64 pages, inclusive of postage and handling. Your remittance should be sent to: Zentrum für USA-Studien, Konto-Nr. 26212, Sparkasse Wittenberg (BLZ 805 501 01). Please fill out the enclosed subscription card if you would like to receive the *ASJ* regularly.

Lutherstadt Wittenberg , November 1996

Hans-Jürgen Grabbe
President, German Association for American Studies

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The new 1996/97 ASSET catalog is ready for distribution. ASSET teaching materials are offered for sale to individuals and institutions engaged in teaching English and American Studies. The catalog describes over 50 items ranging from situational dialogs to scholarly articles and anthologies of primary cultural readings. The program also offers audiocassettes, posters, and maps. There are three new titles in the 1996/97 catalog: *A Teacher's Guide to Basic Readings in U.S. Democracy*, and two new books on teaching techniques: *From Practice to Performance: A Manual of Teacher Training Workshop Activities* and *The Children's Response: TPR and Beyond.* The catalog also contains information about titles which are now out-of-print but still available in limited numbers.

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HISTORY

The Ancient History of the Internet

Edwin Diamond & Stephen Bates

The Internet seems so information-age, that its devotees might find the circumstances of its birth hard to grasp. More than anything else, the computer network connecting tens of millions of users stands as a modern — albeit unintended — monument to military plans for fighting three wars. Specifically, the Net owes its existence to Allied battle strategies during World War II, to the geopolitical pressures of the Cold War, and to preparations for the postapocalypse of nuclear holocaust (the never-fought "final war" with the Soviet Union).

This is not a lineage the cyberenthusiasts dwell on. An effusive profile of the father of the Internet in *The New York Times* in September 1994 skipped entirely the circumstances of his cyberpaternity, while an extended account of the birth of the Internet a month earlier in *Newsweek* mentioned U.S. military sponsorship in one tangential clause but said not a word about why the Pentagon funded the project in the first place. Perhaps these strange omissions are understandable. Internet boosters have created an instant mythology, featuring a fiercely libertarian "hackers' ethic" and the "freewheeling, untamable soul" of cyberspace (to quote a recent paean in *Time* magazine). The G.I. — government issue — stamp seems to let some of the hot air out of the hype. An open-minded recounting of the Internet story, however, still leaves room for individual medals all around, while affirming how once upon a time, government, universities and industry worked together to produce what the late Ithiel de Sola Pool of the Massachusetts Institute of Technology (MIT) called "the largest machine that man has ever constructed."

As with most great advances in the history of ideas, there was no one defining Internet event. No apple fell on a cyber-Isaac Newton. Nor did any visionary set out to build a new communications medium. Rather, it began with a modest analytical system, devised early in World War II, that set the stage for the supportive research environment and the key technical developments that produced today's global network.

The analytical system, called operations research (O.R.), applied scientific modeling principles to military planning. The first O.R. was done for the Allies by military scientists and civilian technologists. These boffins (as the British called them) conducted statistical studies of antisubmarine tactics that showed how the Allies could increase the U-boat kill rate by setting the charges to explode at a different depth. O.R. also devised a way to coordinate radar-operated antiaircraft batteries with the flight patterns of friendly interceptor aircraft, to avoid shooting down Allied fighter planes. Modern warfare, it became obvious, was too complex to be left to intuition; measurement and mathematical analysis were required. (Hitler, relying on a dream he had in which he learned that no German V-2 rocket would ever reach England, critically delayed the Nazi missile development program. Many Allied troops and British civilians owe their lives to his unscientific decision.)

To conduct such analyses, the military sought more-powerful calculating devices. In 1944, Howard Aiken, a Harvard physics instructor, unveiled the Automatic Sequence Controlled Calculator, which he nicknamed the Harvard Mark 1. Almost immediately this immense machine — more than 50 feet (15 meters) long, containing 750,000 parts, and weighing 35 tons — was put to work factoring ballistics tables for the Navy. Meanwhile, Army-funded engineers at the University of Pennsylvania worked on a machine to calculate artillery trajectories. Their handiwork, ENIAC (Electronic Numerical Integrator and Computer), represented a major development in computing technology, though not one that helped the Allied effort; it was delivered just weeks after the war's end.

Following the victories in Europe and Japan, American military planners turned attention to their new

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Cold War adversaries, primarily the Soviet Union but also China (known then as Red China). The three U.S. military services contracted out O.R. work to universities and nonprofit corporations. This produced, among others, the Center for Naval Analysis, administered by the Franklin Institute, in Philadelphia, Pennsylvania; the Army-backed Operations Research Office, run by Johns Hopkins University in Baltimore, Maryland; and, perhaps the most effective of all, the RAND Corporation, the Air Force's principal advisory organization. Initially a technical adjunct of the Douglas Aircraft Company, of Santa Monica, RAND separated from the plane maker in 1948 and was incorporated under California law as a nonprofit company (the name is an acronym for Research and Development). Its initial budget of $3 million came largely from the Air Force. According to Bruce Smith, a Harvard-trained political scientist who worked at RAND in the 1960s, the Air Force, the newest and least tradition-bound service, was able to "experiment more easily with novel organization forms."

On Friday evening, October 4, 1957, RAND's analysts, along with Pentagon officials and the American public, were jolted upright by Sputnik I. The Soviet Union followed Sputnik I with another satellite carrying the dog Laika. No matter that Laika blasted into orbit on a one-way ticket; America had expected to be first into space. The nation's image as a technology superpower and its perceived lead in the Cold War were badly shaken. Most frightening of all, its cities suddenly seemed vulnerable to Soviet attack. One of the authors of this article was a young hotshot reporter covering the Pentagon for the International News Service during the Sputnik frenzy. He still remembers the overheated lead of his Saturday "follow story," played prominently by newspapers around the country: "The same Soviet rocket that sent a satellite into orbit Friday can deliver an ICBM warhead on New York and Washington ..."

Everything went on the table for panicky review. In hopes of producing graduates who could outthink the Soviets, high schools and colleges boosted their math and science requirements. The president of Harvard University, James Bryant Conant, told parents to admonish their children, "For your own sake and for the sake of the nation, do your homework." The "space race" (also called the "missile gap") also affected university budgets. The Defense Department created yet another O.R. group, the Advanced Research Projects Agency, and charged it with doling out high-tech research funds.

Among ARPA's first priorities were projects on command, control and communication, known among war planners as C3. The Defense Department wanted to use computers not only in the Pentagon but also in the field. Bulky, balky mainframes of the era were ill-suited for the battlefield, so ARPA sought a communications solution. For signals sent from a battlefield terminal to reach a headquarters-based computer, they would have to be translated from wire to radio to satellite and back. Nothing like it had ever been done before. In fact, most computer time-sharing then involved transportation rather than communication: Computer scientists keyed their jobs onto paper tapes or punch cards and then shipped them to the closest computing center.

At the same time, America's command posts were burrowing underground in the name of C3 and "nuclear survivability." NORAD, the air defense headquarters, carved a control center into the side of a Colorado mountain. In Washington, nuclear-war plans called for evacuating the president and key officials to supersecret reinforced shelters in the Catoctin Mountains in nearby Maryland, while all 535 members of Congress were supposed to hole up in an elaborate complex under the grounds of the Greenbrier Hotel in White Sulphur Springs, West Virginia. From these subterranean hideouts, federal officials would govern the nation — that is, the parts that survived.

The war-planning needs of the military and the research interests of computer scientists began to converge. The Pentagon asked RAND to analyze how the military could communicate (by voice telephone as well as data hookups) after a nuclear war. The existing phone network seemed far too fragile for such a task. For each call, switches in the network created a circuit between the two parties; if part of the circuit was broken, whether by an ICBM or by an errant backhoe, the connection had to be reestablished from scratch.

RAND's solution, developed by Paul Baran on an Air Force contract, was a network that could route around damage and continue to communicate. In such a system, Baran wrote, "there would be no obvious central command and control point, but all surviving points would be able to reestablish contact in the event of an attack on any one point" through a "redundancy of connectivity." The key to creating this survivable grid was what later came to be called packet switching.

With packet switching, as Baran and others envisioned it, computers would not monopolize a circuit for the duration of their communication, as telephones do. Instead, the messages would get broken up into small packets, which would flow in an intermingled stream with other packets, each of which would carry enough information to seek out its destination. Packets from a single message might take different paths to reach the destination. If one packet did not get through, the addressee would notify the sender to retransmit it. Then, when all the packets had arrived, the addressee would reassemble the message. The approach would be slower than having a dedicated circuit between the two points, but it would be far sturdier. If one connection broke, messages would reroute themselves. The "smarts" of the system would reside in users' computers and in the packets themselves, not in centralized, vulnerable switching centers.

Baran, at RAND, did the basic research on packet switching, but many of his reports were classified. Donald Davies of the National Physical Laboratory in Britain independently outlined the same general concept and contributed the word "packet" for the message components. Other researchers also began to focus on the idea of a packet-switching architecture.

It was an idea that appealed to ARPA, particularly its Command and Control Research Office, headed by a computer scientist named J.C.R. Licklider. ARPA in the 1960s became the patron of computer research, a Medici to the mathematical Michelangelos. The agency funded research into countless aspects of hardware and software development, including graphics, simulations, head-mounted displays, parallel processing and networking. ARPA grants produced the most powerful computer of the mid-1960s, the University of Illinois's ILLIAC IV, as well as nearly all artificial intelligence research in the 1960s. "Far from [our] being evil warmongers," the computer scientist Eugene Miya has somewhat defensively said, "Some neat work was done."

Miya and other hackers (the word then carried no negative connotations) were in deep denial, trying to insulate themselves from the currents of dissent about the Vietnam War sweeping across many campuses. Although their work was funded almost entirely by the "villainous" Pentagon (one of the most prominent figures of the 1990s digital revolution told us that 95 percent of his budget came from the military during his lab's critical early years), the computer scientists continued to insist that ARPA funding didn't make them part of the military-industrial complex. "I like to believe," the computer scientist Alan Perlis later said, "that the purpose of the military is to support ARPA, and the purpose of ARPA is to support research."

As part of its research support, ARPA agreed to fund an experimental computer network. The network, ARPA officials hoped, would demonstrate the feasibility of remote computing from the battlefield as well as test the potential of a post-World War III military communications network. In addition, the network would enable widely dispersed researchers to share the few supercomputers of the era, so that the Defense Department would not have to buy one for every contractor. In 1968, ARPA solicited bids for an expandable network linking four sites already conducting ARPA research: the University of California campuses at Los Angeles (UCLA) and Santa Barbara (UCSB), the Stanford Research Institute (SRI) in Stanford, California, and the University of Utah (Salt Lake City).

While the bids were continuing to come in, a handful of representatives of these proposed ARPAnet nodes met to discuss what lay ahead. "We had lots of questions," recalled Stephen D. Crocker, at the time a UCLA graduate student. People wondered how the computers would be linked and what they would be capable of doing. "No one had any answers, but the prospects seemed exciting," he remembered. The men decided to hold more meetings. The Network Working Group, as they dubbed themselves, proved as fluid and nonhierarchical as the Internet itself would ultimately be; an early memo prefaced a list of group members by saying that "the Network Working Group seems to consist of ..." "We had no official charter," said Crocker. "Most of us were graduate students, and we expected that a professional crew would show up eventually to take over ..." Of course there were no seasoned veterans; the students and professors had to be their own crew.

The ARPAnet construction contract was awarded to Bolt Beranek & Newman (BBN), a research firm based in Cambridge, Massachusetts, which had close ties to MIT. BBN shipped the new communications software in August 1969 to UCLA and then to SRI in October. At a November demonstration the two California machines exchanged data. The first long-distance packet-switched network was in operation. By the end of the year, all four nodes were online.

At this point, the striking figure of Vinton Cerf, the computer scientist *The New York Times* called the father of the Internet, begins to take a leading role in the narrative. Born in 1943 in New Haven, Connecticut, Cerf turned his back on Yale University to do his undergraduate work in mathematics at Stanford University and to get his master's and doctorate in computer science from UCLA. In 1969, Cerf was a graduate student working at UCLA's Network Measurement Center, observing how the new four-node ARPAnet was functioning — and what it would take to make it malfunction. "There were many times when we would crash the network trying to stress it," Cerf recalled.

Soon he was collaborating with Robert Kahn, an MIT math professor on leave to work at BBN. Cerf and Kahn developed a set of software "protocols" to enable different types of computers to exchange packets, despite varying packet sizes and computer clock speeds. The result, TCP/IP was released in 1973 (by which time Cerf was teaching at Stanford). TCP — Transmission Control Protocol — converts messages into packet streams and reassembles them. IP — Internet Protocol — transports the packets across different nodes, even different types of networks. Just as TCP/IP stands for a whole "suite of protocols," not just those two, so were there several fathers of the Internet; Cerf credits many people, "thousands by now," for helping create the computer-network communications system we have come to know.

In 1977, having left Stanford for ARPA (then called DARPA, the D for "Defense" added in 1972), Cerf worked on a different sort of interconnectivity.

From a van cruising along a San Francisco Bay Area freeway, a computer sent messages that traveled, by packet radio, satellite, and landlines, a total of 94,000 miles (150,400 km). "We didn't lose a bit!" Cerf later recalled. The project demonstrated that computers could communicate to and from the battlefield. No longer was ARPA funding pure computer science research; now DARPA insisted on what Cerf termed "militarily interesting" projects like this one. Even so, Cerf's C3 innovation arrived as the Cold War was flagging — reminiscent of how ENIAC had been delivered at the end of World War II.

Cerf has suffered severely impaired hearing since birth and has worn a hearing aid since he was 14. It is serendipitous but fitting, then, that his TCP/IP made possible the textbased Net communications systems so popular today, including electronic mail (e-mail), discussion lists, file indexing and hypertext. E-mail, of course, is the most widely used of the Net services, the most convenient and the most functional.

Ray Tomlinson of BBN is credited with inventing the software and sending the first e-mall messages across ARPAnet in 1972 and 1973. At first, scientists used e-mail to collaborate on research projects; their computer talk was decorous, befitting a serious O.R. project that had had its origins in Soviet-American military rivalries. There were also rules to obey. ARPA limited use of the network to official business. In addition, some users worried that sending personal messages by e-mail might somehow violate the postal laws. "You'll be in jail in no time," RAND's Paul Baran warned his colleagues.

Soon, however, a graduate-student hacker attitude took over. Mailing-list software permitted large groups of people to discuss common interests, making e-mail a mass medium as well as a point-to-point one. The first list, SF-LOVERS, linked science fiction fans. "ARPA was fairly liberal . . . but they did occasionally put their foot down," Bernie Cosell, an early ARPAnet user, later recalled. When ARPA brass complained, SF-LOVERs was shut down — only to rise again a few months later, after users had managed to convince ARPA that the mailing list was serving the vital purpose of testing the network's mail capacity. Soon the network was carrying NETWORK-HACKERS, WINETASTERS, and scores of other mailing lists. ARPAnet had come a long way from C3 and survivability. The science fiction writer Bruce Sterling captured the image best: It was "as if some grim fallout shelter had burst open and a full-scale Mardi Gras parade had come out."

By the mid-1980s, TCP/IP was linking ARPAnet to other networks, including the NSFnet of the National Science Foundation, another federal agency, and Usenet, a network created by graduate students at the University of North Carolina (Raleigh) and Duke University, also in North Carolina (Durham). The result was first called ARPA-Internet and then simply the Internet. ARPAnet split in two, with military communications going onto MILNET and the computer researchers finally over taking ARPAnet in name as well as in practice. ARPAnet shut down in 1990, and NSFnet went off-line last April; the most heavily traveled routes of the information superhighway now are in private hands. Nearly all the various networks used the TCP/IP language. "I take great pride in the fact that the Internet has been able to migrate itself on top of every communications capability invented in the past twenty years," Cerf told *Computerworld* in 1994. "I think that's not a bad achievement."

More elegantly he wrote hacker poetry. When ARPAnet was decommissioned in June 1990, scarcely anyone noticed; other elements of the Internet seamlessly took over all its functions. Cerf wrote a "Requiem for the ARPAnet." It ends: "Now pause with me a moment, shed some/ tears./ For auld lang syne, for love, for years and years/of faithful service, duty done, I weep./ Lay down thy packet, now, O friend, and sleep."

Edwin Diamond is a professor of journalism at New York University and the author most recently of *Behind the TIMES: Inside the New "New York Times."* Stephen Bates is a senior fellow of the Annenberg Washington Program and the author of *Battleground: One Mother's Crusade, the Religious Right, and the Struggle for Control of Our Schools* (Henry Holt).

The Internet at the Crossroads

Herb Brody

As with any romance, the world's present infatuation with the Internet has emphasized the magical and tended to ignore the practical. Couples falling in love dote on each other's wonderful traits. It is only a little later that they float down from the clouds and tackle the economics — how big a house they can afford, what kind of income they will need. The Internet, for most people, is still a new love. Ignore for a moment the few tens of thousands of people who inhabited the Net before the phenomenal population boom began in the late 1980s. For the rest of us, the Internet is still exciting and not a little bit mysterious. But the oddity is that nobody seems to be paying for all the informational goodies that can pour into our computers like water from a broken pipe. You might pay a few dollars a month for the privilege of being connected, but once you slide past the electronic turnstile, it is an all-you-can-consume buffet of bits, from plain vanilla e-mail to participation in online discussion groups to searches of Library of Congress databases to the latest satellite images of the planet. Want to send a 10-page letter to a friend in Australia? Go ahead, no extra charge. Want a nifty piece of software that lets you browse the Net by pointing and clicking? Take it; it is free. Want to mail a fund-raising appeal to 10,000 people? Internet converts this from a $3,200 postal endeavor into one that's more or less cost-free. Internet users seem to have found a kind of surreal restaurant where they can order a bottomless cup of coffee or a lobster dinner for 100 friends and no one ever presents an itemized bill.

Part of the reason is that, at least until the last few years, most members of the Internet Nation plugged in through computers at their workplace or university, so costs were a kind of invisible overhead that someone else worried about. At MIT (Massachusetts Institute of Technology, Cambridge, Massachusetts), for example, a high-speed fiber-optic network called MITnet links computers all over campus. One of these computers serves as a "gateway" that connects MITnet to one of 17 regional networks, in this case called Nearnet and operated by Bolt Beranek and Newman, a Cambridge-based technology consulting company. Nearnet, in turn, is connected to a "backbone" known as NSFNet, because it is funded by the National Science Foundation. NSFNet itself is operated by ANS, a not-for-profit company that has leased high-capacity fiber-optic telephone lines from the same companies that handle long-distance telephone traffic — AT&T, MCI and Sprint. Each organization pays a flat rate to the broader system it taps into; individual users are essentially insulated from cost burdens regardless of the volume of their use.

With similar hierarchical connections, commercial on-line services such as Prodigy and America Online give individual subscribers e-mail privileges on the Internet as well as access to some of its more popular resources, such as the Usenet newsgroups (online bulletin boards on hundreds of topics). These commercial services are heavily promoting such connections, particularly the ability of subscribers to tap into the World Wide Web, an interwoven collection of Internet resources that allows point-and-click navigation without mastery of arcane commands. But although this access brings entrance into an electronic universe where interactivity is not just a marketing slogan but a way of life, the cost is usually just a fraction of what users pay for cable television.

That situation may change as the Internet detaches from the government umbilical cord that has nurtured it through its infancy. As of April 30, 1995, the NSF no longer pays to operate the backbone network. The portion of NSF funding that goes to the 17 regionals is also now on a five-year "sunset schedule," dropping gradually to zero by fiscal 1998.

Under the new arrangement, the federal government grants this dwindling amount of money directly to each regional network and instructs it to shop for backbone service on the private market. The transition resembles, in one sense, the breakup of the Bell [telephone] System a decade ago. But the government is not stepping out of the Internet picture altogether. NSF is setting up and funding three "network access points," or NAPs; any company that wants to operate an Internet backbone must connect to each of these three NAPs, which are located in New Jersey, Chicago and California. To qualify as a backbone service provider, a company must agree to accept Internet transmissions that arrive at each NAP from every other backbone company.

The withdrawal of a large part of government support does not by itself significantly raise prices for users. NSF's total funding for the Internet is only about $20 million a year. The companies, universities and individuals that use the Net pay many times that amount, and dividing that $20 million over the number of present users yields only about $1 per person per year. As the Net grows in popularity, that burden may diminish further. What worries some analysts, however, is that the nature of information being sent over the Internet is changing rapidly, with potential implications for the system's cost and ease of access.

Digital Congestion

Until about two years ago, the overwhelming majority of Net users were transmitting simple text such as e-mail messages and Usenet postings. Text is a highly efficient method of communication: The words composing a page of the *Encyclopaedia Britannica*, for instance, can be encoded in standard ASCII (unformatted-text) form using fewer than 10 kilobytes. But new software and more powerful desktop computers have made it practical to send high-resolution color images, sound files, even full-motion video — anyone with a camcorder and a multimedia computer can conduct a videoconference, for example, over the Net. Such uses consume orders of magnitude more capacity, or "bandwidth," than text. By swamping the network with video signals, relatively few users can temporarily overload portions of the Net.

The World Wide Web has the potential to exacerbate this problem, since Web browsers can easily, almost inadvertently, trigger the transmission of huge amounts of data. Wave a mouse around the screen, click once on an appealing picture, and megabytes start flowing. Without the Web, users must type in a command to retrieve that information — a step that can at least give them pause.

To understand both the Net's capacity to transmit such information and its vulnerability to overload, compare it with the familiar telephone system. That network uses a technique known as circuit switching: When you dial your grandmother's number, you are instructing the system's switches to establish a connection between your telephone and hers. This connection is maintained for the duration of the call — as long as you are on the line, no one else can use this circuit. You are consuming a scarce resource and pay for the privilege.

Although most Internet traffic physically flows through the telephone wires, information is packaged and routed much differently. Each transmission is broken up into discrete "packets" containing roughly 200 bytes (packet size varies). Each packet is stamped with the recipient's address. The packets then bounce from computer to computer along the Net, each computer examining the address and deciding where to send them next for the most efficient transmission. Since these decisions depend on conditions at the moment, the packets may travel different routes to reach the same destination. Eventually all the packets arrive at the receiving computer, which reassembles them into the original form.

This structure — or architecture, as computer scientists like to call it — stems in part from the Internet's origins as a defense project. A packet-switching system is difficult to eavesdrop on, since messages are scattered to the electronic winds before finally coalescing at the receiving point. The design also lowers the risk that a military attack would disrupt communications — a primary concern in the 1950s and '60s when ARPAnet, the Internet's ancestor, was designed by the U.S. Defense Department's Advanced Research Projects Agency. The reasoning was brutally straightforward: If an enemy attack were to knock out the Washington-to-New York connection, say, information would still move between these two cities, albeit in a roundabout manner. A circuit-switched network like the telephone system offers only limited flexibility in this regard because a circuit must be established before communication begins; a packet-switched network can dynamically "heal" itself in mid-transmission.

Although motivated initially by security concerns, packet-switching technology has profound implications for the economics of network communications. When someone sends something over the Internet — say, a piece of e-mail — the packets do not consume a scarce resource in the same way that a phone call does. If a router is busy, incoming packets simply queue up and wait their turn. Longer lines translate into delays, not busy signals. For the uses of the Internet that have prevailed so far, such lags do not make much difference. Unlike telephone conversations, which take place in real time, e-mail communications can easily tolerate delays of many seconds or even minutes. However, the advent of multimedia services on the Internet is making delays less tolerable. If packets queue up at a router, quality of service can deteriorate; video appears lumpy, for example, and moving from one World Wide Web link to another can take so long that the medium becomes more an annoyance than an adventure.

It is possible that advances in technology will provide the needed capacity. The best fibers used in the long-distance links that carry both voice and data traffic can accommodate 2.4 gigabits (billion bits) per second. Over the next two years, upgrades to optical transmitters and receivers will quadruple that data rate. Even better, after more than a decade of development, telecommunications engineers are perfecting a system called wavelength division multiplexing, which enables a single fiber to carry multiple channels of information, each encoded on laser light of a slightly differing wavelength. Such multiplexed systems will be in place by 1998, yielding a capacity of 40 gigabits per second, predicts Vinton Cerf, a senior vice-president at MCI's data services division and president of the Internet Society, a nonprofit organization that promotes Internet usage and standardization. These radical leaps in performance are coming as costs of all component technologies — fibers, lasers and electronics — decline. Technology, in other words, has the capacity to abolish near-term bandwidth scarcity.

Still, if the recent past is any guide, the demand for bandwidth will grow at least as fast as the supply. According to University of Michigan economist Hal Varian, while NSFnet now operates at only 5 percent of capacity, the volume of packet flow is rising by 6 percent per month. At that rate, average traffic volume will reach 20 percent of capacity in only two years. During times of peak use, however, the amount of information put onto the Net far exceeds this 20 percent average, and packets that do not "fit" have to wait until a channel is clear. As the Internet is used more and more for real-time forms of communication such as video-conferencing, such delays become intolerable.

Congestion on the Internet is already hampering attempts to use it for new applications during peak business hours, says Jeffrey Mackey-Mason, an economist at the University of Michigan. The problem becomes particularly acute when some special event occurs. After the comet Shoemaker-Levy struck Jupiter, for example, and people downloaded the dramatic telescope images, large portions of the Internet slowed down. In such situations, urgent transmissions such as a potentially life-saving videoconference between a surgeon and a radiologist might queue up behind a home movie that someone put on the Net just for fun. In effect, the Net can be dominated by people with a lot of time on their hands, and there is no provision for buying one's way to the front of the line.

To Charge or not to Charge

Some analysts therefore contend that there is a need for some kind of disincentive to unbridled consumption of the Net's capacity. If people have to pay for what they do, they will tend to do less, says Padmanabhan Srinagesh, an engineer at Bell Communications Laboratories, or Bellcore. Net users, in other words, might have to say goodbye to the freedom of a flat rate. The Internet would instead be metered, with users paying by the message, by the byte, or by the Web page, just as they now pay by the kilowatt-hour for electricity or by the minute for long-distance phone calls.

Philip Gross, vice-president for Internet engineering at MCI's data services division, agrees that some sort of usage-based pricing is "inevitable," if only so the multiple companies handling backbone traffic can count packets and settle accounts with one another. But the solution to the problem is not as simple as counting packets or bytes. Take a typical transaction: the transfer of a large software file. User A sends a 100-byte request to User B, who responds by transmitting a 1-megabyte program. A naive billing system would charge User B 10,000 times more than User A, even though User A initiated the transaction and received all of its benefits.

Opponents of fees argue that they would rob the Net's vitality as a workplace, playground and social club. The electronic culture that extols instant and perpetual electronic connectedness presupposes that people will not have to fret over a ticking fare meter in cyberspace. Usage pricing might especially dampen the enthusiasm of school and home computer users. "We should be trying to preserve the motivation of people to use the Internet," says David Wasley, director of computer network services at the University of California at Berkeley. The recent introduction of usage fees in Australia, Wasley says, led to a rapid decline in e-mail sent by students.

Not-for-profit organizations that have begun to rely heavily on Internet mailing lists to reach activists and potential donors are particularly vulnerable to pricing changes. Any kind of per-use charge will have a chilling effect on some of these fledgling exercises in "electronic democracy," asserts James Love, president of the Washington-based Taxpayers' Assets Project, a group that monitors the outcome of privatization efforts. "Say you send a message a day to everyone on a 10,000-name list," he says. "If you have to pay per transaction, that adds up."

Other complications also arise. Part of the Internet's value — and charm — lies in its utter transcendence of geography. In today's system, a Net surfer who downloads pictures of Jupiter need not care whether the computer holding these images is 10 miles (16 km) or 10,000 miles (16,000 km) away. All information stored in any computer on the network is, in effect, stored everywhere. Because the Net has traditionally rendered geographical distance a secondary concern, users often do not even know exactly "where" they are traveling. "If you try to charge based on distance or on the number of bits, then the Internet falls apart," says Edward Krol of the University of Illinois, author of *The Whole Internet User's Guide & Catalog*. "If the best resource happens to be in Belgium, you just use it."

Fortunately, the present flat-rate pricing does have some built-in protection against network congestion. As it now stands, the cost of Net access varies with the bandwidth of the basic connection. A user operating from a home or office with a 9,600-bit-per-second link pays less than a business with a 56-kilobit-per-second connection. The size of this "pipe" limits usage just the way the size of a house's electrical service limits the amount of power it can draw off the grid. Nevertheless, when millions of Net users raise their expectations of what is possible on the network, "the Internet will melt," maintains Scott Shenker, a researcher at Xerox's Palo Alto Research Center.

One way to avoid any potential crisis is to outfit the Net with mechanisms that perform electronic triage. Usage that cannot tolerate delays, such as real-time videoconferencing, would be stamped high priority and sail through the Net like an ambulance with siren wailing. Users would pay their Internet provider a premium for this special treatment. Shenker points out that such priority-based preferences would lead logically to usage-based pricing, since people would think twice about conducting real-time videoconferences if they had to pay dearly for the privilege of displacing so much other activity. Most users would routinely put a lowest-priority tag on e-mail and text postings to newsgroups, which rarely require rapid delivery, and the fees paid by senders who demand high priority would subsidize any cost associated with such transmission.

Although companies that provide Net access have stuck mostly to flat-fee structures, they may start promoting congestion pricing as a marketing edge as the number of providers proliferates. Many users will presumably appreciate the ability to pay for what amounts to a guarantee of immediate transmission.

One barrier to such a move is that today's network has no means of tracking packets sent and received. All Internet communication is governed by a set of rules, or "protocols," called TCP/IP (transmission control protocol/Internet protocol). TCP/IP specifies the method by which any digital data — whether they represent text, graphics or anything else — are transmitted, routed, checked for errors and, if need be, re-sent. But nothing in the protocols provides the detailed information that commercial telecommunications companies need to provide a billing record, MCI's Gross says.

Even if the protocols did gather such information, the accounting process is bound to be expensive. More than half of what customers pay for a telephone call goes to cover the cost of the accounting system, Wasley contends. Thus any attempt to bill for Internet use could become a case of self-fulfilling prophecy: The very act of collecting the necessary information could raise the network's operating cost to the point that users will have to pay more. Anthony Rutkowski, executive director of the Internet Society and a former vice president at Sprint Telecommunications, thinks "it won't be worth the trouble to account for users' consumption of the network's capacity."

Whether and how to devise a workable billing system, if and when usage-based pricing arrives, is a decision that will have to be made cooperatively by the companies that carry Internet traffic, along with the Internet Engineering Task Force — an organization with representatives from government, research and educational institutions, and vendors from all over the world — that writes technical standards for the Internet.

A Changing Picture

The next few years will be a time of shakeout in the burgeoning Internet business. Because the Internet operates as a loose cluster of networks, no one is really "in charge," and each provider of local, regional and backbone service is free to price Internet access any way it chooses — each, of course, influenced by the price charged by its access supplier.

The most likely short-term scenario is for flat-rate service to continue as the norm. In fact, the prevailing assumption is that the smartest way to do business will be to maintain the status quo. Online society has mushroomed on the basis of unlimited use, a structure that encourages a kind of freewheeling exploration. The companies that sell Internet access understand this appeal and seem loath to tamper with it. "We don't want to kill the goose that laid the golden egg," MCI's Gross says. He insists that MCI "will not unilaterally impose" usage-based pricing. "We're very content to operate in the current Internet mode" in the near term, he says, and expects to make no major changes in the next year or two. Eric Aupperle, president of Merit Network, the regional network serving Michigan, echoes this sentiment. "My sense is that the community wants flat-fee access," he says, "and that's how it's going to be."

One compromise pricing method is for an Internet customer to declare at the outset whether it will be a high-volume or low-volume user. For a given bandwidth, the Internet service provider could charge the low-volume user less than a high-volume user. That way a small company can get the benefit of an affordable, high-capacity access. MCI wants to put something like this in place "in the very short term," Gross says.

The amount of change that end users will experience depends on the type of Internet service they have become accustomed to. Clients of Nearnet in the

U.S. Northeast and of Barnet in California will feel barely a ripple during this transition. Those networks have been accepting commercial business for years, and so have relied less on NSF. But in other areas of the country, the regional networks have continued to depend heavily on NSF for funding. There, prices to universities and other organizations that hook into the regional network will probably rise.

Into the Marketplace

As federal funding for the Internet winds down, following it into extinction are the NSF's "acceptable use policies," which have restricted use of the Net for profit-making activity. As the Internet is reborn as a medium not just of public discourse but of commercial opportunity, the revenues generated by such activity might well render moot the questions of per-use charges and ensure access by nonprofit groups. Just as retail stores pay rent to occupy a shopping mall, companies that make a profit on the Net will pay telecommunications companies to be there. Microsoft headed in this general direction with its plan to offer Internet access through Windows 95. Microsoft obtains its revenue not from consumers, who pay the company only a nominal fee for Internet access, but from businesses that set up shop on the Net.

Commerce on the Internet is still embryonic. A few companies publish online catalogs, but transactions are still consummated by telephone and credit card and the product arrives in a United Parcel Service delivery truck. But it is in the marketing of information-based products that the Internet's business potential can be more fully tapped. Software Net, for example, delivers computer programs through the Net. Other companies are similarly gearing up to distribute music and digitized art online, according to Bob O'Keefe, a professor at Rensselaer Polytechnic Institute's School of Management in Troy, New York. Commercial sponsorship also made possible "free" radio and television broadcast; following this model, advertising revenue could pay for on-line publications. Such advertising is potentially of more value than printed or broadcast ads to consumers, who can obtain precisely the product information they need with a few mouse clicks on an unobtrusive icon.

Although such moves may solve some pricing problems, the biggest hurdles to Internet access for many people are not fees for service but the cost of a computer. Commercial activity on the Net could help here, too. As a marketplace, the Internet can be subject to a process as old as the Net is modern: taxation. One suggestion, from David Farber of the University of Pennsylvania, is to impose a 10 percent sales tax on business conducted over the Internet. This revenue could create a pool of funds to buy Net terminals that would be distributed widely at libraries and community centers. Given the resistance to new taxes that now dominates the U.S. political landscape, however, such a scheme seems far-fetched.

While equity of access is far from guaranteed in the near term, the public should in the long run benefit as the Internet is released from the simultaneously nurturing and smothering federal sponsorship. Decades of government support have built a communications infrastructure that fosters experimentation. For the last eight or nine years, the NSF has been in the business of "market building," says NSFNet program officer David Staube — constructing an infrastructure and trying to persuade institutions and individuals to use it. That phase has passed. Now, he says, "the market can stand on its own — without our seed money."

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SOCIETY

Looking for Community on the Internet

Evan I. Schwartz

Can a truly vibrant community exist in cyberspace? Can a bunch of individuals at isolated computer stations achieve warmth, caring, and a shared set of values? Is the Internet becoming a pipeline for surrogate communities in an age of technological omnipresence?

Community is not the image of the Internet promoted by government or industry. If you ask the telecommunications giants and media conglomerates racing to build the infotainment pipeline of the future, they point to a world of interconnected business people, students, e-mailers, and government workers, all operating with breakneck efficiency and without leaving their desks. But this image might have little meaning for the numberless millions of actual Internet users, who might have a starkly different collective vision for tomorrow's advanced communications technologies. In *The Virtual Community,* author Howard Rheingold dismisses the now popular notion that the public demands a great stream of interactive entertainment and information. What the people really want, he argues, is a chance to form meaningful relationships with their far-flung neighbors in the global village. Dale Dougherty publisher of the Global Network Navigator, an electronic magazine on the Internet, agrees. The Internet, he says, is filling a deep need: "We want a feeling of connectedness, of having things in common."

The "Net" is an amalgam of electronic bulletin boards, on-line information services, and computer conference sessions — all connected by the same global telecommunications networks to which our phones are attached. For now, communication is mainly confined to written text, but that is changing as the Net gains the ability to handle voice, video, and other multimedia information. Already some cable companies are providing Internet linkups, and there will soon come a day when people with cheap digital video cameras can transmit their footage to the masses.

The virtual community idea approximates much more closely the real Internet than does the popular metaphor of a superhighway running into people's living rooms. The Internet is a spirited web of conversation that you can weave yourself into by tapping on your personal computer's keyboard and powering up your modem. A virtual community, according to Rheingold, is a group of people who have in all likelihood never met face to face, but who enjoy spending time in cyberspace with one another debating politics, discussing their hobbies, conducting business, spilling their guts, or just flirting and playing games with one another.

Rheingold's book provides a tour of the Internet — a tour that begins from inside the specific virtual community to which Rheingold belongs. Based in San Francisco and known as the WELL (for Whole Earth 'Lectronic Link), Rheingold's local virtual community began in 1985 as an experiment. The idea was to give people access to new tools for group communication, letting them decide on their own how it should all be used.

Not surprisingly, the WELL has experienced its greatest growth as a forum for discussing the Grateful Dead. But significantly, the Deadheads on the WELL translate their on-line interactions into face-to-face meetings. Occasionally the Deadheads and other interest groups hold picnics or concerts. For the most part, the Internet acts as a social leveler: Once on-line, no one can tell if you're black or white, old or young, male or female, sick or well.

Perhaps most important, no one can tell how unattractive you are — looks have never played a smaller role in human affairs than they do on the Net.

For Rheingold, the WELL is a place to discuss the joys and problems associated with raising kids. One time, when his daughter got a tick caught in her scalp, he sat down at his PC, typed in his question, and learned from an on-line fellow named Flash Gordon, M.D. exactly how to remove it. The tick was gone by the time a real pediatrician returned a phone call from the author's wife.

Another bulletin board, Baud Town, also emphasizes community by building itself around the analogy of a town, complete with social norms. New joiners receive a lengthy etiquette message explaining that the bulletin-board community allows no X-rated discussion groups, nor messages in capital letters (the latter are the equivalent of shouting on-line). The bulletin board community even has its own "Neighborhood Watch," in which users police one another against abuse of the system. All of these efforts help to reduce anonymous harassment on-line and make for a safer electronic community.

The "citizens" of Baud Town have created an environment in which they give and receive support. Users receive comforting messages from fellow users during difficult times, such as divorce, illness, or death in their families. Much like WELL users, Baud Townies "date" on-line, taking advantage of the low-pressure atmosphere of the Internet that allows users to get to know each other's personality before meeting in person.

The Net's capacity to function as a vehicle for community lies in the differences between it and all previous communications media. While telephones are primarily a one-to-one medium and television a few-to-many medium, the hypergrowth of the Net marks the beginning of many-to-many communication. Greater possibilities lie just over the horizon. In two years, one expert predicts, there will be more users on the Net than there are people living in California. Within five years, the on-line populace will exceed the number of citizens

ROGER'S BAR ON THE INTERNET: Colorado Springs community activist Dave Hughes uses his computer bulletin board — named after a local bar, Roger's Bar — to mobilize public opposition to a city zoning ordinance that would have clamped down on home-based business. Hughes advocates wider use of on-line bulletin boards to raise citizen participation and ensure that officials are responsible to the electorate.

of any single country except India or China. With the Net's ability to transcend time zones and national boundaries, it could contribute to greater understanding between cultures. On the other hand, the freeflowing dialogue could bring on social upheaval, especially in places like Japan, where communication with outside cultures is tightly controlled by the powers that be.

Like physical communities, virtual communities can exert strong pressure on members to conform to behavioral norms and conventions. In April a pair of lawyers in Phoenix, Arizona placed an ad for legal services on the Internet. (Non-commercialization of the Internet is one of the cardinal, if unofficial, rules of the Net.) In response to this transgression, users from around the world "flamed" the couple with 30,000 hostile messages. The barrage, according to *The Phoenix Gazette,* caused the local Internet node, Internet Direct, to overload and temporarily shut down. Internet Direct posted apologies for the ad and suspended the lawyers' access to the system. Internet Direct systems administrator Geoff Wheelhouse told the *Gazette,* "(The incident) has given us a bad reputation." Most actual communities work no more effectively.

The United States might be poised to benefit most from virtual communities. Since the convivial atmosphere that still exists in Italian piazzas and Parisian bistros has largely died in the United States, Americans hunger for a new way to connect with each other. One of Rheingold's sources attributes the decline of public meeting spaces in the United States to the nation's "suburbanized, urban-decayed, paved, and malled environment." Others attribute the breakdown of intelligent public discourse to the fact that "the public sphere," particularly the airwaves, have been commoditized and sold off to media moguls and advertisers. The Internet, by contrast, still has a chance to be run by and for the grassroots.

Internet enthusiasts sometimes see virtual community as a panacea for all sorts of social ills. They go a kit far, for example, when they hold out the possibility that the Net could be a forum for electronic democracy. The people conversing on the Internet and other on-line services are by and large not a bunch of civic leaders. The untamed, freewheeling nature of cyberspace means that it's often filled with every skinhead, Trekkie, religious zealot, and Limbaugh-wannabe with a new theory on how the world should work. The Net is not, at least not yet, much of a town hall meeting.

But cyberspace community is by no means irrelevant to democracy and citizenship. Because it is not centrally controlled, the Internet is a regular proving ground for the First Amendment. The "alt.sex.pictures" bulletin board, for example, was once based on a Texas computer. When local authorities began a crackdown, however, the operators of the service moved it to a computer in Finland literally overnight, causing an instant surge in network traffic to that part of the world. At the same time, on bulletin boards and Internet conferences, the faithful can quietly discuss theology and the Bible. There are boards for every imaginable subject and interest group: sex and substance abuse, veterans, vegetarians, lesbians, animal rights activists, and even one for fat people (it's called the Big Board).

The question is how real these communities actually are and to what extent they really fill the needs of more traditional communities. The answer isn't entirely clear. The Net is uncharted territory both for individuals and for communities. "It's like a boom town in the old West," says Dougherty. "The rules aren't written yet. With TV, people are controlling you. Here you are on your own."

Even Net enthusiasts acknowledge that cyberspace may never be a replacement for true communities. Rheingold, who is clearly caught up in channeling virtual communities as a force for good, expresses openly his reservations about the Net as a surrogate community: "perhaps cyberspace is precisely wrong place to look for the rebirth of community...offering a life-denying simulacrum of real passion and true commitment to one another." And he asks, "If a lonely person chooses to spend many hours a day in an imaginary society, typing witticisms with strangers on other continents, is that good or bad?"

The key word in the cyberspace community lexicon is "virtual." Like an elaborate, electronic flight simulator, the technology is breathtaking and the simulation appears perfect. Only when the users find themselves in the cockpits of real airplanes (or in the midst of real communities) do they realize how limiting "virtual" can really be. Still, for many people, the choice seems to be between a very good simulation of community and no community at all; that choice makes virtual community look attractive indeed.

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The Virtual Future

Albert G. Holzinger

Near the village of Rutherford, at the heart of California's Napa Valley, a majestic redwood barn stands watch over a 35-acre (14 ha) vineyard. The century-old, two-story structure is the centerpiece of Frog's Leap Winery, where the grapes are tended with love — but without chemical fertilizers or pesticides — by the close-knit staff of winery owners John and Julie Williams.

This pastoral setting, the tradition-steeped nature of the winemaking business, and the organic approach to viniculture adopted by the Williams family suggest that the business practices at Frog's Leap are more old-fashioned than the 14-year-old winery's age would indicate. Nothing, however, could be further from the truth.While some methods employed by winemaker John are, indeed, thousands of years old, the financial-management, promotion and sales techniques of marketing director Julie are state-of-the-art. About half of the 20 employees of Frog's Leap are regular users of the company's personal-computer network and its telecommunications link to the networks of some of the winery's business partners. Employees use the high-tech tools to perform tasks ranging from accounting to tracking sales of about 50,000 cases of Sauvignon Blanc, Zinfandel, Cabernet Sauvignon, Chardonnay and Merlot wines "down to the last bottle, to the last retailer, to the last salesperson," Julie Williams says. Moreover, the Williamses envision using the fast-growing global web of computer networks now known as the Internet to reach customers across the United States, in Asia, and in Europe.

If all goes as planned, Frog's Leap wine will be available for purchase soon behind an electronic storefront, named Virtual Vineyards by owner-operator Peter Granoff of Los Altos, California. This online marketplace is located on a graphical subnetwork of the Internet known as the World Wide Web, or the WWW. The Williamses also may forge a relationship with a local company named Napa Valley Virtual Visit. The firm maintains a WWW database not only of selected area wines and wineries but also of Napa Valley restaurants, lodging facilities, special events and tourist attractions such as the Frog's Leap barn. "When we examined the cost of marketing our products and promoting the winery, we felt we needed to look into ethereal areas such as the Internet," Julie Williams explains. "We can't possibly afford to distribute detailed, printed information about Frog's Leap to our 20,000 customers, but we certainly can afford to put it on line."

Improved management and increased sales are two key benefits that could accrue to the owners of small companies as a result not only of advances in information technology but also the convergence of the communications, information and entertainment industries. This consolidation, which could be substantially complete as early as the year 2000, will provide entrepreneurs, their employees and their customers with affordable access to vast quantities of information in text, audio, video and other formats.

In the coming years, Americans will be able to instantaneously receive, display, process, store and even retransmit the diverse data. They will do so using devices ranging from next-generation wired and cellular telephones, radios and televisions to advanced fax machines, pagers, desktop and portable computers, hand-held information appliances known as digital assistants, and high-tech devices still to be invented. The seamless but devilishly complex web linking the communications instruments will be spun from fiber-optic, copper, coaxial and other cables and augmented by cellular, satellite and other wireless-communications signals. The envisioned network is referred to as the national information infrastructure (NII), or the information superhighway.

From the small-business perspective, the potential of this pervasive network of networks and the myriad devices connected to it is immense. The ways in which the futuristic communications scheme

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may help small companies bridge the resource gap separating them from larger competitors are far too numerous to detail. Here are a few of the most promising.

Mobilizing the Work Force

Many small companies will slash overhead by allowing some or all employees to work at home or in remote locations where costs are low. The far-flung employees will be able to maintain video as well as voice contact with colleagues and customers at the principal business location. Moreover, emerging wireless communication devices will enable off-site employees to instantaneously access and update inventory, price, financial and other computerized business data.

"The work force ... will become infinitely more mobile when people no longer are tethered to wire lines," says Ford C. Greene, chief operating officer of North American Wireless Inc., in Vienna, Virginia. "Wireless communications will free people to work from a variety of places that are currently impractical, including the beach," he adds. Greene's company is involved in development and deployment of an advanced, digital wireless-communications system known as Personal Communications Services, or PCS.

High-performance, hand-held personal computer that allows users to perform business applications virtually anywhere.

Improving Ties To Business Partners

The NII will facilitate automated ordering among cooperating businesses. Also commonplace will be instantaneous, secure transfers of funds and sharing of intelligence and other information important to the participating companies. Furthermore, engineers and managers at partnering companies will use the audiovisual and data links made possible by the NII to improve and speed up product design and manufacturing. Says Neil Selvin, president and chief executive officer of Global Village Communication Inc.: "Small businesses already get excited when we ask them, 'How would you like to communicate with suppliers . . . as easily as you send [electronic] mail around your office?' " Selvin's firm, in Sunnyvale, California, markets communications products and services to entrepreneurs who want a presence on the Internet.

Reaching Out To Customers

Small companies will gain lucrative promotion and sales opportunities well beyond today's Internet marketing once most American homes are equipped to send and receive audio, video and data. For example, home shoppers will be able to admire themselves on television "modeling" selected products of on-line retailers of clothing or other products. Achieving these advances may be relatively inexpensive, as thousands of current and start-up companies compete intensely for shares of the more than $1-trillion-a-year communications business.

"If the trend toward decontrol keeps going ... there will be a lot more players in the communications marketplace," notes John Vette, a director of the Telecommunications Industry Association, in Arlington, Virginia. Its members are vendors of telecommunications products and services. "The small-business user and the consumer will ultimately benefit from the sheer fact ... that there is competition," he says. Greene of North American Wireless concurs: "Providers have figured out that with corporate America downsizing, small businesses and individuals are the market. Products and services are going to have to be priced to appeal to these people."

With so much at stake, it is critical that the information superhighway meet the diverse needs of the American business community, says Jody Olmer, director and special counsel of domestic policy for the U.S. Chamber of Commerce. Like it or not, she says, "all businesses are becoming information-technology companies through their use of or dependence on communications products and services." Last year, Olmer helped the Chamber form a broad-based task force to recommend positions for building an NII of maximum benefit to U.S. business. "The basic premise of the task force," she says, "is that current and potential business users are underrepresented in the ongoing communications-infrastructure debate."

The task force surveyed 6,500 diverse companies nationwide, and it found that business overwhelmingly wants the NII to be affordable, reliable, easy to use and secure from electronic theft of proprietary material. Approximately 1,600 respondents to the survey said they plan to use the NII in coming years to send electronic mail, train employees, access published information, conduct videoconferences and market electronically. Why might small companies at least begin exploring such uses of electronic networks if they are not using them already? The potential for such systems is vast. Take electronic marketing, for example. Its prospects can be assessed by examining today's Internet.

The Internet was launched 25 years ago by the U.S. Defense Department to link government and university computer networks. It now has about 25 million users in the business, consumer, government and academic sectors and is growing by about 160,000 users a month. However, large audience numbers are not the sole reason the "Net" is an increasingly popular marketing vehicle. Among the findings of a survey conducted recently by a leading national Internet access provider, O'Reilly & Associates Inc. of Sebastopol, California, 71 percent of users are in a prime consumer age bracket — 25 to 45 — and 67 percent have household incomes exceeding $50,000.

Young, affluent people are apt to buy homes. So it is no wonder Paul Heltzel, operations manager at Heltzel Mortgage Corp., in Manassas, Virginia, reports that acceptance of the firm's online offerings "has been really good."

The small, family business recently began enabling customers to obtain home-mortgage and related information and apply for and finalize loans through a virtual storefront called "digitalMortgage." Service is available all day, every day without an appointment — and at no cost to users, almost all of whom are in the Baltimore, Maryland-Washington, D.C. area. "This company has seen many changes since my father started the business in 1965," says Rob Heltzel, the firm's president. "We thought it was time to offer customers a new, space-age way of reaching us and vice versa. And this system makes a lot of sense." Attesting to the reach of the Internet, to which digitalMortage is connected, the company recently received a loan inquiry from France.

For the past 10 years, Americans have been "working longer hours with more demands" than ever, observes Bill Bluestein, director of computing strategy research at Forrester Research Inc., in Cambridge, Massachusetts. "People want to regain control of their lives," he says, and online shopping for products and services, on-demand from anywhere and through a number of digital devices, is one way of achieving this. However, establishing a presence on the Internet is not a sure-fire formula for building a business. When Forrester Research surveyed 25 consumer-goods and service companies with a presence on the World Wide Web recently, all reported that their sites were visited frequently, with some receiving tens of thousands of inquiries already this year. But many of the companies lamented that sales have lagged far behind interest.

Despite this uneven performance, the NII almost surely will offer small firms tremendous opportunities by 2000. Nicholas Negroponte, director of the Massachusetts Institute of Technology Media Lab and an Internet pioneer, succinctly summarizes the beliefs of those participating in the communications revolution: "I think it's bigger than the printing press. And it's certainly quicker."

Albert G. Holzinger is deputy editor of *Nation's Business*.

SOCIETY

Fax, CD-Rom, On-Line Services and Newspapers

Tony Case

As newspaper companies busy themselves building their section of the information superhighway, they ought to keep in mind what put them on the road in the first place, the head of one of the country's biggest media conglomerates recommends.

"I think we've got to have the fingers going out in each direction, but I think we've got to remember the newspaper is the core product, and while we now can describe newspapers as reader gateways, I think we best not forget that the newspaper is still the thing for us that will drive the information, that gets it through the electronic systems whatever they may be," said John Curley, chairman, president and CEO of Gannett Co. Inc.

Curley joined Eugene Falk, executive vice president and general manager of the *Los Angeles Times,* and Joe Hladky, president and publisher of the Gazette Co., Cedar Rapids, Iowa, on a panel titled "Newspapers' Strategic Direction: Challengers and Partners in the Future" at the Newspaper Association of America's Nexpo '94 technical exposition and conference.

The discussion allowed the participants to promote their companies' multimedia and interactive ventures before hundreds of conferees packed into a cavernous assembly hall at the Las Vegas Convention Center.

But amid the talk about fax, CD-ROM and on-line services, the executives stressed that technology is a means of building on the success ink on paper has long enjoyed and not, as some have prognosticated, newsprint's successor.

"For nearly a couple of centuries, newspapers have gathered, edited, packaged and distributed the news in one form or another, and in the last decade, our local and national news franchises have found ways to reach those consumers whose appetite for news is not limited to what we publish in our newspapers," Curley told the Nexpo attendees.

In the last decade, newspaper concerns such as Arlington, Virginia-based Gannett have developed products that have expanded their audiences and increased the impact of their reportage.

Curley related that the nerve center of his company's electronic news and information services is the Gannett/USA Today Sports and Information Center in Greensboro, North Carolina.

Established in 1989 primarily as a sports statistics provider, the center today repackages content from *USA Today* and other Gannett papers and makes it available electronically. The service offers full-text news stories, brief items on topics such as business, travel and weather, and a bulletin board allowing users to communicate with each other.

Curley touted database-supported advertising models created in Gannett's newspaper division — "the kind of thing we need to use databases and video and all the other things available to us so that we can bring more revenue into our newspapers" and the development with Hewlett-Packard Co. of a model for a library archive at the company's Rochester, New York, properties.

"But let's not forget our newspapers in our efforts to make this core product even more useful to our readers, with all the touchy-feely stuff out there through electronic communications," Curley warned.

New technology is "fine and maybe it will be helpful in the future, and maybe it will unlock the door," he said, "but I think if we can add 3 percent to 5 percent in readers on an annual basis, reversing the downturn, we would find the advertising dollars very, very rewarding."

The *Times*' Falk echoed Curley's contention that technology will serve to enhance newspapers' existing base by helping them meet emerging consumer and advertiser needs not met by print.

As the general public experiments with these new advances, so will the flagship of Times Mirror Co., Falk told the audience. "We want them to migrate with us," he said of the paper's customers.

Electronic services also serve as barriers to new competitors, he added, commenting, "Many of the niche services these new upstart players are looking at as opportunities will look a lot less attractive if we are already providing them!"

The *Times* is also creating new localized media important in on-line services. The paper's products will include a combination of news and information, communications and advertising with transactions.

And "after a lot of negotiations," Falk told the gathering, the *Times* has arranged for Prodigy subscribers to add the newspaper as an extra service for a charge of \$4.95 a month. Those who are not Prodigy users can subscribe to the service for \$6.95 monthly.

"This business model is important because we wanted our customers to be able to subscribe to us on a stand-alone basis, without national Prodigy, if that's what they prefer," he said. "By handling it this way, we can maintain the direct customer relationships, which . . . are a key part of our vision for electronic services."

"Which of these services will dominate the new medium is a big unknown," Falk said, "but it is clear that all three will be needed to attract enough consumers and advertisers to make a viable business out of it."

He considers the *Times'* initial offerings evolutionary steps toward the establishment of broadband services.

"We believe it's going to take a while — indeed, quite a while — to get anything like the 500-channel world operating across America," he said. "The lessons we learn along the way using today's technologies will guide us to what the ultimate role of newspapers will be on the information superhighways of the future."

Implicit in the paper's vision for electronic services, Falk related, is a belief that the newspaper represents a series of databases across a range of information categories such as national and local news, real-estate listings and retail advertising.

Of course, the *Times* will continue to package the information in its daily editions, but electronic distribution will let the paper "go deeper and provide greater value to our customers within selected key market categories," he said.

Among the paper's high-tech projects are its electronic shopping venture with Pacific Telesis announced in January and an on-line deal with Prodigy.

Using the shopping service, consumers can access a database of classified and yellow-page listings through several delivery platforms, including operator-assisted, on-line and interactive video services.

The *Times* will control all content, the packaging of advertising with editorial material and the pricing of subscriptions and advertising.

For this "independence and control," Falk said, the paper will pay Prodigy a share of its revenues from the service.

These projects "contain all the elements of our vision for how newspapers should begin providing electronic services with today's technologies and evolving them into the future," Falk said.

"If the superhighways end up growing rapidly, we will be there to capitalize on whatever opportunities develop. If the highways get bogged down, we will have covered our bets for a relatively modest cost, and we'll still be able to provide a newspaper while others wait for the highway to develop."

Gazette Co., which publishes the *Cedar Rapids Gazette,* has used technology not only to secure the future of newspapers but to ensure there will be newspaper readers tomorrow.

The company's Newspaper in Education program has teamed with Foundations in Reading, an initiative developed by Breakthrough Inc., Iowa City, Iowa, that uses computers to help children struggling to learn to read.

"I think there is great potential for every local paper to be seen in a positive light since many of the Foundations in Reading stories feature benefits of reading outside the classroom," president and publisher Hladky said.

Each student participating in the program gets a supplemental workbook printed in newspaper format.

"I can see a natural tie-in for the local paper being identified with these workbooks," Hladky told the conferees.

About a year ago, Gazette introduced an electronic classified ad locator called ExpressWay Classifieds after recognizing that existing systems were not widely embraced by the public.

"I don't think any telephone service is an easy sell today, but we felt any new service should be very user-friendly as the database is queried," Hladky said.

Software was developed in conjunction with Philadelphia-based AudioTechs. The system runs on an Alpha computer from Digital Equipment Co., which also markets the software.

The program offers a seamless transfer of data from the classified section of the company's SII system to the DEC computer on which data is stored.

A series of prompts guide callers through the database, allowing them to narrow their search, always with the option of moving back a step. Users are informed of how many autos are available fitting the criteria they have entered.

Gazette presently has about 1,000 vehicles on its electronic parking lot. The service receives about 100 inquiries a day.

When considering the future of phone services, Hladky suggests employing a standard rationale: If you don't do it, someone else will.

"The mission of our company states that we want to be the information provider of choice through a dynamic mix of products and services," he said. "We don't identify the medium; that choice should be the consumer's!"

Regarding newspapers' traditional role, he recommended they "focus our efforts on that which we do best: collecting information to satisfy consumer interest."

He said, "New telephone technology is evolving and every newspaper will want to offer voice information using the telephone as part of its mix of services." But he added that "we should not get hung up on any one communication vehicle; we should offer several."

The company's Decisionmark subsidiary created MediaStar software for application in the circulation, advertising, direct marketing and news departments, using Microsoft Windows and operating either on stand-alone work stations or networks.

"To explain MediaStar software, I like the five-words-or-less definition: it integrates maps and data," Hladky said. "The people who developed MediaStar would say the software gives you immediate access to database and census information, letting you identify and analyze data graphically and present it for improved comprehension and decision-making."

According to Hladky, MediaStar enables Gazette to:

• Plot the location of subscribers and nonsubscribers in order to track promotions and improve the return of marketing dollars. "This element alone justifies our development effort," Hladky said.

• Display data on households according to neighborhood.

• Track and measure carrier or district manager draw and/or penetration over time.

• Overlay census or other demographic data on specific geographic areas, zip codes, neighborhoods and households, allowing the company to follow trends in the market.

• Define distribution areas for maximum cost effectiveness.

• Plot advertisers' customer lists and merge/purge with Gazette's subscriber list or other data "to offer an advertiser the most efficient means of reaching desired customers.

• Create custom maps easily.

• Research information for news stories, including crime statistics, housing costs and population changes.

Hladky said MediaStar allows Gazette "to more fully utilize the vast quantities of data that we have available at the newspaper but seldom use."

And additional uses for the software are being explored. "We are just starting to define applications for the newsroom," Hladky related, "and the list of possibilities is really exciting."

Tony Case is a Staff Writer for *Editor & Publisher*.

The Need for New Copyright Laws

Bruce Lehman

[Editor's note: The following is exerpted from comments made during a Worldnet Dialogue Program on the copyright challenges posed by our new digital world. Worldnet is the international television network of the U.S. Information Agency.]

U.S. Patent and Trademark Office recently issued a study called the "Report of the Working Group on Intellectual Property Rights of the National Information Infrastructure." The National Information Infrastructure Task Force is a government-wide committee that was set up by President Clinton to meet the challenge of a pledge that he made during his campaign when he ran for president. I think he was the first leader in the world who in running for office actually targeted the information superhighway as an area that required presidential involvement and the focus of the national government.

President Clinton felt that the information superhighway was important for two reasons. One is that it provides tremendous potential benefits to all of our citizens in terms of being able to get access to information; and the second, I think this is a very important point, is that President Clinton saw the information superhighway as a vehicle for economic growth. Not only are the industries that create the physical electronic network very fast-growing industries, but also the industries that create content products are very fast-growing as well. So we set up a task force to study all of the implications of this new technology.

I was asked by Secretary of Commerce Ron Brown, the head of the overall task force, to chair a working group on intellectual property. We have recently issued, after about two years of work, a roughly 250-page document which explains how intellectual property will work in the network of the electronic superhighway environment. The main thrust of this report is to show how owners of content, which will be delivered through the new network environment, will be able to protect themselves, and to protect the integrity of their product. This is very, very important, because the president sees the new network environment as being a marketplace where information products can be sold to the public — and new information products that we do not even yet know about can be created. This will not only provide new products for consumers, but it will obviously provide a lot of economic activity and jobs for people in the industries that create these programs.

However, since you are dealing with intangible creation, intellectual property — the kind that has historically been protected by the copyright law — is very important to make certain that those laws are effective in protecting those intangible products from unauthorized use. Otherwise you can never have a marketplace in this electronic environment. So that is the thrust of our report.

Basically, we concluded that the existing copyright law of the United States is adequate to support this electronic marketplace, but that there are a couple of areas in which we do need some "fine-tuning." Specifically, we wanted to make it clear that when one delivers a product to a consumer electronically, as opposed to delivering it to them in paper form — for example at a book store or record shop, or something of that type — that the same rights attach to electronic distribution of a product as apply to the physical distribution of a product.

We also recognize that the use of encryption technologies is going to be very, very important. People are not going to simply put these materials out of the

Internet, for example, and expect a great deal of copyright protection, unless they first take steps to encrypt them or technologically protect them from unauthorized use. Then, if someone wants to have access, they will have to get a code to be able to download or obtain authorized access. So we are proposing that U.S. law be updated to make it clear that people who go into the business of trying to sell devices or instruments that would enable unauthorized access to works will be liable to some sort of legal action on the part of copyright owners.

We wanted to make it clear that there will be a lot of continued free use. This free use will explode and continue to explode in the electronic environment, and that nothing we are doing to protect the rights of business people trying to sell their products in this network will restrict the continued free use of these networks.

The Management of Rights

One of the bedrock principles of our report is that exclusive property rights should attach to the creators of the new products that will flow in the electronic commerce. Now, because of that, we are very sensitive here in the United States, and we very strongly resist any attempts anywhere in the world, to force some kind of collective management of rights without the free assent of any individual rights holder. Now, that does not mean that once having been guaranteed the exclusive right to any intellectual creation an author may not conclude that the most efficient way to license his work in this environment, just as in past environments, would be through some kind of collective management.

We don't yet know how the system is going to completely work itself out, because the marketplace will determine that. But I will imagine that we will have a variety of licensing techniques that will be used in the electronic environment. For example, when you have widespread distribution in an electronic environment, and you know we have already the equivalent of broadcasting on our Internet here in the United States — in that kind of situation I would guess that you would continue to use collective management. Certainly the music that is used in that environment would continue to be licensed by performing rights societies, as they have in the past. On the other hand, there will be many, many products which will be licensed on an individual basis, depending on the particular kind of use that is involved. For example, if a sound recording, or a phonogram, is going to be delivered to a customer electronically instead of through a record shop, I would assume that complete exclusive rights would be required, and there would have to be a one-on-one of the right in the sound recording. I know in Europe that that is a "neighboring right"; in the United States, it is covered under copyright law. Of course, all of the other rights that might be obtained in that sound recording also would be licensed on a direct or exclusive basis.

So, I think that there will be a variety of techniques. I think performing rights societies, as we have known them, will increasingly look to alternate licensing techniques for the portfolio of rights which they administer. I think that they will probably in some cases use computer technology to grant rights on an individual basis, but they will be the mechanism that administers the system, simply because for many individual creators they're not going to have a volume of work that is going to be significant to enable them to exploit that on a massive level. Obviously, if the work is owned by a large corporation, like a motion picture company and so on — they have greater ability to be able to license — develop licensing mechanisms and sell their products in effect directly. But for many creators they will probably want to use some kind of collective licensing mechanism.

Now, there are competition questions there. We in the United States have multiple collecting societies, so that provides some competition. In other countries there are not multiple collecting societies, and those issues will probably start to become more important, and there will be scrutiny about those matters from a competition point of view as time goes on, quite apart from the intellectual property issues that are involved.

Patents and Trademarks

We also looked at the application patent law and trademark law to this network environment, and the report contains discussions of the law in both those areas. The treatment is relatively brief, because in both cases the report concludes that there is little need at this point for law reform. However, both of those areas of law are areas that have application in the Internet context. For example, with regard to trademark law, trademarks, of course, unlike copyright — where you have worldwide protection under the Bern Convention, enhanced now under the TRIPS text (part of the GATT agreement, the new WTO regime) — trademarks continue to be granted on a national basis. Well, when you are selling information, when you are using names, when you use terms that might constitute trademarks on a global Internet, that national fragmentation that we know in trademark law starts to break down. So I think it is going to be important for us as time goes on to attempt not only to harmonize trademark law, but if there are problems that develop in trademark protection, to work to resolve those.

In the area of patents, of course, as far as the United States is concerned, we do not see any problems at the present time. However, software, computer software, is a very important part of the network in the Internet environment. In the United States last year we issued 7,500 patents on computer software. This is a phenomenon which we do not find repeated in Europe, or even in Japan — much less in other countries. In fact, there is still some question, for example under European law, by and large as to whether or not these software inventions are even patentable. This eventually could create problems which would require international discussion and resolution, if we have the United States going off and providing exclusive patent rights to some of this technology, which is very important to the network environment, we have our counterparts anywhere else in the world not providing that protection.

Deregulation and Competition

The Administration position is that there should be a deregulated network environment. That is, the companies and organizations that provide access — through fiber optic cable, through telephone lines, through satellite and microwave distribution — should function in a competitive free market and a deregulated environment. There have been differences of opinion in an attempt to continue a long-standing process of deregulation in the United States. Those differences of opinion tend to revolve around the question of whether or not the deregulatory legislation that is now under consideration in Congress will in fact provide a competitive environment.

You know, when one entity — for example, a local telephone company or a cable company — has a de facto monopoly already, simply by the fact that it has virtually every subscriber in a community, or maybe a state, or maybe even a region, already connected to its system or its service, you simply don't go overnight by wishing — by simply stating deregulation, that there is competition — from a system where you have had no competition to a system where you have competition. And the administration has wanted assurances that there in fact will be a competitive environment, and that we won't automatically hand over to people with a de facto monopoly a completely unregulated legal environment to continue to use anti-competitive practices to unfairly retain that monopoly. And that is the prime issue. It's not at all a question of not believing in a deregulated environment. The Clinton administration wants to see a thousand flowers bloom in the network environment.

There is an international aspect to this as well, and the vice president has made it very clear that we want to open our markets to foreign competitors, to foreign telecommunications companies; but we will only do so on a reciprocal basis, and this is because to the extent that we have had monopolies in the United States, that has even been more true in the systems of many of our trading partners, where you have had state PTTs. Simply saying that you are going to deregulate again is a lot different from having in place a system of competition. Also, it is very important from the point of view of the United States that if we are going to have foreign ownership as part of our telecommunications system that we have the right to also participate in ownership of competitive telecommunications systems elsewhere in the world.

So clearly the touchstone of the administration is deregulation. It is a totally competitive free market environment. The world has not worked that way for many years, either in the United States or abroad. So we need to manage the transition to that new environment in such a way that we actually achieve that goal. I think that is a very worthy goal that the president and the vice president have given to all of us.

Bruce Lehman is Assistant Secretary of Commerce and Commissioner of Patents and Trademarks.

The American Internet User Survey

FIND/SVP's Technologies Research Group

Introduction

The American Internet User Survey is a multi-client research study designed to identify, quantify and characterize Internet users in the U.S. today. It is sponsored by thirty major companies with diverse interests in the Internet, including companies in: computers, networking, online services, telephone and cable companies, publishers, and business and consumer service providers. The American Internet Survey is designed to optimize the breadth and depth of insight into Internet user behaviors. Over 155 questions were asked in lengthy 30+ minute telephone interviews — preceded by focus groups and a series of online studies.

Some 9.5 million Americans now use the Internet, including 8.4 million adults and 1.1 million children under 18, who tap into it from the workplace, school and homes, according to findings from the American Internet User Survey, a brand new study by FIND/SVP. The study culminates a year and a half of intensive research and development by FIND/SVP and is being described as the most accurate and in-depth survey yet fielded on how the Internet is being used in the United States. The research was sponsored by some thirty major companies involved in the Internet, including major computer and networking companies, online providers, telephone and cable companies, publishers, and numerous consumer and business product and service companies.

The American Internet User Survey was fielded by telephone in November and December 1995 to 1,000 randomly dialed Internet users. It was preceded by focus groups and a series of online surveys, and represents the fourth time FIND/SVP has studied Internet users by telephone in the past 18 months. This makes the firm one of the premier research firms in the burgeoning Internet survey business and possibly the only firm with historical random sampled data that enables behavioral tracking since 1994.

The interviews included over 155 in-depth questions (some 400 response choices) closely detailing how Americans use the Internet for business, personal and educational purposes, including questions about trade-off's between use of the Internet and other information and communications media. The study is by far the most comprehensive random-sampled survey of Internet users ever conducted.

"The findings confirm that the Internet is already rapidly evolving into different things for different people," said Thomas E. Miller, vice president of FIND/SVP's Emerging Technology Research Group, which produced the study. "For some it's a way to master the information explosion, for others its an educational tool, and for still others it represents a new way of shopping, banking or doing business. Just as the telephone network supports all these kinds of activities, so too the Internet will evolve in ways that support a wide variety of information and communications needs."

Smaller Numbers than Previously Believed; But Fast Growth of the Internet is Confirmed

The American Internet User Survey found fewer total Internet users than some recent research had led many analysts to believe. Even so, the total already nearly matches the total number of users of commercial online services, which was estimated to be 10 million subscribers at year end 1995 (Source: Arlen Communications; Note: subscribers outnumber subscriber households due to multiple subscriptions per household). Importantly, over half the Internet users interviewed said they began using the Internet during 1995, confirming that the Internet audience more than doubled in the past 12 months. The research firm concludes that the Internet is definitely more than a fad, although there is much potential yet to be realized in further development of the worldwide network.

Daniel Campbell, FIND/SVP's Director of Emerging Technology Research, pointed out that part of the obsession about estimating the total number of Internet users lies in the challenge of defining who an Internet user is. There are many different parts of the Internet that can be used separately, ranging from email to the worldwide web to more obscure applications such as FTP, gopher and others.

"Defining an Internet user is rather like defining a telephone user," Campbell said. "Is it a business user, someone who's dialing for information or to place an order, or simply someone who wants to communicate with a personal friend? The Internet has all these features, and more." He explained that once people get past the Internet "numbers game", the really important research objective is defining how to segment the user universe and understanding much more in-depth the different uses people make of the Internet.

Internet User Definition

To qualify as an "Internet user" in the FIND/SVP survey, respondents had to be current users of at least one Internet application beside e-mail. Qualified respondents included users who access the Internet from commercial online services (e.g., America Online, CompuServe, Prodigy, Microsoft), those who rely on independent Internet service providers, plus corporate and academic server users.

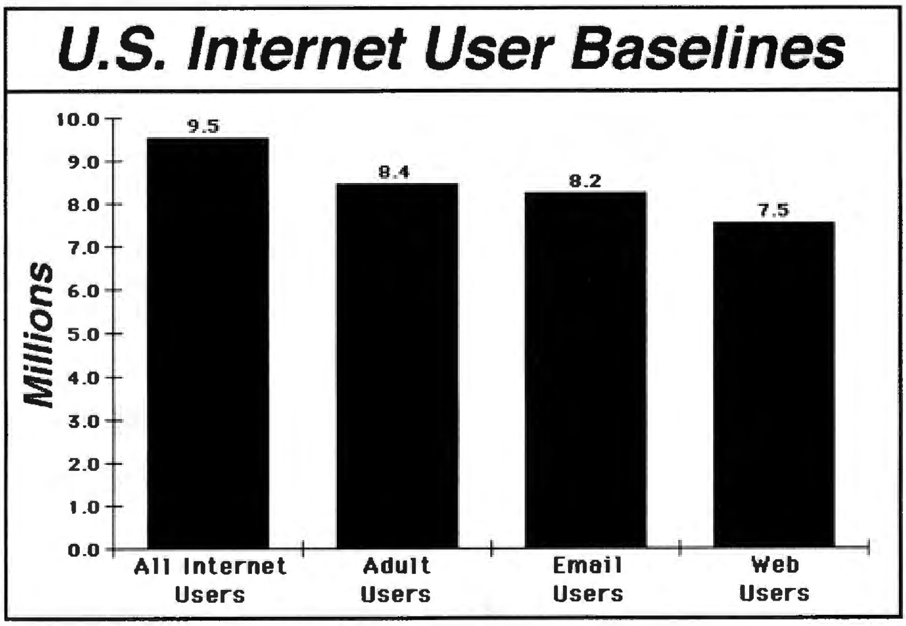
Using the definition: "one Internet application besides e-mail," the survey found that the 9.5 million total Internet user universe breaks down as follows:

• 8.4 million adults aged 18 and older use the Internet, including for work, personal, or academic purposes — also at all types of locations (work, academic, home, mobile).

• 7.5 million total users access the Worldwide Web, including business and personal users who access it from work, academic, home, or mobile locations.

• 7.3 million home users, including adults and children, use the Internet (for any application) from home.

• 5.8 million adults use the Internet for business activities, vs. 6.0 million adults who use the Internet for personal activities. Sixty percent of adults use it for both.



• 1.1 million children under 18 use the Internet from any location, including home or school. Approximately 700,000 of these children access the Internet from home.

Fast Internet Growth is Confirmed

• Overall, 51% of all Internet users reported they began using their first Internet application in 1995.

• This implies 100% average annual growth in the overall American Internet user universe in 1995.

• Of the 3 leading Internet applications, Web use is the most recent, i.e. most likely to have begun in 1995. In 1995, four million people began using the Web, nearly matching the total number of users to date on AOL.

Home Access Higher than Expected

The study found that personal use of the Internet is rising rapidly, and that mixed use for both work-related and personal purposes is the norm. Surprisingly, two-third's of all users now tap into the Internet from home, including 37% who do so exclusively from home. Of those who began using the Internet in 1995, nearly half, a remarkable 48%, use it exclusively from home. Thus:

• Only 20% of Internet users said they tap into the Net exclusively from work.

• Another 8% indicated they tap the Internet exclusively from academic locations.

The location of Internet access does not strictly dictate the purpose for which people use it. Home users often tap in for business purposes, just as corporate users also use it for personal reasons. As such, only 11% of all Internet users tap the Internet solely for business purposes, while 29% never use it for business purposes.

Overall, personal use is definitely rising fastest. Highlights here include:

- 61% of all Internet users said their personal use of the Internet is "very likely" to increase in the coming year.

Among users who currently spend 100% of their Internet time for business purposes, 46% said their personal use would increase in the coming year.

The Internet is Used First for Communications, Second for Finding Information

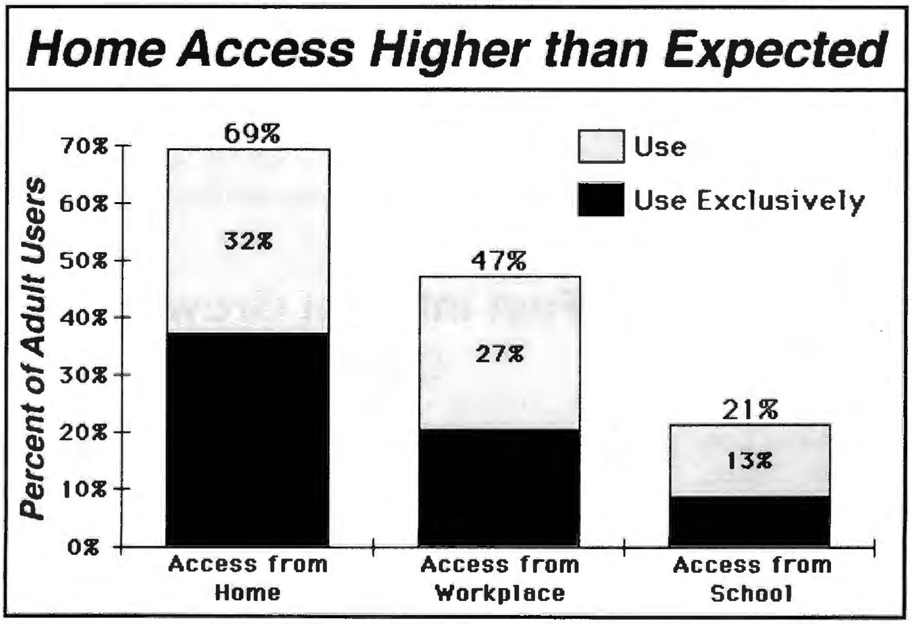
E-mail remains the number one Internet application used by more people and used most frequently. Indeed, a striking 41% of all Internet users reported they use e-mail on a daily basis, while another 27% use it at least weekly.

By comparison, some 24% of all Internet users reported they search for information on a daily basis, with an additional 44% who search weekly.

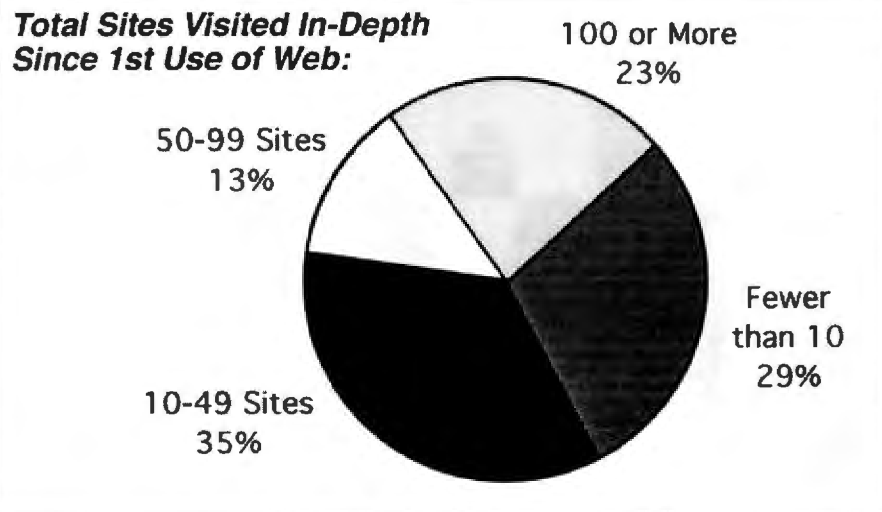
Daily or weekly use of other specialized Internet applications such as Newsgroups, FTP or mail lists is limited to a relatively much smaller number of users.

Most Web Users have visited under 100 Sites

A striking finding of the American Internet User Survey is that by far the majority of current users have visited fewer than 100 web sites in-depth. This finding, which was supported by focus group research findings, confirms that apart from younger techthusiasts, for whom the Internet represents a kind of alternative lifestyle, most users view the emerging Worldwide Web as a reference resource rather than an integral part of their media lives. Indeed, nearly 60% of web users indicated they visit fewer than 10 sites on a regular basis, at least once a month or more.



Web Use is Selective



"Lack of consistency is a real obstacle toward wider use," said Miller, pointing out that three quarters of all web users reported that they experienced trying to find a web site only to discover it wasn't available when they got there, while fully one-third of all web users indicated they turn their graphics browsers off at least some of the time to speed access.

Women Who Use the Internet are Somewhat More Likely than Men to Use E-mail

The survey confirms that men are much more likely than women to use the worldwide web and such specialized applications as FTP and the Usenet. However, women are slightly more likely than men to use Internet e-mail and to participate in Internet mail lists, underscoring a strong predisposition among women toward Internet communications features.

Notably, 76% of women said their use of the Internet had increased the last 6 months, compared to 72% of men. Meanwhile, among current users who do not use the web, women are almost twice as likely as men to be planning to use the web in the next 12 months.

Additionally, women are more likely than men to use the Internet exclusively from work or academic locations, while men are more likely to use the Internet from multiple locations, including afterhours use from home. Behind this finding is the related finding that men are significantly more willing than women to actually personally pay for Internet access. Thus, men are more than twice as likely as women to access the Internet from home.

America Online is the Leading National Internet Access Provider

The survey found that Internet users rely more on commercial online services to reach the Internet than any other single category of access providers. Thus, nearly half of all Internet users rely on commercial online services for access, while approximately one in four use workplace servers, academic servers or independent access providers, respectively. Many use more than one access method.

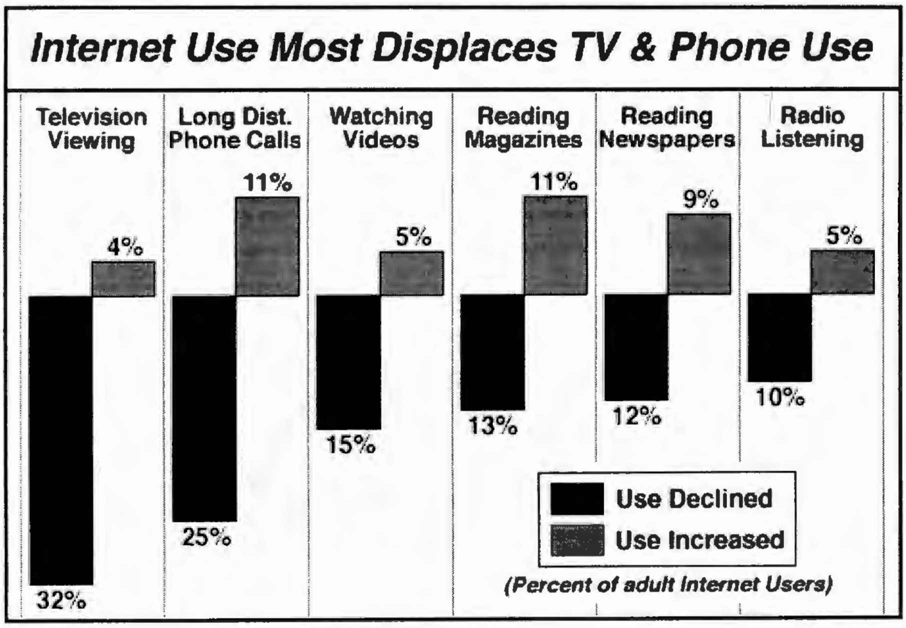
In this context, America Online has already emerged as the leading provider of Internet access, with a 30% share of all Internet access.

AOL is the Single Most Popular Net Access Method:

(Percent of All Internet Users Access Via Method Shown)

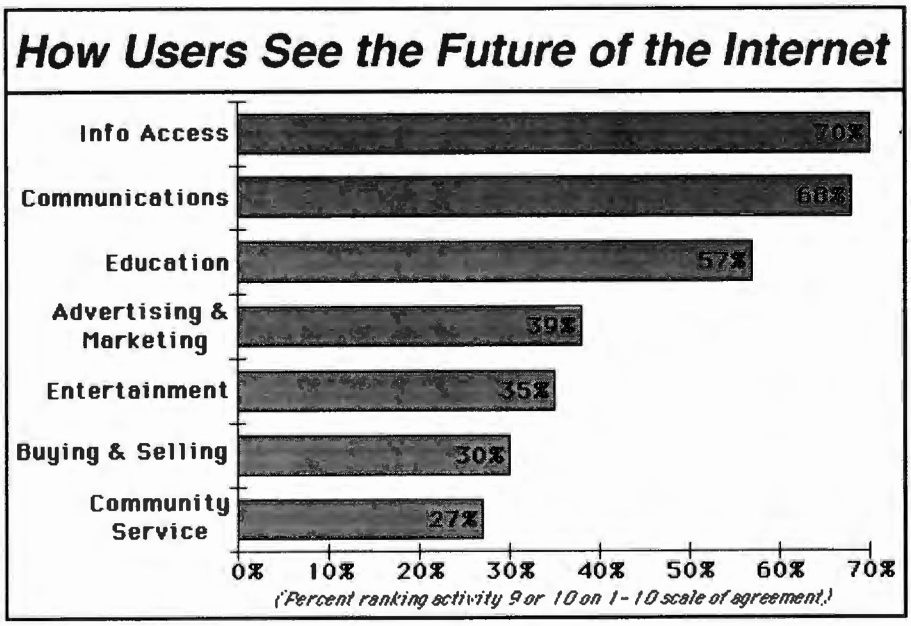
Via an Online Service	46%
America Online	30%
Workplace Server	28%
Academic Server	27%
Internet Service Provider	25%
CompuServe	11%
Prodigy	9%
Microsoft Network	2%

Internet Usage is Most Likely to Displace TV Viewing, Followed by Use of Long Distance Phone Calls



Users reported they are on the Internet an average of 6.6 hours/week — time which has to come from somewhere. When asked which other media were affected by their Internet use, the following impacts were noted:

Television viewing was most likely to be displaced among people whose Internet use is 50% or more for personal reasons, including, especially, users who tap into the Net via AOL.



Today's Users See the Future of the Internet Foremost as "Information Access, Communications, and Education"

When asked about the future value of the Internet, users ranked a series of activities in the order shown below.

"The Internet Has a Great Future as a Medium for..."

More information is available on the Internet under http://etrg.findsvp.com/features/newinet.html

Basic Principles for Building an Information Society

Al Gore

The Global Information Infrastructure (GII) — a massive network of communications networks — will forever change the way citizens around the world live, learn, work, and communicate.

This global network would permit the most remote village to browse through the most advanced library. It would allow doctors on one continent to examine patients on another. It would help a family in the Northern Hemisphere stay in touch with relatives in the Southern Hemisphere. And it would instill in citizens everywhere a deeper sense of their shared stewardship of our small planet.

Developed and developing nations in a number of international gatherings have forged a consensus that the best information network would be built on five core principles: private investment, competition, flexible regulation, open access, and universal service. The goal of these guiding principles is to speed the development of the GII and ensure its longevity.

These principles were adopted in Buenos Aires two years ago at the meeting of the International Telecommunication Union and affirmed last year at the G-7 Telecommunications Ministerial in Brussels. They have also been reaffirmed in a wide range of regional and multilateral fora — the Asia Pacific Economic Cooperation meeting, the Summit of the Americas, and they were noted at the Information Society and Development Conference.

All five principles are tightly linked and depend on one another for their force. We should think about how these principles can advance both the particular interests of individual nations and the common interests of all citizens of the world.

Let me review the core principles. Let's start with private investment and competition. President Clinton signed into law the Telecommunications Reform Act of 1996, which will open our communications markets to competition among a host of companies. We believe that liberating private businesses to compete with each other has proven time and again to be the best technique for sparking creativity, creating jobs, boosting profits, and bringing an array of new services to consumers.

This is a tremendous opportunity for the private sector — as we have seen in South America, in Asia, and now in parts of Africa. But private investment, wherever it occurs, must be accompanied by robust competition.

We've learned that lesson in the United States. When a federal judge broke up AT&T, the world's largest telephone monopoly, the results surprised even the fiercest proponents of deregulation. The price of a long-distance telephone call dropped dramatically. New companies, with new jobs, burst onto the scene. And AT&T itself eventually became a stronger company — more competitive and innovative.

Developments in Chile also illustrate the benefits of private investment and open competition. In 1994, Chile put in place a strongly pro-competitive regulatory structure.

The number of long-distance carriers in Chile increased from one to 12. The portion of homes with telephone service jumped by more than 50 percent. And prices dropped from about two U.S. dollars per minute to about one-fifth of a U.S. dollar per minute. The industry's revenues increased too — about twice as fast as the overall economy.

Private investment and competition are essential for the GII's development.

So is smart, flexible regulation, the third principle. In order for investors to take risks and competition to take hold, regulations must ensure stability, freedom, and flexibility, while also offering consumers fair prices and wide choices.

In the United States, we regulate many communications industries through an independent agency, the Federal Communications Commission (FCC). This expert body has the know-how to make technical decisions. And with other agencies in the U.S. Department of Justice and Department of Commerce, the FCC has the capacity to monitor changing market conditions.

Just as these new technologies are overthrowing the old commercial order, those of us in government must topple outdated regulatory structures while remaining true to their underlying values and ideals.

Another core principle — tightly linked to the principles of private investment, competition, and flexible regulations — is open access. All nations and all parties need to be able to connect to the GII.

The reason can be illustrated, in part, by a principle well-known in computer science as Metcalfe's Law. Metcalfe's Law holds that the power of a computer network increases at roughly the square of the number of people connected to it.

That's why the Internet is growing so fast. The more people who connect, the more other people there are who want to connect. If you double the number of people on line, you quadruple the number of possible ways to link people and combine their talent and ideas.

That is why open access is so important. Keep people off the network, and the networks won't be as valuable. Let people on, and the value everyone derives will soar.

Therefore, the owners of networks must charge non-discriminatory prices for access to their networks. The only way to realize the true promise of the GII is to guarantee that everyone who connects has access to thousands of different information sources — from video programming to electronic newspapers to computer bulletin boards — from every nation, in every language.

The fifth and final principle is perhaps the most important — universal service. We believe that universal service can be a natural outgrowth of the first four principles. Certainly the combination of open access, flexible regulations, competition, and private investment will tug us in that direction. But by themselves they will not take us fully to that destination.

That is why President Clinton and I have challenged our nation's private sector to help connect every school in America to the information superhighway by the end of this decade. And that is why I renew my call for the creation of a Global Digital Library, so all the world's citizens will have quicker and richer access to all the world's information.

***AL GORE**, Vice President of the United States of America.*

Of course, in each nation the exact contours of universal service will differ. But its basic shape should be similar in most locales. For instance, providing basic service at prices people at all income levels can afford, making high quality service available regardless of a person's geographic location or physical ability, and teaching consumers how to use these technologies effectively.

The GII is a historic undertaking. It is strengthened by participation, bolstered by openness, and fortified by strong nations and talented people pursuing dreams of a better tomorrow. Join me in building the 21st century's first great achievement.

The Global Environment Education Network

Edward Taishoff

Thousands of students in hundreds of schools around the world have launched a unique partnership which uses space-age communications to expand knowledge about and understanding of our planet's environment.

The program, Global Learning and Observations to Benefit the Environment, or GLOBE, officially got under way April 22, 1995, the 25th celebration of Earth Day, with the participation of schoolchildren across the United States and in a number of other countries.

At regular intervals, the participants take basic measurements of their immediate environment and enter them on schoolroom computers. Then the computers transmit the data via the world's cyberspace "information highway" to a central data processing facility located in the U.S. state of Colorado.

The data is processed, converted into graphic displays and stored in a databank on the international communications network. GLOBE students are able to use their schoolroom computers to retrieve from the network these vivid electronic portraits of the environment in their local region, their country and the rest of the world.

VICE PRESIDENT AL GORE discusses the Global Learning and Observation to Benefit the Environment (GLOBE) program with students in several countries across the world during his Earth Day, 1994, appearance on WorldNet, the United States Information Agency's international television network.

Vice President Al Gore announced the project on Earth Day, 1994, inviting the rest of the world to participate. The thousands of letters his office has received from students and teachers since he proposed GLOBE are, he says, "strong indications of the need and desire for hands-on science education programs in our schools." Gore believes the program "builds excitement about science and math among our young people and helps all of us to better understand our global environment."

Well over 100 countries have expressed an interest in joining GLOBE. Bilateral agreements regarding participation have been concluded with some nations and are being negotiated with a number of others.

Prominent groups representing the U.S. educational and scientific communities have endorsed the project. They include the National Science Teachers Association, the American Chemical Society, the Institute of Electrical and Electronic Engineers and the Mathematical Association of America.

In July, 1994 four leading U.S. scientists, including three Nobel Prize Laureates, wrote the chairman of the House of Representatives science and technology committee urging his support for the program. They called GLOBE's outreach effort "commendable in its farsightedness from the perspectives of scientific and goodwill values."

One of the letter's signatories was Dr. Glenn Seaborg, who won the Nobel Prize for chemistry in 1951.

A pioneer in the field of nuclear chemistry, Seaborg has for several decades been associate director of the Lawrence Berkeley Laboratory of the University of California at Berkeley, one of the world's leading research institutions. He has also served as chancellor of the university and was Chairman of the U.S. Atomic Energy Commission for ten years, under three presidents.

"The GLOBE program," Seaborg told USIA, "attacks the critical problem of restoration and maintenance of the environment on a broad, sound basis. It involves, on an international scale, scientists, science teachers and, especially, students, who are the hope for a sustainable future."

The United States has designed and developed the GLOBE system and is responsible for its operations and maintenance, including its data processing, environmental image processing capabilities and other necessary technology. The effort involves six U.S. government agencies, including the National Atmospheric and Oceanic Administration (NOAA), the U.S. weather service, the Environmental Protection Agency (EPA) and the National Aeronautics and Space Administration (NASA).

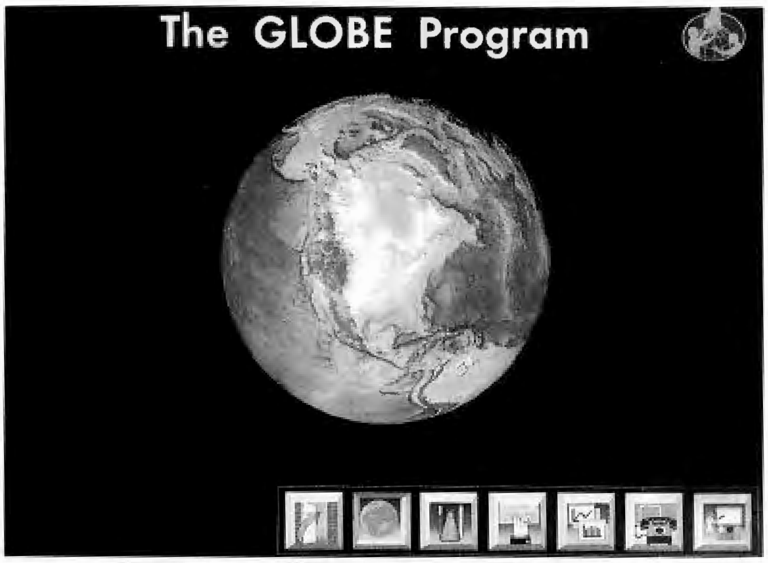
According to the official GLOBE program summary released in January, 1995 it is designed "to bring school children, teachers and scientists from around the world together to:

• enhance environmental awareness of individuals worldwide,

• increase scientific understanding of the Earth, and

• support higher standards in science and mathematics education."

GLOBE is a classroom-based program involving the active participation of primary, intermediate and secondary school students in the collection of environmentally significant data. The measurements were selected by a distinguished group of international scientists who wanted worldwide observations that contribute to scientific understanding of the global environment.



STUDENT GATEWAY to the GLOBE program may look something like this. The large computerized image of the Earth (center) is color-enhanced to show differences in the height of surface features such as mountains and plains. Each drawing, or icon, in the row of boxes at the bottom of the display represents program elements, such as data entry and transmission and access to images of the environment based on GLOBE measurements, that can be activated by a special pointing device. Image produced by the Scientific Visualization Studio at the Goddard Space Fight Center of the National Aeronautics and Space Administration (NASA).

Students measure such factors as air, water and soil temperature, rain and snowfall, groundwater and precipitation acidity and soil moisture in the vicinity of their schools.

They also assess other environmental factors such as cloud cover, tree growth and type, foliage density and the biology of the local habitat, sometimes with measuring devices they make themselves.

The program is designed so that all students, even the youngest in the early elementary grades, are able to make significant contributions by collecting meaningful data. Students in the higher grades will make more sophisticated measurements.

The student-collected data is entered on personal computers and transmitted via the Internet to NOAA's Forecast Systems Laboratory in Boulder, Colorado, near Denver.

The information is processed, combined with data from other sources such as satellite sensors and converted into graphic displays showing environmental conditions in the general areas where participating schools are located. These images are stored in a database accessible through Internet. The students will then be able to call up on their computers images of their local environment, conditions in a broader area of their country or continent, or even other regions of the world.

GLOBE will accommodate international partners which, for various reasons, may not have the same access to computers and sophisticated communications technology as participants in highly developed societies.

Such schools can still gather significant environmental data and forward it to a central point which will be able to transmit the information onto the worldwide network. Although these schools may not be able to retrieve GLOBE graphics by computer network links, they could still get them by other means, such as satellite television broadcast or photo reproduction.

Even if a school does not actively participate in the program, it can still be a "GLOBE affiliate," electronically retrieving GLOBE imagery and educational materials available on-line through Internet. Such schools will be encouraged to become active participants in the program. The hope is that by the end of the century, thousands of schools around the world will be collecting data and sharing global perspectives with each other.

Participating schools will receive a set of GLOBE educational materials developed in consultation with leading educators, including student worksheets and a teachers' guide. Instructional material involving environmental measurement and data reporting procedures will be available in the six official United Nations languages — English, French, Spanish, Russian, Chinese and Arabic.

To assure consistency in data collection and other aspects of the program, the United States will sign bilateral agreements with each participating nation specifying the roles and responsibilities both of the United States and the individual international partners. Cooperation will be on a no-exchange-of-funds basis, with the United States providing the education, science and technical infrastructure and international partners managing the program and equipping schools in their own countries.

Each partner will select its own schools and name its own country coordinator, preferably someone with experience in both the nation's educational system and its environmental activities, who will manage the local program. Partners will adapt the GLOBE educational materials as appropriate to their own curriculums.

GLOBE will conduct workshops which will train foreign partner country coordinators in the program. The country coordinators will use the "train-the-trainer" approach to insure that all GLOBE schools have a GLOBE-trained teacher guiding student activities.

Margaret Finarelli, GLOBE Assistant Director for International Programs, has visited officials in countries around the world to explain the details of the GLOBE program and to negotiate agreements for cooperation.

"A most exciting part of the program", she says, "is the way each country is building on GLOBE as a base and is using it in the context of its own environmental and educational approaches and priorities.

"Our partners see GLOBE as a real opportunity to promote environmental awareness while contributing to the international scientific effort to understand the Earth," she says. "They also see it as an opportunity to enhance computer literacy and the use of technology in the classroom."

According to Finarelli, "international participation is integral to the program design and is critical to our achieving our goals." As examples of worldwide interest in the project, she notes that in the Czech Republic, 25 schools across the country will participate in GLOBE's pilot program, as will five to ten schools in the Netherlands, three in Namibia and three in China.

GLOBE demonstrates how modern communications technology is rapidly transforming education.

The public school system in Fairfax County, Virginia, a suburb of Washington, D.C., for example, operates its own educational television system, which regularly broadcasts not only to its own students, but also to more than five million students in 16,000 schools across the United States and in eight other countries.

The county school system media director, Dr. Glenn Kessler, sees in GLOBE the beginnings of an educational revolution.

"In the future," he told USIA, "learning communities will be tied together electronically." He thinks that eventually, school children might actually "create their own electronic textbooks." One of the most important aspects of the GLOBE program, according to Kessler, is that "it uses kid power to create meaningful data."

In his opinion, countries now experiencing the biggest technological disadvantage relative to other societies have the most to gain from the GLOBE program. Kessler says it might give them the chance to "leap over" existing gaps by gaining quickly technical knowledge and experience that otherwise might come much more slowly.

In such countries, Kessler believes, the fact that GLOBE will deliver to participants a tangible sophisticated product to which they personally contributed should boost the self-esteem of children in the program, give them confidence in their ability to use technology and raise their expectations about what they might be able to accomplish in their lives.

For more information on the GLOBE program, contact Mrs. Margaret Finarelli, Assistant Director for International Programs, GLOBE Program, 744 Jackson Place, N.W., Washington, D.C., 20503.

"Equipping Our Children with the Tools to Compete Successfully in the New Economy"

Larry Irving

Remarks by Larry Irving, Assistant Secretary for Communications and Information, National Telecommunications and Information Administration, Department of Commerce, National Urban League's Conference on Technology and Community Development

New Orleans, Louisiana

August 12, 1996

I commend the National Urban League for bringing attention through this conference to the need for us to develop concrete action plans on how the African-American community should move forward into the 21st century.

In an age of channel surfing and call-waiting, it's not easy to get people's attention. Perhaps that is what, in part, makes the Olympics such a national phenomenon. For 17 days, the Olympics brought our nation together. As reported by NBC, 209 million people, or 91.7 percent of our nation's 95.9 million TV homes, tuned in to some part of its coverage of Olympic Games from Atlanta. Every morning in offices and houses across the country, we replayed the athletes' triumphs. We were riveted by Michael Johnson's gold shoes; we debated the decision to keep Carl Lewis off the relay team.

Now we need to come together as a nation and focus on the development of our children and community. Today I want to address the important issue of equipping our children with the tools to compete successfully in the 21st century.

Meeting the Challenges of the New Economy

At the turn of the 20th century, the 12 largest companies in America were (in alphabetical order): the American Cotton Oil Company, American Steel, American Sugar Refining Company, Continental Tobacco, Federal Steel, General Electric, National Lead, Pacific Mail, People's Gas, Tennessee Coal and Iron, U.S. Leather and U.S. Rubber. Ten of the twelve were natural resource companies. The economy was a natural resource economy, and wherever the most highly needed resources were to be found, employment opportunities would follow.

In contrast, as we near the beginning of the 21st century, a knowledge-based economy has emerged, what many people call the "New Economy." The fastest growing industries both domestically and globally include microelectronics, telecommunications, computers, and biotech. In the 1950s, three out of every four Americans had manufacturing jobs. Today, fewer than one in six do. Recent studies show that rates of return for industries that invest in knowledge and skill are more than twice those of industries that concentrate on plant and equipment.

The New Economy's dynamic industries are characterized by a pace that even Michael Johnson would have trouble maintaining. We have seen amazing growth and development of long-distance telephone service, wireless services, and the computer industry in this country. Microsoft, MCI, TCI, Compaq, Netscape, Yahoo, DirectTV — these are all new companies that have emerged in the last twenty years. The World Wide Web is only four years old, and yet June 1996 Web sales reached $130 million. In the computer industry, almost 80 percent of revenues come from products that did not even exist two years ago.

But perhaps the most important transformation brought by the New Economy is the changing nature of work for Americans. We now live and work in a knowledge-based economy where we succeed because of what we know, what we create, how we manage information, and how we organize ourselves to deliver it.

A college education is more important than ever before. In 1972, the average male college graduate in the United States earned 43 percent more than a worker with a high school degree. Today, that "college premium" has soared to 96 percent.

And workers with computer and technology-related skills will almost be as sought after as the top NBA players. Through the year 2005, the number of computer engineers and systems analysts is expected to grow more than 90 percent, an increase of 621,576 jobs. And other technology-related jobs are growing nearly as fast. Currently, college graduates in computer engineering are getting four or more job offers, often starting at $40,000 - $50,000 a year — O.K., not quite the salary that Shaq will be pulling down.

Computer and technology-related skills have become an essential skill for almost every vocation. Today's garage mechanics need to be adept at using technology — the modern car often has as much computer capacity as an Apollo space capsule. In many other fields as well — printing, publishing — there is a need for workers to have these skills. In the United States, more than 23 million workers are now plugged into e-mail networks.

By the end of the decade, 60 percent of our nation's jobs will require skills that only 20 percent of the existing U.S. population has — and many of these will be technology-based. Our new concern is not unemployment but unemployability.

With the ability to make goods and process information anywhere in the world and sell it anywhere else in the world, businesses can cherry pick the skilled workers they need. More than ever before, Americans will be competing with well-educated and skilled foreign workers.

The implications are simple. As Bob Dylan said in Subterranean Homesick Blues, "You don't need a weatherman to know which way the wind blows." If America wants to generate a high standard of living for all its citizens, we must ensure that our current and next generation of workers have the requisite skills and knowledge. This poses new challenges for the American educational system.

Technological literacy — the ability to use computers and other technology to improve learning, productivity, and performance — has become as fundamental to a person's ability to obtain a good job as traditional skills like reading, writing, and arithmetic. Yet, many schools lack the wiring, hardware and software, and trained teachers to enable students to acquire technological literacy. Indeed, only 4 percent of schools have a computer for every five students (a ratio deemed adequate to allow regular use) and only 9 percent of classrooms are connected to the Internet.

And many African-American children lag behind their white counterparts. African-American children are much less likely to use computers in school than are white children: 56 percent of white students but only 39 percent of African-American students use computers in school. African-American students also have less access to computers at home: 36 percent of white students are in families that own computers while only 15 percent of African-American students have access to home computers.

Make no mistake — technology alone is not the panacea for all of our educational system's ills. But technology is a valuable tool, which when combined with good a curriculum and good teachers, can improve our children's education.

Creating Educational Opportunities

The Clinton Administration is working hard to ensure that American children can meet the challenges of the New Economy. Almost three years ago, President

Clinton and Vice President Gore set forth a vision of connecting every classroom, library, hospital, and clinic in the United States to the National Information Infrastructure by the year 2000. In his 1996 State of the Union address, President Clinton underscored the importance of using technology to achieve our educational goals. The President declared that "[i]n our schools, every classroom in America must be connected to the information superhighway with computers and good software and well-trained teachers ..." The President has followed up with several initiatives, including

- signing into law the Telecommunications Act of 1996, which ensures that schools, libraries, hospitals, and clinics will have affordable access to advanced telecommunications services;

- endorsing a proposal championed by Congressman Markey and Senator Dorgan called "E-Rate." E-Rate has been referred to as "education rate," "equity rate," and "equal opportunity rate." It all means the same thing — a proposal for all schools and libraries, whatever their financial situation, to have access to the information superhighway through a free basic telecom connection. In addition, schools and libraries would receive advanced services at highly discounted rates.

- kickstarting "NetDay96," an effort to wire all classrooms to the information superhighway. The first NetDay took place in California on March 9, 1996, in which more than 20,000 volunteers and more than 200 businesses installed about 6 million feet of wire to connect classrooms in 2,600 schools to the Internet. NetDays will take place in other states throughout the coming year.

- initiating the Technology Learning Challenge grant program, whereby communities form local partnerships of school systems, colleges, universities, and private businesses to focus on integrating innovative learning technologies into school curricula.

- recruiting "21st Century Teachers" — on May 29, 1996, a coalition of 11 major education organizations, including both major teachers' unions, announced the creation of a voluntary corps to help more teachers learn how to use new technology to improve teaching and learning. 100,000 teachers who are proficient with the new technologies will each train five of their colleagues during the 1996-97 school year. There is a real need to train teachers in these new technologies. As Peter Cochrane has said, "Imagine a school with children that can read and write, but with teachers who cannot, and you have a metaphor of the Information Age in which we live."

A student explains to his instructor the program he has just devised.

The Administration is also working hard to bring the benefits of new telecom and information technologies to underserved communities and their schools. My boss, Secretary of Commerce Mickey Kantor, understands the importance of reaching both rural and minority communities. His background — as a young boy growing up in Tennessee and a young civil rights lawyer — gives him an understanding of the importance of such initiatives as the Telecommunications and Information Infrastructure Assistance Program (TIIAP). TIIAP, which is administered by my agency, NTIA, is a competitive, merit-based program that provides matching grants to state and local governments, schools and universities, libraries, health care providers, community groups, and other non-profit entities to access new telecommunications and information technologies. Over the past two years, we have awarded $60.4 million to 209 TIIAP projects.

Because of the program's modest funds, TIIAP projects are selected in part because they serve as models that can be replicated across the country in similar communities. TIIAP grantees are, in effect, setting up small laboratories all over the country; figuring out what is the best way to connect schools, libraries, clinics, and not-for-profit hospitals; how to overcome geographic and financial obstacles; and how to use technology creatively to improve our children's education, boost local economies, and mend deficiencies in the delivery of medical care. We're collecting success stories that can be passed on to thousands of others. The benefits derived from these projects extend far beyond the immediate communities in which they take place.

Let me give you an example of a TIIAP project. The school children of Roper Middle School in a low-income, minority section of Washington, D.C. are involved in a new educational technology initiative. Students take "virtual visits" to the Smithsonian Institution's Museum of Natural History through interactive real-time systems that allow two-way interaction with various experiments and hands-on exhibits. The program provides exciting new materials, an opportunity to gain technology skills, and a new love of learning. The catalyst behind this project is a $450,000 TIIAP grant. The Federal funds are matched locally by over a dozen community businesses.

Another example is "Plugged In," a non-profit community access and training center for computers and the Internet in East Palo Alto, California. Plugged In offers more than 30 computer classes and creative computer-based projects to low-income youth and families. At Plugged In, children create multimedia slide-shows about their community. Teenagers use computer technologies to create video-documentaries and pages on the Internet. Adults participating in a drug-recovery program write a newsletter about the recovery process. Plugged In produces kids like Ben Carson ...

A Call for Action

The Clinton Administration can be the catalyst for many of these educational technology endeavors, but the continuing leadership and initiative must come from local communities — cities, school boards, and the private and non-profit sectors. And it is critical that the African-American community get involved. I see three key steps for us to take: (1) getting the message about the importance of computers and technology to the African-American community; (2) exposing our young people to new technologies; and (3) promoting public-private partnerships among schools, business, and nonprofit organizations.

Getting the Message to the African American Community

First, African Americans need to recognize the importance of using these technologies to improve education as well as to equip students with the necessary skills to perform tomorrow's jobs. African Americans historically concentrated in agricultural, personal service, and blue collar occupations are now disproportionately displaced in the emerging Information Age.

Asian-American males between 24-54 years old, college-educated, and grossing around $75,000 annual income are the largest group in the United States to use computers at home or at work. Unfortunately, African-American males between 19-54 years old, under-educated, and making between $11,000-20,000 annually are the largest group in the country that do not use computers.

The good news is that a few African-American entrepreneurs are taking advantage of telecom and information technologies. You should know about Davis Ellington and NetNoir, an Afrocentric on-line service; and MelaNet, an African American-focused information and communications network; and Bingwa Software, software targeted specifically to African Americans and other ethnic groups; and United Black Pages, a directory of black-owned Web sites. You should know about New York On-line and EUR — Jet on the Net. And recently, an increasing number of Mom-and-Pop operations are selling their wares on the Internet. The success of these companies shows that there is vibrant market, with room for more enterprising companies. But there is still very little computer software geared to minorities; and there are still relatively few minority firms with a presence on the World Wide Web.

WAYNE STATE UNIVERSITY STUDENTS Krystal Miller and Sonya Vann receive instruction from Ruth Seymor (right), director of the school's Journalism Institute for Minorities in Detroit, Michigan. The program helps talented minority students get a running start in the highly competitive news media business.

Exposing Young People to New Technologies

Second, I cannot overstate the importance of exposing our young people, especially those living in traditionally underserved areas, to such technologies as the Internet, which open a whole new world for them and can inspire a love of learning.

This past January, conductor Henry Lewis died. In an interview last year in which Lewis talked about his tenure as the first African-American conductor of a major American orchestra — the New Jersey Symphony in Newark, Lewis noted:

"1968 was the year of the riots there, the big Newark riots and fires. The very first thing I did was take the orchestra down to play in one of the burnt out lots in the center-city — that was so unheard of in those times. People were afraid to go; they thought the riots would begin anew, but of course that didn't happen. People were hanging out of windows, listening to the orchestra."

Inner-city residents responded to the orchestra with enthusiasm, once they are exposed to it. I believe that same is true for inner-city kids who are exposed to Monet or Cezanne during a virtual visit to the Louvre, or exposed to Native-American culture during a virtual visit to the Smithsonian Museum. Computers and video conferencing can open a vast and varied world to children, and enlarge their choice of careers and hobbies. Studies demonstrate that computers in the classroom and community centers can improve students' test scores as well as bolster self-esteem.

I saw this response first-hand when I visited a housing project in Charlotte, North Carolina — the Anita Shroud Community Center — that is connected to the community network and the Internet ...

Promoting Public-Private Partnerships

Third, we should encourage public-private partnerships among schools, businesses, and non-profit organizations. NetDay96 in California showed what great things could be accomplished when individuals and companies stepped up to the plate and physically wired classrooms. NetDay96 is galvanizing students, teachers, parents, business leaders, engineers — indeed, all members of the community — to come together and improve our schools.

But I have one fear as I watch these efforts evolve — that minority communities are being bypassed. The late-Secretary of Commerce Ron Brown was a passionate spokesman about the need to ensure that we are not creating a society of information haves and have nots. He saw first hand at the Ralph Bunche School in Harlem and the Roper Middle School in D.C. the positive effects that bringing technology into the classroom had on inner-city kids. Secretary Brown's words and commitment must continue to shape our policies and our actions. We must educate minority communities about the need to bring technology into their schools, and we must provide them with the resources just as we are doing for the middle class and affluent areas.

I am asking the National Urban League, as a group and as individuals who represent many other companies and organizations as well, to establish links with local schools and communities and contribute your expertise and resources to initiating and maintaining educational technology projects. This fall, virtually every state has scheduled a NetDay96. I'm urging you to make sure that all communities are a part of this important initiative. For it to be fully successful, it is imperative that minority and rural communities are involved. We need your help. Now is the time to commit yourselves to helping underserved, minority schools. The longer we wait, the wider the gap between these kids and the kids who are technology-affluent.

I know that the National Urban League has already taken steps in this direction. The National Urban League has set up 40 training centers nationwide to teach African-Americans computer literacy skills, and has put out a home page on the World Wide Web where browsers can access information targeted at African Americans. But, yes, I am asking you to do more.

Are we too idealistic in pursuing such goals? Are we demanding too much of ourselves and our community? Why are we pouring all this energy into such a project?

President John F. Kennedy articulated the answer back in the 1960s when he explained our nation's efforts to put a man on the moon. He said we do it not because it is easy, but because it is hard; because it measures the best of us. It is a legacy that we can leave our children.

It is that spirit that we saw in many of our Olympic athletes — of setting personal goals to be the best in the world, of striving for individual excellence and national pride. It's what enabled Carl Lewis to jump 27 feet, 10 3/4 inches, and Kerri Strug to vault for the team gold.

President Clinton's commitment to put the tools of technology into the hands of our children captures this same sense of striving for the best, of reaching our potential as individuals, as communities, as a nation.

Conclusion

I'd like to end my remarks with an anecdote about a young mother and her daughter. The young mother was ready for a few minutes of relaxation after a long and demanding day. However, her young daughter had other plans for her mother's time.

"Read me a story, Mom," the little girl requested.

"Give Mommy a few minutes to relax and unwind. Then I'll be happy to read you a story," pleaded the mother.

The little girl was insistent that Mommy read to her now. Suddenly, the mother had a brilliant idea. She tore off the back page of the magazine she was holding. It contained a full-page picture of the world. As she tore it into many pieces, she asked her daughter to put the picture together and then she would read her a story. Surely, this would buy her considerable relaxing moments.

A short time later, the little girl announced that she had finished putting together the puzzle project. To her astonishment, the mother found the world picture completely assembled. When she asked her daughter how she managed to do it so quickly, the little girl explained that on the reverse side of the page was the picture of a little girl. "You see, Mommy, when I got the little girl together, the whole world came together."

Each of us has the responsibility to put our world together. It starts by getting our children put together, and in today's world, that means equipping them with the tools to compete successfully in the New Economy. When we do this for our children, we will find our communities coming together, too.

Thank you.

The Learning Connection: Will the Information Highway Transform Schools and Prepare Students for the Twenty-First Century?

Introduction

Linking schools to the emerging telecommunications network has become one of the hottest education topics of the 1990s. Politicians proclaim their commitment to it. Businesses tout their contributions toward achieving it. And schools are spending substantial sums to accomplish it. All are propelled by a vision of students engaged in authentic and challenging tasks, linked to vast stores of information and "real world" experts beyond the school room, learning higher-order intellectual skills, and developing civic virtues on a global scale.

There's a clear logic to these goals. Advanced communications technologies are increasingly shaping how we work, play, and relate to one another. According to the Department of Labor, almost 50 percent of all workers use computers on the job (double the rate of just 10 years ago), and those who do earn 43 percent more than other workers. Some 37 percent of U.S. households have computers, and although the number connected to networks remains relatively small, it is growing exponentially. Indeed, the importance of computer networks is likely to grow enormously in the years ahead, as they become the means for delivering not just text and data, but video, audio and graphical information as well.

More than the ability to use the latest technology is at stake. Increasingly, employers say that the workplace of the future will require employees who are independent, flexible, innovative, and able to solve complex problems. Political and cultural life also require — more than ever — the ability to find, sift, sort, and analyze vast amounts of information from diverse sources. These are the same skills associated with computer networking.

But we are a long way from achieving the vision of connected classrooms. The average student spends just two hours a week using a computer in school. Students in only 3 percent of the nation's classrooms currently have access to the Internet. And the cost of providing schools with up-to-date computers linked to the communications network could easily total $30 billion — plus operating costs that could run another $5 billion a year. While that may seem small compared to the $242 billion annual budget for K-12 public schools, it would require a substantial increase over the $2.7 billion the schools currently spend each year on technology.

Still, the rapid rate at which schools have been buying computers — there are an estimated 5.8 million computers in schools today, more than twice as many as existed just five years ago — and the exponential expansion of online services suggest this may be a propitious time to promote networking in the classroom. But schools face substantial financial pressures, and winning financial support for connecting classrooms won't be an easy sell.

The Vision

"My curriculum has never been so alive, so up to date, so exciting for me, "says Patrician Weeg, who teaches at Delmar Elementary School (http://www.intercom.net/local/weeg) straddling the Delaware-

Maryland border. KIDLINK, a grassroots project that has brought together more than 35,000 students between the ages of 10 and 15 into a "global dialogue," has made it possible for Weeg's students to have computer "keypals" in Finland, Iceland, Russia, Tasmania, Peru, the United Kingdom, Japan, Brazil, and elsewhere. They have talked about farming and the Nile River with an Egyptian schoolgirl, learned from kids in Alaska about life in a village so remote it can be reached only by airplane, and discussed the life of street kids with a student in Peru.

"Are we linked to a larger teaching and learning community?" Weeg asks on her school web page. "You bet we are! The world is our classroom! In the global classroom, the curriculum is a 'living' curriculum with real people — not textbooks — feeding our desire to learn and explore."

It sounds great, but is it just an expensive gimmick? Mary O'Haver, a social studies teacher at Fairland Elementary School (http://www.wam.umd.edu/~toh/Fairland.html) in Montgomery, Md., thinks it is much more. She has turned her fifth grade social studies class into a veritable publishing empire. Using sophisticated desktop publishing skills, her students have prepared handsome autobiographical newspapers. They have presented commemorative stamps and book reports on their school home page. The attractive results serve as a powerful motivator, as does the awareness that the published results potentially have a global audience.

"Kids know parents or teachers are going to say, 'Good job,' " says Joyce Brunsvold, a Fairland reading teacher who is impressed by the sheer amount the students write, as well as its quality. "When a total stranger sends e-mail commenting on their work, it means a lot to my students." O'Haver constantly ventures into cyberspace for online discussions with fellow teachers throughout her state, as well as collaboration with teachers as far away as British Columbia and Australia. She plans to enroll students this year in Monarch Watch, a research project run by a group of entomologists at the University of Kansas that has enlisted 20,000 students nationwide to track the annual migration of monarch butterflies. O'Haver's own web page is full of suggestions for other teachers about resources, lesson plans, collaborative projects, and more. "Who would have thought that these machines could bring me so many friends and so much contact with my professional peers?" she asks.

Not far from Fairland, at Montgomery Blair High School (http://www.mbhs.edu), students are taking education-by-the-Internet a step further. As a sophomore, Yi-Lun Ding set out with a team of other students to design a device that could analyze stratospheric ozone. Seeking expert information, he went to the school's computer lab and connected with the National Aeronautics and Space Administration. That link-up eventually led him to the chief ozone investigator at the National Oceanic and Atmospheric Administration. "We corresponded through e-mail for a while and learned the techniques he used in his experiment," Yi-Lunrecalls. "We even received a videotape, articles his team wrote for Science, and booklets from NASA, which helped with our presentation."

COMPUTER SPECIALIST Tom Neese teaches students at Tohatchi High School in New Mexico how to use electronic mail. The e-mail system enables these American Indian Upward Bound students to transmit their monthly homework assignments to the University of Colorado, and communicate with program participants in other reservations.

The online world is full of such stories of students taking charge of their own education, engaging in real-world tasks, and sharing information nationally and internationally. At the same time, the convergence of traditional media is enabling students to take exciting "field trips" by video hook-up and computer to exotic places including the bottom of the ocean, Hawaiian volcanoes, and the stratosphere. Advocates say that these experiments show that advanced communications can turn students into active learners and help them develop such higher-order skills as writing, problem solving, fact finding, analysis, and synthesis — all in a highly enriched atmosphere.

"Distance learning multiplies the resources available to schools and teachers, greatly increasing opportunities for both teaching and learning," writes the National Academy of Sciences on its web page. "It invites students anywhere in the country to acquire the information they want directly from experts. Network links expand and enrich the pool of teachers in mathematics, science, and other fields. Moreover, the information students receive via networks can be individualized to fit their specific needs."

Inspired by schools like Fairland and Blair, President Clinton said in his 1994 State of the Union Address that the nation should set a goal of connecting all classrooms to the information superhighway by the year 2000. Through the National Science Foundation (http://www.nsf.gov) and the Department of Education (http://www.ed.gov), the administration has provided seed money to scores of projects designed to demonstrate the educational potential of computer networking. Some states have gone even further. North Carolina and Iowa are connecting schools to their state-built fiber optic networks, and Delaware has just decided to link its public school classrooms to a similar network.

But much of the action is at the state and local levels. A variety of schools, businesses, and nonprofit groups have formed partnerships to bring computer networks to classrooms. In Union City, N.J., for instance, Bell Atlantic Corp. is providing students and teachers at Christopher Columbus Intermediate School with computers and Internet connections in support of a school-reform plan launched by the local school district. And in Mendocino, Calif., the public schools have joined hands with the NASA and various private-sector partners to establish an Internet connection and develop a comprehensive network-based curriculum.

In Baltimore, Md., the Abell Foundation has joined forces with the state department of education to establish a regional technology center to help schools choose appropriate hardware and software, as well as obtain training. Numerous states are establishing networks for teachers. Nonprofit organizations like the Jason Foundation for Education and the National Geographic Society are developing curriculum and lesson plans that students in disparate locations can use for interactive, online learning. Companies like Microsoft Inc. are supporting technology training programs for teachers colleges, and corporate donations of computer equipment to schools total more than $100 million annually.

Computers and networking have gained adherents partly because they are seen as enhancing the very skills considered necessary to survival in the twenty-first century. "In 1850, it took about 50 years to double the world's knowledge base," notes Frank Withrow, director of learning technologies for the Council of Chief State School Officers. "Today, it takes only a little more than a year. The way we store, retrieve and use information is vastly different in the Information Age. The U.S. work force does not need 'knowers,' it needs 'learners.'"

The Reality

The ideal embodied by teachers like Mary O'Haver and students like Yi-Lun Ding is far from being realized in most U.S. schools. According to a survey conducted for the National Education Association (http://www.nea.org/) and other education groups, only 16 percent of teachers use the Internet and online services. In contrast, 58 percent use cable television in the classroom. As yet, no single entity — neither government, industry nor the nonprofit sector — has come up with the resources to bring interactive connections like the Internet to the majority of classrooms. Estimating the costs of connecting schools is a speculative business. Schools have a wide range of choices, from installing a few networked computers in computer labs to putting one on every student's desk. Moreover, technology is changing so rapidly that today's prices are an uncertain guide for future costs.

In an analysis for the Department of Education, Massachusetts Institute of Technology researcher Russell I. Rothstein estimated that installing up-to-date computers in all U.S. schools, linking them to each other and to the Internet, and providing a telephone link with sufficient capacity to allow transmission of some video and other advanced applications could cost between $11.8 billion and $27.5 billion to install. Operating costs would run another $1.9 billion to $4.9 billion annually. That is the equivalent of between $267 and $625 per pupil in installation costs and between $42 and $112 in annual operating costs.

The range is so great partly because the cost for different schools, on which Rothstein based his estimates, varies widely based on location, their current level of resources, and other factors. A separate study by Brent Keltner and Randy Ross of the Rand Corp. analyzed six schools with Internet connections. They found that the annual cost — if hardware and software costs are amortized over five years and infrastructure changes over the next 10 years — ranged from $142 to $416 per pupil. McKinsey & Co., which conducted its own study, concluded that technology spending by schools would have to rise from its current level of about $2.7 billion to as much as $10 billion annually.

Acquiring the hardware is just part of the battle. According to the General Accounting Office (GAO), 60 percent of all central city schools and almost half of all schools in rural areas and small towns say that their wiring and electrical power will not support advanced telecommunications. And many schools also will have to install air conditioning to maintain computers and telecommunications equipment. Making such improvements could require aging schools to undertake costly asbestos removal. Many schools face a need for improvements in lighting, ventilation, and security systems as well. Overall, the GAO estimated that it would cost $112 billion to repair facilities to meet various health and safety regulations and allow for full use of technology.

Partly because of the lack of infrastructure, half of all school computers are installed in computer labs (and another 15 percent are scattered between libraries, offices, and special instructional rooms), making it almost impossible for most teachers to integrate them into the curriculum. Even if all hardware problems could be surmounted, however, students still would not benefit unless teachers received sufficient support and training to make effective use of the new technology. Partly for this reason, even though the number of computers installed in schools has climbed sharply, the average U.S. student spends just two hours a week using a computer. And students spend much of this time in computer labs learning about computers, rather than in classes using computers as tools for communication and research.

A 1992 survey by the International Education Association (IEA), analyzed by University of California Professor Henry J. Becker for the Office of Technology Assessment (http://www.ota.gov), showed that fewer than 3 percent of U.S. students used computers 10 times or more during an entire school year in science, social studies, foreign language, or industrial arts courses. For mathematics, the portion was just 7 percent, and for English it was 10 percent.

In the absence of network connections and well-trained teachers, many schools use computers extensively for rote learning through drill-and-practice routines, rather than for activities that foster higher-order intellectual skills. Professor Becker sees some improvement on this score, though. In 1983, he reported that computers were being used primarily for computer literacy classes and drill-and-practice programs and to teach programming. But in his review of the 1992 IEA data, he found that fifth graders were devoting about one-fourth of their time at computers to writing, analysis, synthesis and other higher-order skills. The percentage rose to 44 percent for eighth graders and 50 percent for students in the eleventh grade. Becker says that those results "are not as disappointing as might be expected, but they certainly leave much room for improvement." Some analysts contend that simply introducing computers into the classroom can encourage development of higher-order skills. In a 1990 survey by the Center for Technology in Education, cited in the Office of Technology Assessment's report Teachers & Technology: Making the Connection, many teachers said that computers enabled them to introduce more complex material, individualize their instruction, allow more independent work, and spend less time lecturing.

But others say such changes are far from inevitable. Earlier generations of school reformers thought the motion picture, radio, television, and even the airplane would revolutionize education. Each time, however, they were disappointed. According to Stanford University Professor Larry Cuban, technology advocates overlook powerful traditions that have preserved the structure of education. These include three notions: First, knowledge is transmitted by teachers to students; second, knowledge consists largely of concrete subject matter that can be broken down into discrete segments and conveyed piecemeal as students progress from grade to grade; and third, that schools should be organized into self-contained, age-graded classrooms in which students and teachers come together for short periods of time.

Cuban says that there are powerful practical reasons for these traditions — including the fact that teachers are responsible for maintaining order and educating millions of students from diverse backgrounds, inculcating cultural values such as punctuality, the work ethic and competitiveness, and helping to channel students into different socioeconomic niches. Writing in the journal Teachers College Record (winter 1993), Cuban said these same forces could thwart hopes that computers will lead to a fundamental restructuring of the educational system. He titled his essay "Computers Meet Classroom: Classroom Wins."

Bridging the Gap

What does all this mean for those who want to bring networking to students and teachers? The main lesson is that connecting the schools will require a massive effort–one that tackles not just technological issues, but also educational concerns and social issues.

Specifically, a strategy to connect classrooms must address what kind of schools society wants, give teachers the training and resources they need to use computers effectively, demonstrate clearly that computer networking helps achieve the desired educational goals, and maintain the traditional American commitment to educational equality.

Building support for a new pedagogy

If the only goal of networking schools is to engage students in practicing routine skills, or even to enable them to dial up the Library of Congress card catalog or the Smithsonian Institution, it is not clear that the investment would be worthwhile. Research suggests that when computers are used to reinforce traditional teaching practices, the result is only modest improvement in easily measured areas of student achievement. Moreover, the gains measured seem to dissipate with time, suggesting that novelty, rather than some more enduring quality, may be the decisive variable. "Educational media alone do not influence the achievement of students," conclude authors Ann D. Thompson, Michael R. Simonson and Constance P. Hargrave in the Association for Educational Communications and Technology's (www.aect.org) exhaustive Educational Technology: A Review of the Research. "Media permit the delivery and storage of instructional messages but do not determine learning."

Roy D. Pea, a Northwestern University educational researcher, underscores the need to look beyond technology itself to how it is actually used in classrooms: "We know that technology may have important contributory effects to learning, but that they are crucially mediated by social practices in the classroom by teachers and students."

In "Using Technology to Support Education Reform," a text prepared in 1993 for the Department of Education, a group of researchers argue that computers and other new technologies should be used in ways that engage students in "authentic, challenging tasks." Under this "constructivist" model, teachers would no longer serve as repositories of all knowledge; instead, students would be encouraged to define their own learning goals and then seek, sort, and analyze information to achieve them. Teachers would serve more as mentors, guides, and facilitators. The new approach also stresses collaborative work, which advocates say more closely mirrors how workplaces function in the modern economy than the older, individualistic, competitive model.

But the authors note that "technology and reform do not necessarily go hand in hand." As Cuban's history of technology — and the continuing use of computers for rote exercises — suggest, advocates of computer networking must look beyond technology and consider the broader school context if they hope to see the new model for schooling take hold. On this score, Cuban, who himself has some doubts about the value of computers in schools, believes that technology advocates have fallen short. "Unless existing classroom and school settings are altered substantially, much beyond the conventional will be tough to attain," he writes in *Teachers and Machines,* his history of educational technology. "No computer advocates that I have read or heard, for example, have suggested that schools should hire more teachers and adults to reduce the teaching load, bringing it closer to the college schedule than to the factory. No computer advocate urges increasing school district budgets by half to modify the existing school and classroom arrangements concerning class size, governance, training, and teacher collaboration. Their sole recommendation is to put money into classroom computers."

Helping teachers

Teachers will need considerable support if they are to make effective use of computers in their classrooms. Although many say that using networked computers makes teaching more satisfying, most teachers say that using computers to foster higher-order skills also makes teaching harder — at least initially. First, there is the challenge of mastering the technology itself. And that may be relatively easy compared to the challenge of helping students who are learning independently. When students are no longer expected simply to master a uniform body of knowledge conveyed by their teachers, but instead are expected to gather information themselves and take on projects that require more critical thinking, teachers actually must know more than ever about the content of their subjects, according to the authors of "Using Technology to Support Education Reform."

In addition, teachers must know a great deal more about the learning process and about the individual learning styles of students. And to the extent that they encourage students to work in groups, teachers need to develop skills both to evaluate group performance and to pinpoint problems of individual students.

Despite the obvious need, school districts often find it easier to acquire computers than to help teachers learn how to use them creatively. On average, school districts devote less than 15 percent of their technology budgets to training, according to *Teachers and Technology: Making the Connection,* a study by the Office of Technology Assessment (OTA). The OTA, a research arm of Congress, said the percentage should be at least doubled.

Moreover, the typical approach to teacher training — offering a short course on a single topic, such as a specific computer application — may be particularly ill suited to preparing teachers to use computers effectively. As millions of Americans who have learned to use computers on the job know, the task requires continuous hands-on experience and follow-up support. Yet the OTA found that in 1992, only 6 percent of elementary schools and 3 percent of secondary schools employed a full-time computer coordinator. The agency said 60 percent of all schools have assigned no staff member to coordinate or supervise computer use.

But the biggest problem teachers face may be a simple lack of time — time to gather materials, develop lesson plans, assess student performance, maintain contact with parents, and keep up with advances in teaching and in academic subjects. "Teachers are given very little compensated staff development time, and there are multiple competing demands for this time," the OTA said. "Unless there are significant changes to the rhythm of the school day or changed incentives for giving teachers more time to learn and experiment with new technologies, this barrier to technology use will remain immense."

Developing better ways to assess the impact of electronic networks

Parents and policymakers will demand evidence that a substantial investment in computers and communications infrastructure is worthwhile — especially if the investment is accompanied by a change in the nature of classroom work. This will require new assessment tools.

Standardized tests, the traditional measure of student achievement, generally gauge mastery of discrete skills and factual knowledge, not whether students can solve complex problems, engage in sustained intellectual inquiry, work collaboratively, and analyze information from diverse sources. "Traditional testing methods don't capture all of the changes that technology can encourage in the classroom," says Steven Hodas, an analyst with Sterling Software in Washington, D.C., who has worked on the National Aeronautics and Space Administration's K-12 initiative (http://quest.arc.nasa.gov).

Moreover, standardized tests exert a considerable conservative influence on teachers. To the extent that the current push for increased accountability on the part of schools and teachers leads to more emphasis on standardized test results, teachers may be inclined to use computers for drill-and-practice exercises to eke out whatever marginal gains in scores they can achieve, rather than in imaginative ways for which results may be more difficult to measure. Says Cuban: "Concentration on quantitative standards reinforced by high-stake test results usually diminishes risk taking in classroom and school innovations."

As an object lesson in the pressures on school officials and the inadequacy of traditional testing methods, a number of researchers have cited the case of Belridge School in McKittrick, Calif. The school spent heavily to purchase computers and software, as well as laser disc players and television production equipment. Students were assigned such projects as producing their own television news shows and running a computer-based presidential election. But when standardized tests two years later showed no improvement in scores, parents picketed the school and elected a new school board to find a "back to the basics" principal. And computers were removed from students' desks.

A small but growing number of studies are seeking to assess the impact of new technologies in fostering higher-order skills. Margaret Riel, a researcher at the University of California at San Diego, for instance, found that fourth graders in San Diego who had helped produce an online news service with students in Hawaii, Mexico, and Alaska showed marked improvement in reading and writing skills compared with students who had not participated. She theorized that editing another student's writing teaches a student more than looking for his or her own mistakes, and that students feel freer to edit the work of distant peers than that of their own classmates.

In another study, Riel found that judges scored articles that students wrote for their peers on the network significantly higher than the work they wrote for teachers, suggesting that the motivation to perform well is greater when students are engaged in authentic tasks rather than in artificial exercises. The Software Publishers Association (http://www.spa.org) cites similarly encouraging evaluations of the National Geographic Society Kids Network, in which fourth- and fifth-grade students shared data on acid rain that they had collected online with remote classes. The students showed significant gains in the ability to organize, represent and interpret data. They also demonstrated considerable achievement in geographic knowledge, in the ability to use latitude and longitude to identify map location and in understanding environmental issues.

Educational researchers are working to develop more "performance-based" testing methods that gauge what students actually learn and can do. Crucial as this work is to the future of school reform, it is in the very early stages of development and implementation. Much work remains to be done, both on the research front and in persuading parents and universities to accept more complex and subtle assessment techniques.

"DR.CARLA" — Carla Craycroft, head of the Agricultural Communications Services for the University of Kentucky's College of Agriculture, and a young helper co-anchor the elementary-school "distant learning" program "Gee Whiz in Agriculture," which links students in the United States and Canada via interactive satellite communication.

What's Next?

Clearly, computer networking has captured the imagination of many who are eager to help prepare students for the Information Age. The energy and enthusiasm it has unleashed create high hopes for our schools. To sustain the effort, all of us — policymakers, educators, the business community, public interest groups, parents and citizens at large — must focus on long-term goals and seek collaborative relationships wherever we can. Specifically:

We must remember that while technology has enormous potential to help students prepare for the new demands of the twenty-first century, merely installing it will accomplish little. Networking advocates are unlikely to succeed unless they convince parents, policymakers, and the public that using technology to empower students, promote active learning, and break down walls between classrooms and the "real world" adds up to a better way to prepare children for the Information Age.

In addition to addressing these issues directly, businesses, government agencies, and nonprofit groups should consider how they can make the information they produce available in ways that educators can use. The substantial contribution NASA has made to K-12 education provides a model for others.

Technology experts must continue to build bridges to the education community. To avoid another round of disappointment such as those that followed previous efforts to introduce technology into the classroom, we must ensure that teachers are given the training, technical support, and time needed to integrate networking into the curriculum. Further, many people are not as naturally enthusiastic about computers and networking as the experts are; user-friendly applications and advice that meet the needs of those less comfortable with technology will help to spread the use of networking through schools.

Helping all teachers get connected would be a good starting point. It would both enable teachers to share ideas with their professional peers and help build a powerful constituency for further efforts to connect classrooms.

Educators and others interested in promoting networking in schools must become involved in the broader debate over the nation's telecommunications future. In particular, we must seek a telecommunications structure that is fully interactive. Systems like traditional cable television, which allow only one-way transmission of information, have their place. But since students are most likely to acquire the higher-order intellectual skills demanded in the Information Age only if they can participate in communications networks as both consumers and providers of information, our top priority should be to build two-way networks.

As a practical matter, creative partnerships among diverse players — government agencies, businesses, and nonprofit groups — must play a major role in connecting schools to communications networks. Current fiscal and political realities will prevent the government from doing the job alone. But government must take the necessary steps to ensure that low-income and other disadvantaged groups have the same chances as others to succeed in the Information Age. It must not shirk from its traditional role as the guarantor of equal opportunity.

This is an exciting time. Networks are already helping teachers like Patricia Weeg and students like Yi-Lun Ding extend their reach far beyond the classroom. To create the same kind of opportunities for all students, the collaborative spirit that has energized the connected few must spread to parents, communities, businesses and other institutions. The result will be students better prepared for work and citizenship in the twenty-first century. In the end, the community at large will benefit at least as much as today's students.

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"Virtual" Classroom — Telephone company employees in Albany, New York, share an Empire State College business-math course with students in Syracuse, more than 100 miles (160 kilometers) away.

Classes on the Web

Jeffery R. Young

Barbara Johnson remembers the days of fumbling with handouts, photocopying hundreds of copies of her class syllabus, and, occasionally, misplacing a student's paper.

Those days are behind her, or so Johnson hopes. She has put the materials for her literature classes at the University of Connecticut at Storrs on the World-Wide Web. Her students look to the Internet, rather than to a stack of papers at the front of the lecture hall, to find out what to read each week. They can do some of the readings online, hand in their papers electronically and review exhibits and other materials on their personal computers or in the computer center.

Moving course materials to the computer network has done more than make Johnson's briefcase lighter. Her students, she says, spend more time "surfing" class information and even show it to friends who are not in the course. "The kids love it," she says. "They've grown up on video games. Why can't they read a book and play with a computer at the same time?"

More than 50 classes at the University of Connecticut have set up similar "virtual classrooms" on the Web. And professors at many other institutions are putting their classes on line, sometimes as part of campus-wide efforts but more often as individual attempts to take advantage of new technologies.

Interest in Web pages is growing, professors say, because the technology is easy to use, enables them to offer more current information and makes the syllabus more flexible, since it can be changed in mid-semester.

However, some of them worry about whether their campuses have enough computers. Some are concerned that putting materials on Web services could violate copyright law. And a few students see the Web pages as a distraction and prefer to read printed materials.

"Easy, Inexpensive, Painless"

The idea of using the Internet as an extension of the classroom is not new. Since the beginning of the global network, universities have seen cyberspace as a possible extension of the classroom. For many years, they have set up electronic mailing lists to encourage discussions. Gopher, an Internet tool developed at the University of Minnesota four years ago, was quickly adopted by some professors, who put syllabi and class announcements on the network for the convenience of students.

The World-Wide Web, however, offers the ability to integrate charts, graphs, photographs, sound and video. Students can connect to related material on computers around the world by clicking with a mouse on highlighted words.

Professors usually begin with simple Web pages, delivering the same handouts they have printed and distributed in the past. "This is an easy, inexpensive, painless way to distribute administrative information," says John M. Unsworth, director of the University of Virginia's Institute for Advanced Technology in the Humanities, in Charlottesville.

The Web also makes it easy for students to keep track of the information during the semester, professors say. It provides "a one-stop location for reviewing lecture presentations, getting old exams, getting announcements, reading questions and answers, finding the office hours of teaching assistants, finding out about their grades and much more," says Steven C. Myers, an associate professor of economics at the University of Akron, in Ohio.

Putting the information on line is surprisingly simple, even for those who are not Web experts. Professors say they quickly learned Hypertext Markup Language, the series of codes needed to prepare computer files to be presented on the Web. "You can learn this in a day," says

Alan Filreis, an English professor at the University of Pennsylvania (Philadelphia) who has put material for three classes on the Web.

The difficulty, the professors say, is in finding time to get started. "I worked very hard to get this much together, on my own time and often staying up half the night," says David Bogler, a botany professor at the University of Texas at Austin who created a Web page for his class in ecology and evolutionary biology.

Not everyone is eager to convert class materials to digital form, however. Some professors say they simply do not have the opportunity to learn the new tricks of the Internet.

"I Prefer Hard Copies"

"Because there are very few enlightened administrators, not to mention incentives, at the typical organization, this will require quite some time before it is commonplace," says Rodney P. Riegle, an education professor at Illinois State University (in Normal) who has put at least one of his classes on the Web.

Others are afraid of making too much information available. "I do have lecture notes typed up, but I decided that if I made these available, then students would not go to lecture," says Bogler.

Many students also are not ready to break with the familiar way of doing things. "Generally, I have to say I prefer hard copies, because I'm something of an underliner," says Holly D. Loth, a student in one of Filreis's English classes at Penn. She says she spends two or three hours a week reading materials from the class Web page. Although students can print out anything they need, this can be inconvenient if they do not own a printer and have to pay to use a university printer.

Most students and professors who have tried the Web are won over by the technology — and have plenty of examples of how the virtual classroom has helped them.

Gary Hardcastle, a professor of philosophy at Virginia Polytechnic Institute and State University (Blacksburg), discovered that the World-Wide Web could deliver materials with an immediacy that is beyond that of most printed texts. He made *Time* magazine's articles about the Internet, for example, available to his science-and-technology class last spring before they were available on the newsstands. He added a link to *Time*'s "Pathfinder" site, where the articles were posted, and the class was able to discuss them at its next meeting. "All of this would have been impossible without a Web site," he says.

Data from a Local Lab

Dale W. Kirmse, an associate professor of chemical engineering at the University of Florida (Gainesville), says the Web gives his class access to materials unavailable anywhere else. His "Introduction to Chemical Engineering" class uses the Web to gain access to data from a local laboratory, so that students do not have to learn from hypothetical situations. "We're trying to set up examples and prototypes of how you use this," he says.

Others see the Web as a chance to look over the shoulders of their peers to see how they structure their classes. "The Web can make teaching a more collaborative enterprise, where we can take more advantage of what each other is doing," says John H. Krantz, a professor of psychology at Hanover College (Hanover, Indiana).

Richard Mendez, an administrator in the computation center at the University of Texas at Austin, was among the first to see the Web's ability to improve communication among professors. Last year, he set up a Web service called "World Lecture Hall" (http://www.utexas.edu/world/lecture/) as a guide to classes that use the technology. Visitors can find materials there for courses in more than 50 disciplines, from the humanities to engineering.

E-mail from All Over

"I wanted to create a page that would inspire University of Texas faculty to copy others at other universities," he says. "So they would say, 'Gosh, if Notre Dame's doing it, we should be able to do it.' "

Some entries on Mendez's service offer materials so comprehensive that it is possible to take the class from any computer on the Internet. "Anyone can browse it, can read it, can learn from it, whether they are at the university or not," he says.

Many professors who are listed in "World Lecture Hall" say they get E-mail from people all over the world, with questions, comments and an occasional correction of a fact or figure. "This is changing the way that universities in general relate to the outside world," says Virginia's Unsworth. "You have not only the local audience, but anyone in the world could stumble in."

Cathy Ball, an assistant professor of linguistics at Georgetown University (Washington, D.C.), who put a tutorial for Old English on the Web, says she has been surprised by how many outsiders consult her as "some sort of omniscient, online, Old English professor." She advises colleagues, "Before you make your materials available on the Web, make sure you have enough spare time to handle the responses."

Some of those on line from outside the campus are likely to be parents of students, professors say. Some job-hunting graduate students and professors hope that colleagues with positions to fill are looking in, too. "I just finished my degree, and I'm looking for a teaching job," says Nick Strobel, who has put all of his lecture notes on line for the astronomy class he teaches at the University of Washington (Seattle). "This is a way to say, 'Here, look what I've done.' "

"Sincere Appreciation"

Perhaps the greatest benefit, professors say, is watching students become more involved with the material as they experiment with the Internet. "In over two decades of college instruction, I have never received the sincere appreciation I now frequently get simply for giving them this opportunity to experience the Internet," says Illinois State's Riegle.

Not all of the students in Myers's economics class at Akron are so appreciative. Several complained in responses to a questionnaire that he spent too much time teaching the technology, rather than the subject matter. "I think that when you spend our time repeatedly going over this in class time, it does waste our time," wrote Kristy R. Yovicbin. "We did not sign up to take your class to learn how to surf the Net, but to learn econ."

Others in higher education see additional factors limiting the use of the World-Wide Web for class materials. "I think that the really interesting and hard issue is the access issue," says Marc Eichen, director of academic computing at Hunter College of the City University of New York. His institution does not have an extensive computer system, almost all of the students live off the campus and many do not own computers.

He notes, however, that information often can be more accessible on computers than in university buildings. "The reserve room is not open at 4:30 in the morning, but the Web is open. The Web is always open."

Survey of Participants

The three classes that Hunter has put on the Web this semester are an experiment to see if they are worth the time and effort of converting documents, he says. The college plans to survey the 750 student participants on their reaction to the service.

Professors say a potential problem is the fallibility of the technology. Susan M. Blanchard, an associate professor of biological and agricultural engineering at North Carolina State University (Raleigh) who has put her class on line, says a power failure brought an end to her demonstration of class Web pages one day. "One of the hazards of on-line demos is you never know when the power's going to go out or when the computer's going to crash," she says.

Other professors are concerned with how much information they can legally place on the Web. Some subjects, such as history or classics, use older materials that are in the public domain. In other disciplines, publishers own the rights to many texts and images, and they do not want professors sharing them with the world at no charge.

"I'm still struggling with copyright issues," says Connecticut's Johnson, who wants to add more texts and images to her pages. "I don't want to get my school in trouble."

Some professors try to respect the interests of copyright owners by limiting Web-page access to students enrolled in the course.

Ignorance about copyright law and confusion over how it should be applied to computer networks are causing problems, says Carol Twigg, a vice president of EDUCOM, a consortium of about 600 colleges and 100 companies dedicated to increasing the use of technology. "Professors are probably one by one violating copyright laws," she says.

But Twigg is optimistic that the use of the Web is on the rise. "The next generation of faculty," she says, "are going to do this naturally."

Jeffrey R. Young is with the electronic products staff of *The Chronicle of Higher Education*.

The Internet is Changing Higher Education

Neil Rudenstine

I want to talk about the Internet and higher education: what changes are taking place in universities as a result of this recent advance in information technology? Are the changes significant and are they likely to be long-lasting (as I believe they are)? If so, why?

The questions are obviously important, because our conclusions will determine whether Harvard and other institutions should make very large financial investments in the next five to ten years, at a time when flexible resources are clearly constrained.

But more important than the financial issues are those of substance. Any deep transformation in communications — in our ability to gain access to data, information, and ultimately knowledge, and in processes that can help us to discover, invent, teach, and learn — will necessarily have profound effects on higher education. So as we assess the new information technology — the Internet — we have to make the right bet, because the stakes are high.

When I refer to the Internet in this talk, I mean to use the term as shorthand for a cluster of technologies that includes networked personal computers, hypertext and hypermedia, the World Wide Web, and other adjuncts.

This cluster has, during the past few years, already begun to have a dramatic effect on the ways that many students and faculty are approaching the whole activity of teaching and learning. In the context of Harvard and at least some other universities, these changes are more dynamic and pervasive than any previous breakthrough in information technology during this century — including the introduction of the personal computer itself. The effects are visible in nearly every part of our own campus, as well as elsewhere in higher education.

From one point of view, the Internet marks just one more point on a long continuum of inventions — one that has unfolded over the course of the last century and a half — from the telegraph and cablegram, through the telephone, radio, recorded sound, film, television, early calculating machines, and then the earliest computers.

But we know that certain events along a continuum can represent much more than another simple step in a natural, gradual progression. There are moments of real transformation, and the rapid emergence of the Internet is one them.

Many inventions (such as radio, film, and television) have of course had a massive effect on society — on how people spend their time, entertain themselves, and even gain information. But, in spite of many predictions, these particular inventions have had little effect on formal, serious, advanced education. Why should the Internet be any different? Is there any evidence — or a reasoned explanation — for betting on the Internet, when so many earlier inventions have fallen short of expectations?

Let me start by mentioning a few facts. In our Faculty of Arts and Sciences, nearly all of our nine professional schools, teachers and students — including freshmen — are online, with easy access to the network. E-mail is commonplace. Activity on the Net is heavy at nearly all times of day and night, with the only major slowdown occurring between 3:00 a.m. and 6:00 a.m.

Speech by President Neil Rudenstine at Harvard's Conference on the Internet and Society, May 29, 1996

In 1992, we began a retrospective conversion of Harvard's entire library catalogue system — the largest university library system in the world — at a projected cost of $22 million. By next year, full catalogue entries for the (approximately) 12 million volumes, in our 92 libraries, will be online and "searchable" in any number of ways. In addition, there are, of course, more and more actual texts, images, and other materials online. The rate of change and growth is exceptionally fast.

A year ago, the Arts and Sciences Website (which includes many subsites) experienced about 150,000 "hits" in the single month of March. This March, just one year later, the number of "hits" had increased from 150,000 to 2.3 million. There is no sign of a slowdown.

A year ago, the volume of e-mail traffic on the Arts and Sciences network was about 80,000 transactions per day. Twelve months later, the number had grown by about 170 percent, from 80,000 to about 215,000 per day — or about 6.5 million per month.

These figures, let me stress, are only for Arts and Sciences. They do not include our Schools of Business, Design, Dentistry, Education, Government, Law, Medicine, Public Health — or our central administration and various other units.

So if I am asked whether something very unusual — something qualitatively and quantitatively different — is under way, the answer is a clear "yes." And we are only at the beginning.

In purely economic terms, Harvard has recently committed itself to spend approximately $50 million on new administrative data systems in the next five years. In addition, we expect to spend something in the range of $75 million to $100 million on academic-related information technology — above and beyond the substantial investments already made since the early 1990s.

The last time universities experienced such far-reaching change in information processing, along with exponential expenditure growth, was during the last quarter of the nineteenth century and the first quarter of the twentieth. It was then that the huge information systems that we call university research libraries reached their point of "takeoff" in accelerated development.

At Harvard, the moment of takeoff came during the 1870s and 1880s. When that moment arrived, universities were forced to confront many problems — including that of information overload — similar to several of the "electronic" problems we now face.

In 1876, for instance, Harvard's President Charles Eliot reported that the main library building had become completely inadequate to accommodate the sharp rise in acquisitions. Books, he said, "are piled upon the floors... Alcoves are blocked up... Thousands of [volumes] ... have been placed in temporary positions." He noted that large numbers of books were being stored haphazardly: "42,000 volumes scattered among twenty-nine [locations] ... in sixteen different buildings."

The real challenges, however, were not those of space and money. They were organizational and conceptual. How should books be arranged for optimal use? What kind of cataloguing system could be invented to allow rapid access to the huge number of volumes that were now being acquired? How could convenient linkages be created among books and articles in different but related fields? How should library books be integrated into the university's programs of instruction; especially if the library owned only one or two copies of a book which fifty or sixty students were asked to read for class discussion?

Finally, what was to prevent students (and even faculty) from disappearing into the stacks for days on end, pursuing a subject from book to book, shelf to shelf, unable to discriminate easily among the unlimited number of volumes, or to absorb more than a small fraction of the information available on a given topic? And what could possibly prevent less industrious students from simply browsing their lives away in sweet procrastination?

Some of these fears were not completely new. Anxieties had been building for some time. As early as the 18th century, Diderot remarked that "a time will come when it will be almost as difficult to learn anything from books as from the direct study of the whole of the universe.... The printing press, which never rests [will fill] huge buildings with books [in which readers] will not do very much reading... [Eventually] the world of learning — our world — will drown in books."

Meanwhile, a treatise on public health, published in Germany in 1795, warned that excessive reading induced "a susceptibility to colds, headaches, weakening of the eyes, heat rashes, gout, arthritis, asthma, apoplexy, pulmonary disease, indigestion, nervous disorders, migraines, epilepsy, hypochondria, and melancholy."

People were warned not to read immediately after eating, and only to read when standing up, for the sake of good digestion. Fresh air, frequent walks, and washing one's face periodically in cold water were also prescribed for habitual solitary readers. Most of all, it was feared that excessive reading would make people socially dysfunctional, would take the place of direct human contact, and could well lead to a society composed of certified misfits.

Historical parallels are never exact, but the story of university research libraries, and of the habit of solitary reading, has some obvious relevance to modern information technology — especially to the Internet's ability to give individuals unbounded access to a new universe of information that they do not yet know how to manage at all well.

There is also the serious problem of the very mixed quality of the information available. How do we sort it? How do we gain maximum return on the time and energy invested in searching?

More recently, another concern has surfaced: the problem of electronic addiction. A *Washington Post* article reported that, at MIT, students unable to break the Internet habit, riveting themselves to their computers for days on end, can request that the university simply deny them access, cold turkey, whenever they try to sign on. At Columbia, the university's Center for Research on Information Access noted that there is an increasing number of students who "really drift off into [the Internet] . . . world, at the expense of . . . everything else." Several students have already flunked out, purely electronically.

Given this situation, it is not surprising that many people are now asking some of the same questions that were raised in the early days of research libraries — and expressing some of the same fears. The Internet is in fact not easy to navigate; much of its available information is trivial; it appears to be hazardous to the health of at least some people; and it also has the capacity to distract many people from following what others regard as more serious pursuits.

Some of these concerns can be alleviated by recalling the story of our research libraries and their evolution. Other concerns — such as the worry that the Internet may turn out to be no more educationally useful than radio or television — need to be answered differently.

Why is the Internet likely to succeed as a vehicle for real education, when so many other inventions have faltered? Why isn't it simply one more in a long train of distractions? Doesn't it, ultimately, take students and faculty further and further away from books, from the hard work of sustained study and thought, and from direct human contact with other students and faculty?

Let me suggest some of the main reasons why I believe that the Internet is fundamentally different from those earlier electronic inventions, and why I believe it is already having — and it will continue to have — such a major effect on higher education.

To begin with, there is the steadily mounting evidence of dramatic change and intensity of use, as I mentioned just a few moments ago. All of this is certainly not a mirage.

More fundamentally, there is in fact a very close fit — a critical interlock — between the structures and processes of the Internet, and the main structures and processes of university teaching and learning. That same fit simply did not (and does not) exist with radio, film, or television. This point is in many respects a remarkably simple one, but — in the field of education, at least — it makes absolutely all the difference.

If I say there is a critical interlock or fit here, I mean nothing more complicated than the plain fact that students can carry forward their work on the Internet in ways that are similar to — and tightly intertwined with — the traditional ways that they study and learn in libraries, classrooms, lecture halls, seminars, informal discussion groups, laboratories, and in the writing and editing of papers or reports.

Some of these activities are more cumbersome and less successful when transplanted to the Internet environment. Others are substantially improved. In most cases, however, the new technology acts primarily as a powerful supplement to — and reinforcement of — the major methods that faculty and students have discovered, over the course of a very long period of time, to be unusually effective forms of teaching and learning in higher education.

Specific examples can be helpful here, so that we can see more clearly how the capacities and processes of the Internet relate so closely to the university's traditional forms of education.

For instance, the Internet — as we know — can provide access to essentially unlimited sources of information not conveniently obtainable through other means. Let's assume for the moment that most of the technical and other problems of the Internet will in time be solved: that there will be, as there are now in the research library system, efficient ways of helping users to find what they want; that there will be procedures for information quality control, and for creating more effective linkages among different bodies of knowledge in different media.

At that point, the Internet and its successor technologies will have the essential features of a massive library system, where people can roam through the electronic equivalent of book stacks, with assistance from the electronic equivalent of reference librarians. In short, one major reason why the characteristics of the Internet are so compatible with those of universities, is that some of the Internet's most significant capabilities resemble, and dovetail with, the capabilities of university research libraries. Just as the research library is an extremely powerful instrument for learning, so too is the Internet — and for much the same reasons.

In fact, the library and the Internet are being viewed increasingly as a versatile unified system, providing an enormous variety of materials, in different formats — so that data, texts, images, and other forms of information can be readily accessed by students and faculty alike. Indeed, we are already well along this path.

If we now shift for a minute from libraries to the formal curriculum, we can see that the Internet has another set of highly relevant capabilities: it can provide unusually rich course materials online.

For instance, traditional text-based Business School "cases" are already being transformed. I recently reviewed one of the new generation of multimedia cases, which focused on a small sock-manufacturing plant in China — an American-owned plant plagued by serious production and delivery problems, and losing money much faster than it could make either toes or heels.

The materials for this case began with a video tour of the plant, close-up moving pictures of the workers operating their machines — or not operating them — followed by interviews with several managers at different levels in the company's hierarchy. Interviews with the workers were also available. Detailed production and supply data, financial spread sheets, and a company report containing an official analysis of what was wrong with the plant — all of this and more was obtainable in the electronic course-pack.

What one saw, of course, was that the interviews with different people revealed totally different theories about the plant's problems, and the data was anything but conclusive. The company's official report, meanwhile, only served to complicate the picture further. Students who were taking this course had to analyze not just a text and statistics, but also the whole range of attitudes, expressions, and behavior — recorded on video — of the different executives, as well as the workers.

How many of the plant's problems were basically cultural — since the key American manager spoke no Chinese, and had to communicate with the workers through interpreters? How many problems were the result of a more general human systems failure, given the fact that the plant was embedded in a larger surrounding bureaucracy? How much of the difficulty stemmed from internal inefficiency, bad organization, and managerial blundering?

What is so effective about cases that are presented in this way, is that far more of the entire human and social — as well as operational and financial — situation can be revealed, and this requires students to deal with a vivid dramatization that is much closer to the complicated reality of an actual company that is functioning in a particular culture. Suddenly, the case becomes three-dimensional or multidimensional. The viewer has to bring to bear all the skills of a careful observer of human nature, along with those of an operations analyst, a financial analyst, and a scholar of organizational behavior.

In short, the Internet turns out to be an exceptionally fine tool for the creation of densely woven, multilayered, and highly demanding new course materials, that are in several respects superior to traditional case studies. Once again, an important component of university learning, the course and its texts, can now be reinforced — in this instance, it can be considerably enhanced — by the introduction of Internet technology.

Another point of compatibility between the processes of the Internet, and those of the university, concerns the basic activity of communication. We know that the constant exchange of ideas and opinions among students — as well as faculty — is one of the oldest and most important forms of education. People learn by talking with one another, in classrooms, laboratories, dining halls, seminars, and dormitories. They test propositions, they argue and debate, they challenge one another, and they sometimes even discover common solutions to difficult problems.

The Internet allows this process of dialogue — of conversational learning — to be transferred easily and flexibly into electronic form. Communication can be carried on at all hours, across distances, to people who are on-campus or off-campus. Student study groups can work together online; faculty members can hold electronic office hours, in addition to their "real" office hours; and teaching fellows can make themselves available for after-class electronic discussions.

In all these ways, the Internet works to create a significant new forum — a limitless number of electronic rooms and spaces — where one of the most fundamental educational processes — energetic discussion and debate — can be carried on continuously.

It's also worth noting that recent experience suggests that student participation levels tend to rise in the electronic forum. Students who are consistently reticent in actual classrooms are more likely to speak out, regularly and confidently, on the network.

No one should believe that electronic communication can be — or should be — a substitute for direct human contact. But the electronic process has some features that do permit an actual extension of the scope, continuity, and even the quality of certain forms of interaction, even though communication over the network lacks other absolutely essential aspects of "real" conversations in the presence of "real" people.

Finally, the Internet may well be having — it's not altogether easy to tell — a subtle but significant effect on the relationships among students, faculty members, and the subject or materials that are being studied in a course.

Let me oversimplify for a moment. The direction of movement in teaching and learning has, for more than a century, been shifting away from a previously established model that viewed the faculty member (or an authoritative text, or a canon of text) as the dominant presence — as the transmitter — with the student as a kind of receiver.

Since at least the 1870s, the emerging theories of education have stressed not so much the authority of the faculty member as a teacher, but the role of the student as an active agent, an energetic learner: someone who asks questions, searches for information, discusses ideas with others, and generally moves ahead as if he were an investigator, discoverer, or adventurous scholar-in-the-making.

In this model, the faculty member retains "residual" authority; but the faculty role, more and more, is to draw students out, to steer but not actually direct the discussion unless it becomes necessary to do so. The faculty also organizes the structure of the curriculum, of courses, and class assignments. But the course materials are not likely to be treated as "authoritative texts" that offer definitive solutions. They're intended to be approached critically, and they are usually arranged in a point-counterpoint way. This arrangement inevitably suggests that many or even most of the important questions in a course are still open and unresolved, waiting to be discussed and addressed and answered.

As a result, it's perfectly natural for us now, in the 1990s, to assume — something that would have been quite radical just a little more than a century ago — that students should conduct much of their education on their own: with constant guidance and the right kind of Socratic teaching from the faculty, but with a very large part of the positive charge coming from the students themselves.

We don't have to agree fully with this theory of education in order to see that it has in fact produced very potent results in colleges and universities. We can also see why the structure and basic processes of the Internet technology appear to be so closely linked to — so compatible with — the approach to education that I've just been describing.

The Internet virtually requires or even demands that the user be an engaged agent, searching for information and then managing or manipulating whatever is found —

solving problems, buttressing arguments with evidence, and exploring new, unknown terrain. Students are beguiled into tracing linkages from one source to another. They can easily share ideas with others on e-mail. They ask for comments and criticisms. Their posture or attitude, seated in front of the computer, is to make something happen. And they generally act or pursue, rather than merely react and absorb.

So, if we step back and look at the full picture that I've tried to sketch, we can, I think, start to understand why the Internet and its successor technologies will not only have a profound effect on society in general—as radio, film, and television previously did—but why it has so quickly and dramatically begun to transform significant aspects of higher education, in a way that previous inventions simply did not.

As I've tried to suggest, the cluster of technologies that we call the Internet has very distinctive powers—a unique ability to complement, to reinforce, and to enhance many of our most powerful traditional approaches to university teaching and learning.

The Internet is new, it is different, and there is always reason for caution when things are changing so quickly. We need to find the right pace in order to achieve the best possible results for education—and those results will require an intense focus on the substance of what the new technology can deliver, as much as on the process.

It takes time and money to create superior course materials. It also takes considerable faculty expertise—technical as well as scholarly. It will take time before the Internet and the Web are easily navigable, and before they possess a large enough store of rich material to rival our greatest research libraries.

But these things will happen, and as they do, education will be enriched. Meanwhile, I believe that universities have a special responsibility to exert real leadership in this sphere: not so much in the development of the technology itself, but in the imaginative and thoughtful uses of the best technology for the purposes of better teaching and learning.

We must be prepared to do now—over the course of the next ten to twenty years—what our predecessors achieved during the late 19th century, when they made a conscious decision to create unrivaled university research libraries, new curricula, and new teaching methods. It can be done, and now is the time to begin.

Is there a cautionary note on which to end? Only one: good data, new information, and excellent communications are all critical to virtually everything that we do, in universities and in life. But they are not self-justifying, and they obviously do not in themselves constitute the essential stuff of education.

All the information in the world will be of no avail, unless we can use it intelligently and wisely. In the end—as we know—education is a fundamentally human process. It is a matter of values and significant action, not simply information or even knowledge. The Internet will not tell us what to do about individuals and societies that cannot afford to be on the Net. It will not tell us how to pay attention to those who are left out of the race—or who appear to have already lost the race. It will not show us—any more than our libraries full of books will show us—how to create a humane and just society.

So, as we think in this conference about the effects of the Internet on society, let us not forget what we mean by a "society": what it is that we want to have an effect on—and what kind of an effect we want to have. It is how we address these questions—of values, of aspirations, of the consequences of our choices on real human lives that will finally determine the effectiveness of our new technologies for education, and for people and communities around the world.

The Media Lab at 10

Fred Hapgood

For a few years after it officially opened in 1985, the Media Laboratory of the Massachusetts Institute of Technology (Cambridge) may have been the most celebrated research institute in the country, at least as measured by inches of newsprint or minutes of air time. Perhaps it still is. Most major periodicals and TV science series have done a spread or segment on the organization, taking the reader or viewer through a carnival ride of speech-driven task managers, holograms, lip readers, eye trackers, gesture recognizers, virtual reality modelers, and more. A book called *The Media Lab*, in which writer Steward Brand did the same (though at a slower pace), became one of the major pop-tech sellers of recent times.

The argument used to rationalize all this attention was that the Media Lab was "inventing the future," a phrase used by Brand in the subtitle of his book and by *The New York Times* in its August 1987 profile of the facility. Inventing the future is by definition the agenda of any technical research institute, but in this case the expression referred to a more ambitious claim: that the Media Lab was defining the next keystone technology, the theme around which the other technologies of the time would orbit, like steel production in the 1800s or electric-power generation in the first half of the 1900s. The candidate being primed for this role for the late 20th century was human-machine interactivity.

"Imagine," wrote the lab's founder and director, MIT professor Nicholas Negroponte, in his 1968 book, *The Architecture Machine* (The MIT Press), "a machine that can ... discern and assimilate your conversational idiosyncrasies ... (that can) build a predictive model of your conversational performance." OK. And what would be the point of that? The point, Negroponte said, is that dialog with such a machine "would be so intimate — even exclusive — that ... (it would) bring about ideas ... unrealizable by either conversant alone."

When Negroponte wrote those words, he had in mind a house — he began his career as an architect — a building that would act as a consultant on the question of its own redesign, engaging its owners in an ongoing dialogue on such issues as ventilation, illumination and drainage. When both parties pronounced themselves content with said redesign, the owners would go off for a few days, perhaps on vacation, and the house would reconstruct itself autonomously, metamorphosing into the desired form.

As a concept, this "Architecture Machine" may have been a great example of interactivity, but it obviously faced a few short-term fabrication constraints. So, through the 1970s, Negroponte pushed his ideas into more flexible and plastic contexts, specifically the media: broadcast, publishing, movies and telecommunications. He liked to talk about asking the TV to summarize or expand on a point, or have the set watch a show and then tell you if you'd like it and why. Your newspaper could track what you skipped and reread and where you paused, then use those cues to evolve into a composite *Daily Me* that would carry only the news you cared about most. Advertisements would watch people watching them and continuously adapt to their responses. At another time, these ideas might have made no more than an interesting essay, a counterpoint to the conventional opinion — as developed by psychologist Bruno Bettelheim — that normal people did not have "intimate and exclusive" relationships with machines. As it happened, however, Negroponte wrote against the background of the extraordinary success of the personal computer. The intimations of change that spread in the wake of that success sent thousands of corporate executives streaming into the vision marketplace, where they went milling about, crying out for guidance.

Given occasion, Negroponte could soar as high as any futurist ("Monologs will become conversations; the impersonal will become personal; the traditional 'mass media' will essentially disappear," he proclaimed in *The Media Lab*), but his argument about autopersonalizing machinery was more focused, tighter, easier to grasp than most of the nostrums being peddled in this sector. Business leaders flocked to hear his analyses. When Negroponte proposed organizing a facility that would pursue this vision firsthand, supporting itself by selling ringside seats to the adventure, corporations responded enthusiastically. In 1985, after being housed for two years in the MIT computer science department, the Media Lab opened in a cool, closed-in block of a building known locally—after its architect, I.M. Pei, and its distinctive exterior white tilings—as "the Pei toilet." On the most general level, the lab's agenda was the man-machine interface, a phrase that encompassed ways to talk to machines (such as speech recognition), ways for machines to talk back (such as holography), and processes that supported this interaction (such as video compression).

THE WEISNER BUILDING in Cambridge, Massachusetts, known familiarly as the "Pei Toilet," is the white-tiled building designed by I.M. Pei to house the Massachusetts Institute of Technology's Media Lab, a cutting-edge research facility.

Many of these technologies, let alone the general theme of machine interactivity, were being researched elsewhere, but the Media Lab came at questions a little differently. Unlike in-house researchers or contract labs, it was looking not for new applications but for new application domains. The idea was not to cut a specific path but to illuminate the landscape, usually by simultaneously prototyping several different but related applications in a single domain.

This was a new niche in technical research, somewhere between industrial R&D, with its near-term orientation, and the academic engineering sciences, in which real-world constraints are assumed away in order to define problems of "professional interest," issues that are old enough—and popular enough—to have attracted a pool of expertise sufficient to staff the committees that control funding and editorial decisions within the professions.

As is often the case in nature, occupying a new niche requires radical mutations of the underlying phenotype. In this instance, what mutated was the look, feel and structure of the institutions that had been responsible for the technical research of the past 50 years. For example, members of these facilities have traditionally assumed that visitors understand the core concepts of the technology. But the Media Lab had a second constituency: executives in marketing, strategic planning, and corporate development. These were big-picture/high-concept types on tight schedules, corporate movers who needed to be able to glance at something, get it, and be off. And so the Media Lab became famous for its "demos," colorful, witty and stylish presentations — usually in code or on tape (or videodisk) — that demonstrated how a particular project would work in a real-world context.

A second difference was that the breadth of the Media Lab's mission—to illuminate new technologies by prototyping them in several contexts—required it to draw resources and expertise from a wide range of cultural sectors. The small faculty included an opera composer and a filmmaker, an artificial-intelligence scientist, graphics specialists and a team of educators. A person walking the halls might see demos of new musical instruments in a concert hall, holographic modeling for a manufacturing company, and speech-driven task schedulers for an office, all side by side. There was not a hint of the professional partitions that divide—some prefer the term "focus"—the attention of traditional research institutes.

Most facilities have a small number of sponsors, often one; research is naturally dominated and defined by the interests of that sponsor. Work done at industrial labs is controlled by corporate management. Research in academia is controlled by professional panels that make sure that every project funded falls somewhere on the short list of venerable theoretical issues deemed to be "of professional interest." (Not every interesting question qualifies. The Rockefeller University professor emeritus Donald Griffin, who discovered echolocation in bats in the late 1950s while still a student at Harvard, recalls that his advisor suggested he drop the topic. Who would peer-review his work?) In either case, a researcher who wants to pursue an interest not shared by his sponsor is out of luck.

By contrast, the Media Lab's product is not a "product" but a seat on an expedition across the technological frontiers. This positioning provides the lab's work many hundreds of potential buyers, each with their particular perspectives and needs. Unlike institutes living off government money, the Media Lab's financing opportunities are not restricted by national borders — half its funding comes from overseas.

Consequently, the place has unusual freedom of action. "If one sponsor isn't interested in a project, another one will be" says Walter Bender, the lab's associate director of information technology. "I remember getting one of those do-this-do-that letters from a sponsor," recalls a Media Lab student. So what did he do? "I sent him this vicious flame [a scathing e-mail message]," the student says. "And I copied it to everyone. They know they're not supposed to do that."

This spirit of independence has helped the lab to form and follow its own identity. Four years ago, for example, the Media Lab came out swinging for digital high-definition television, despite the fact that several of its sponsors at the time had made substantial investments in the rival analog technology. Finally, the size of its market allows the Media Lab to go down branches of research that might lead nowhere. "Coming up empty" is the ultimate nightmare in other funding models, but for the Media Lab, one annoyed sponsor is not the end of the world.

From the point of view of the sponsors, what the Media Lab sells is the opportunity to follow and examine in detail aggressive investigations of new technologies. "It's an idea factory," says Gary Bottger, manager of external technology at longtime sponsor Eastman Kodak Company. And these are the terms on which the Media Lab has to produce. Sponsors are naturally happiest if they can see a steady flow of ideas — perhaps not on each visit, but regularly.

This imposes intense pressure on the students to keep cranking. "To have no demo is not a good state to be in here," a graduate student says dryly. On the other hand, the lab tries to pay 100 percent of the tuition for its students and frees non-tenured faculty from fund-raising responsibilities — nobody has to write grant proposals — so both can concentrate on keeping the river flowing.

And so the river flows, at the Media Lab's distinctive pace. Touring the lab once, I passed a game demo running on a wall-size display. The game could read a player's silhouette through a mounted camera and react accordingly. Turn one way, and the view on the display would slide in the other direction; if you fired a gun, the display would figure out what you were doing and where the gun must have been pointed, then detonate the proper portion of the landscape, synthesizing the appropriate sound effects.

"He wrote that in a couple days" my guide said, pointing to a student. The student heard him. "Actually it took me more like three weeks," he said modestly.

Perhaps what made the Media Lab so celebrated when it opened a decade ago was less the romance of human-machine interactivity than the spirit of the place itself. The cultural variety gave it the outline of a complete society; the relentless flood of projects made the place feel as if wherever it was going, it was getting there without losing a moment; and its collective self-possession gave it authority and stature. One felt the different qualities and characters of the culture mixing, reacting with new energies, bursting out of the dead hands that shape the atmosphere of other institutes. It may have been that the technology was the least part of the future being invented.

Ten years later, it seems fair to say that the age of intimate and exclusive relations with machines is still a bit over the horizon. The impersonal has not become personal. (Whatever that might mean, it hasn't happened.) The mass media have not "essentially disappeared," though they might be turning a bit brown around the edges. Both interactive TV and interactive movies are moribund; the interactivity that has developed most rapidly over the last decade has not been human-machine but human-human — e-mail, newsgroups, talk radio, home shopping.

And one of the biggest pieces of news in machine interfaces has been Microsoft's struggle to make its operating system look more like that of the 1985 Macintosh, an example of inventing the past, if anything. Perhaps the spread of CD-ROMs and the popularity of the Web might allow machines to claim a gain of a couple of IQ points, though even there, not many applications autocustomize in any interesting way.

Yet, today's visitor wandering the passages of the Pei toilet will find projects extending far beyond the lab's original media horizons: narrative recognition, the gender of machines, directable cameras, neighborhood nets, remembrance agents, augmented realities, automated performers, steganography (hiding one signal in another), haptic holography, storyteller systems, fast physics simulations, wearable networks, embroidered circuitry, evolution-driven animation, and on and on — about 100 projects in all.

Perhaps paradoxically, the Media Lab has prospered even more than its vision. Over the last decade, the lab's budget has grown at an average annual rate of 30 percent a year to a present level of about $25 million. By contrast, in the last five years MIT, which gets much of its money from the government, has lost approximately 30 percent of its gifts, grants and bequests.

The Media Lab now has more than 100 students, up from 58 in 1986, and like its neighbor MIT, the lab relies heavily on its students' work. Applicants to the Media Lab don't apply through MIT; the lab has its own procedure: students are admitted by specific faculty members with whom they then work very closely — faculty members sometimes refer to their having "hired" a given student. Students work cheap, and low costs are probably necessary to console executives with giving up control over research. (The average amount paid by a sponsor is about $200,000 a year, but entry-level memberships go down to $75,000 a year for a three-year commitment, about the price of four quarter-page ads in *The New York Times*.) The regular and rapid turnover of students maintains the flow of new ideas that attracts sponsors, and according to Kodak's Gary Bottger, Media Lab graduates are in intense demand.

Employability, of course, is not the only test of a student's success. When Joshua Smith, now a master's student at the Media Lab, started thinking about graduate school, he faced a problem common to intellectually active students, almost symptomatic of the breed: his interests did not respect professional boundaries.

PLAYING WITH A VIRTUAL DOG, as viewed on a video screen, becomes possible with computer technology at the Media Laboratory of the Massachusetts Institute of Technology (Cambridge). As part of the Artificial Life Interactive Video Environment (ALIVE), a video camera views the human interactor and relays information to a computer, which creates the simulation of the dog. On the video screen, the computer combines both into an interactive video.

He had one bachelor's degree in computer science and philosophy (a double major), and a second BA in physics. "I wanted to combine the mode of inquiry of physics with the domain of computer science," he says. "I was interested in whether we could make models of computation that worked as well as our models of the physical world. Questions like that don't fit in at many graduate schools."

Smith had heard about Neil Gershenfeld, a physics professor at the Media Lab who shared similar interests, and came by to talk. Gershenfeld "hired" Smith, who joined his project on interface transducers. The idea was to fill a volume of air with electric fields such that when a user waved his hands through the air, like a symphony conductor, the device could infer changes in the position of the hands from changes in the fields. The technology has been prototyped in gaming and instructional contexts as musical instruments and as a pointing device, like a 3-D mouse.

From Smith's perspective electric-field sensing combined all of his interests, including philosophy, given the issues of logical inference. Yet, Smith knows he is doing an end-run around peer review: "As a potential academic," he says, "that makes me feel a little funny." But there is no professional academic community of electric-field sensing — the whole field is too new. His "peer" group is the sponsors. Sponsor engineers critique his designs, but the opportunity for technical review seems to matter less than the support and enthusiasm of this small community that has sprung out of the sponsor mix. Smith says that overall, the lab shaped his interests in physics and information into a commitment to the problems of sensing, which he says he expects to be thinking about for some years yet.

When Nicholas Negroponte started the Media Lab, his aim was to build an institution that reached the very highest levels of influence and innovation, such as MIT's Research Laboratory of Electronics in the '40s, Bell Labs in the '60s, and Xerox PARC in the '70s. Probably — history retains its freedom of judgment — the Media Lab flunked this standard in the '80s. But the standard itself is absurdly high: If the Media Lab was not the Xerox PARC of the '80s, neither was anyplace else. To put it into perspective, over the last 20 years, MIT as a whole has received thousands of millions of dollars in research funding. How many people can name one big idea or significant technical innovation — besides X Windows — brought about by the expenditure of all that money?

When the sponsors are asked about the Media Lab's contributions, they talk less about being inspired to beam themselves into a new commercial universe and more about getting help with the hard technical questions that come with adapting a given industrial mission to a changing world. Ed Horowitz, CEO of Viacom Interactive Media, says the Media Lab has played a big role in his company's work on image archiving. Gary Bottger credits the lab with helping to expand Kodak's ideas about digital camera applications and develop desktop publishing standards. Sam Fuller, vice president of corporate research at Digital Equipment Corporation, says his company was strongly (and wisely) influenced by the lab's thinking on digital HDTV. Bill Molteni, senior scientist at Polaroid Corporation, sees the lab as a high-end user's group, a place that can be depended on to know more about the best new technology than its own manufacturers.

COMPUTERS CAN IDENTIFY HUMAN faces through Perceptual Computing done at the Media Lab of the Massachusetts Institute of Technology (Cambridge). Among its many possible applications, the program may be used for security purposes.

These are all exactly the kinds of services that industry has looked to MIT to provide for most of its history — the services that were a major source of support for MIT before the government started funding academic engineering research at such a high level.

The lab, however, missed what turned out to be the decade's best ideas in machine interactivity: hypertext markup language and browsers. And the Media Lab might be constitutionally incapable of generating these types of ideas. Both of these programs were thrown together by people who wanted something cheap and crude that they could hand out to their friends for free. Because neither program pushed out the wall of software development, few working in the Media Lab might have thought such programs interesting enough to develop.

One has to wonder how far the Media Lab model — private funding, lots of sponsors, a sweeping mission, institutional autonomy, the deep mixing of a wide range of cultural modalities — can be pushed. Can there be a Media Lab for biotech? For materials research? Can we stop subsidizing the research professions and be the better for it?

A decade after its inception, the lab serves as a model for the organization of technical research and the relation of research to industry. It is also a model for education, in which art and engineering are combined in a project-centered curriculum where students' work is reviewed by real-world experts instead of academic professionals. No doubt this model has limitations, but we live at a time when the old ideas on these issues are simultaneously rusting out. Perhaps the single biggest achievement of the last 10 years will turn out to be the Media Lab itself.

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Hypertext Hamlet

N. Katherine Hayles

A literature student shakes her head, perplexed. She does not understand a line from *Paradise Lost* on the computer screen. Noticing that some words appear in blue, she clicks a mouse, causing new text to appear with biographical information to provide context for the puzzling line. She nods and goes on reading in the library.

Nearby, another student is studying *Macbeth.* When he gets to the scene where Macbeth, on his way to murder Duncan sees a bloody knife hanging in the air, he wonders how different directors have staged the hallucination. The next instant he has before him video clips and stage histories to compare. Across the room, a student specializing in contemporary literature is reading a text, creating a narrative, and constructing an interpretation — all at the same time.

What do these students have in common? They are working with a new kind of interface, where words become electronic and literature takes shape in a computer. Some think that these students and like-minded colleagues worldwide are participating in the most significant revolution in writing, reading, and interpreting texts since the invention of the printing press. The changes that computer technologies are bringing about in literary studies are occurring in three distinct but related areas. First are electronic archives of print texts. At Project Gutenberg, for example, teachers at a small Jesuit college are encoding thousands of print texts into electronic format. Elsewhere others are compiling electronic archives of medieval manuscripts, which otherwise would have highly restricted access. For projects such as these, the transformative effects of computer technology are subtle, for the intent is to preserve the essential features of the print text while still taking advantage of digitization. Nevertheless, if the medium is the message (as Marshall McLuhan proclaimed), electronic texts are not merely more accessible or convenient than their print counterparts.

A second use of hypertext and CD-ROM technologies in texts such as *Paradise Lost* and *Macbeth* is to embed scholarly research materials into the same electronic environment as the primary text. This usage invites such questions as how is reading Shakespeare on CD-ROM different from reading a variorum print edition? Or how is Tennyson in hypertext different from Tennyson in a Norton Critical Edition?

A third area of literary studies affected by electronic textuality is interactive fiction. Here, the transformative effects of computer technologies are indisputable, for in these texts one sees a quite different aesthetic at work. Charting the emergence of this aesthetic will illustrate the sea change that literary studies is undergoing.

Of the thousands of books published in the United States this year, only a handful will escape digitization during some phase of their existence. What difference does it make that the paperback I read in bed last night was once a string of electrical polarities on someone's hard drive? For the casual reader, probably none. In any case, the end product is a print text. But the situation changes when we consider the processes behind the product. Recently, I made a last-minute trip to Kinko's to prepare transparencies for an out-of-town talk I was giving. One of the images I wanted to retrieve was on a CD-ROM. I downloaded the image from the CD-ROM into a graphics file. Then I used a desktop publishing program to edit the image, removing the screen border and tweaking the program so it gave greater resolution. When the image was finally printed, it appeared to be much the same as if I had photographed or photocopied it. The manipulation the image had undergone, however, made me acutely aware of the particular risks, demands and rewards of the medium. In a flash of illumination, I understood why photographers so often use light as the subject of their compositions. Working in a chemical medium sensitive to light, they feel in their bones the centrality of light and express this realization in their pictures. Similarly, I felt in my synapses that patterns of electrical polarities were central to the image sliding out of the printer.

What difference does this knowledge make? Before the widespread use of microcomputers, realistic representation was achieved through perspectival painting, photography and xerography. Although each of these media is of course quite distinct, they share a common dependence on proportionality. When an image

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is photocopied, it can be made smaller or larger, darker or lighter, but the shape remains the same. In xerography, as in photography and perspectival painting, proportionality is conserved. By contrast, computer imaging works through digitization. The computer divides the screen into small units called pixels and assigns each an individual address. Each pixel can be manipulated independently of the others. As a result, images assume a fluidity inconceivable in a print medium. They can be rotated, viewed from different perspectives, or morphed into altogether different shapes. The image I retrieved for my transparency was from the *Macbeth* CD-ROM produced by my colleagues David Rodes and A. R. Braunmuller. It was a representation of an 18th-century drawing of David Garrick, the Shakespearean actor. Because the image was digitized, I could manipulate it in ways not possible in a medium based on proportionality. Feeling irreverent, I might turn the figure around to see Garrick's backside, stretch his neck (which appeared to me rather too short), burden or lighten him by twenty pounds, put Shakespeare's head on his body. This power of mutation, and the startlingly different relation it suggests between informational pattern and material instantiation, is an important way that an aesthetic based on digitization differs from one connected with print.

My colleague Richard Lanham has written about how the techniques made possible by digitization — changing scale, adding color, varying proportions, rotating spatial angles — bring new vitality to the text as image. Computer technology not only integrates text with image, it also makes us aware of text as image. Lanham highlights this aspect of electronic textuality by making a distinction between looking through and looking at. Accustomed to print, we think of ourselves as looking through the page to the reality the words evoke for us. When we look at the screen, however, we attend to it as a material reality in itself, operating in conjunction with its representational function. Part of a digital aesthetic is an increased emphasis on looking at as well as looking through. No wonder that the work of many contemporary writers expresses a radically altered vision of the relation of material substance to informational pattern. The cyborg mutations of Mark Layner's *My Cousin, My Gastroenterologist* and the dazzling combinatorial possibilities of Milorad Pavic's *Dictionary of the Khazars* are cases in point. They illustrate the conceptual and formal changes that occur when a digital aesthetic emerges. These works demonstrate that the digital medium is not a passive piece of technology but an active force transforming a wide range of cultural texts, including codex books.

Hypertext reveals other aspects of emerging digital aesthetics. The idea of hypertext was first proposed by Vannevar Bush in the 1940s. Bush argued that human thought is primarily associatonal. He proposed a device, the Memex, which would mimic human thought by linking blocks of text by association, rather than by linear sequence. Although the Memex was never built, the idea came to fruition in computer hypertexts.

A hypertext is an electronic document in which textual units or lexia, are connected with one another in multiple ways. Whereas a print text is bound (literally) into a linear sequence, a hypertext is constituted as a web through which one can navigate. The reader moves from one block of text to another by clicking on interactive elements — an icon, a highlighted word or phrase, or a concealed "hot spot" found through trial and error. Like the "Choose Your Own Adventure" stories many of us read as children, a hypertext narrative presents manifold possibilities that are actualized in a given sequence through a reader's choices. The reader becomes not so much a consumer of the text as a collaborator who works with the author to bring the narrative into existence.

Last winter, students in my graduate seminar explored electronic textuality. At the beginning of the term, many of them were properly skeptical about the new medium. What did it really change, they asked? Their skepticism remained more or less intact until they approached the end of the term, when they were required to construct their own hypertexts. As they wrestled with the software, puzzled over design problems, and meditated on connections between form and content, they began to move from judgments based on print media to the beginnings of a new aesthetic. Their projects reflected a growing sophistication with the new medium.

One woman, an exchange student from Italy, was accustomed to cities such as Florence and Rome that had definite centers and boundaries. When she arrived in Los Angeles, she encountered an entirely different kind of urban geography. It struck her that L.A. was a hypertext city — decentralized, difficult to grasp in its totality, navigated as a series of pathways that the individual user selected in conjunction with choices laid out by urban planners and local usage. Her project involved transforming a diary that she had been keeping of her L.A. experiences into hypertext format, accompanied by commentary analyzing connections between the cultural and physical geography of the city. Another student who had previously worked on the pornographic/philosophical texts of the Marquis de Sade saw connections between Sade's obsessive attention to body boundaries and the remapping of textual boundaries that hypertext entails. Through lexias that rearranged Sade's texts and connected them with such critical texts as Foucault's *Discipline and Punish*, he explored analogies between violation and transgression in Sade's work and the potentialities of hypertext as a medium of critical inquiry.

Yet another student took as the focus for his project the paragraph in the California Legal Code that defines forgery. The paragraph, a single gargantuan sentence, has a grammatical structure so complex that it would make Faulkner pale. The student showed how the sentence could be made intelligible by mapping it into a hypertext; connections between lexia constituted a decision tree determining whether a given case meets the criteria for forgery. He also included critical analyses of the idea of forgery in electronic media, where the distinction between an original and a copy is subverted by the primacy of informational pattern over material instantiation.

How does a canonized text, say Tennyson's *In Memoriam*, change when it is put into hypertext? George Landow, working with his students at Brown University, has created a series of pedagogical hypertexts that embed the primary text in a web connecting it to critical commentary, graphic material and biographical information. Compared to a critical edition, these hypertext documents give a more decentralized sense of the primary text. With the *In Memoriam* hypertext, for example, links in the hypertext juxtapose related sections of the poem and at the same time connect them to critical commentary explaining the significance of the links. Such juxtapositions are the bread and butter of undergraduate literature teaching, but here the cognitive operations constituting these critical acts are enacted within the design of the technology itself. The design implies that a text is not an isolated object but a tissue of connections spreading out to a variety of cultural documents; that an author is not an individual genius scribbling in a garret, but one voice in a chorus of heteroglossia; that a reader is not a consumer of texts but an active participant in the creation of the text.

These implications lead us to a different kind of question. Precisely because the medium has such transformative power, ought not classic texts like *In Memoriam* be read as codex books, since that is the medium in which they were written? Are we not changing the work by changing the medium? And is it not especially important for first-time readers like undergraduates to encounter the text in the original medium? A similar argument has been made against colorizing black and white films; I think the point has merit. What it ignores, however, are the transformative effects of technology within the culture in general. To read a codex book in an era saturated by television, video games, computer networking and Internet flirtations is already to have a different experience than to read it when people traveled by foot, conversed in person and undertook formal courtships by first asking the father's permission.

The ideal situation, in my view, is a course that combines print books with hypertext media to ask questions about the transformations that occur when culture, technology and literary signification interact.

Nowhere are these transformations more visible than in interactive fiction. Michael Joyce's hypertext fiction, *Afternoon*, illustrates the pleasures and limitations of the form. At the beginning of the story Peter, the narrator, proclaims that he may have seen his son die that morning. On his way to work he comes upon the scene of an accident just in time to see a car that looks suspiciously like his former wife's being towed away. He reads what happened from the tire marks and realizes that someone has been injured seriously or killed here. Afraid of what he might learn, he tries to determine what happened by indirection. First he calls his son's school, but the headmistress answers evasively because he is not the custodial parent. Then he tries the hospital but, unwilling to talk with anyone directly, he connects to the automatic voice mail, again getting an indeterminate answer. As the text unfolds through the reader's choices, the accident scene becomes a metaphor for webbed connections that are seldom decisive because they are constantly modified by other pathways, other interpretive possibilities.

Teaching this fiction, I quickly discovered that the seemingly banal question, "What text did you read for today?" was nontrivial. Virtually everyone in the class had read a different text, either because they did not discover all the lexia, or because they read the lexia in different sequences. In one lexia, for example, Peter's psychoanalyst is speaking to her husband, and it appears from their conversation that Peter himself was driving the car that caused the collision. In this reading, Peter knows all too well what happened and is repressing the knowledge because it is too painful for him to acknowledge. The exit from this lexia leads back to the screen describing the accident, making this interpretation equally possible. Students who encounter the accident scene through this lexia will have a very different interpretation of the text than those who do not. Faced with radical indeterminacy, not only did we have to come up with different answers to the usual questions one wants to ask about texts; we also had to invent new questions. A new aesthetic, we learned, necessitates a new pedagogy.

The twelve participants in my NEH (National Endowment for the Humanities) Summer Seminar (1995) on "Literature in Transition" included people whose professional lives have been transformed by electronic textuality. The librarian has seen far-reaching changes as libraries incorporate electronic texts into their holdings and move onto the Internet, with its fabulous and overwhelming resources; the composition specialist knows firsthand about the use of computers to teach writing, one of the fastest growing areas of computer-assisted instruction; the Shakespearian has ideas about how performance and text come together in CD-ROMS; the postmodern theorists are interested in the relation between textuality, information technologies and culture; the poet sees in electronic textuality a new potential for combining voice with text.

The possibilities are exhilarating and sometimes scary. Whatever satisfactions and frustrations we encounter, whatever conclusions we come to, I can say one thing with confidence: It won't be boring.

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