Most students entering our colleges and universities today are younger than the microcomputer, are more comfortable working on a keyboard than writing in a spiral notebook, and are happier reading from a computer screen than from paper in hand. For them, constant connectivity—being in touch with friends and family at any time and from any place—is of utmost importance. And they will be assuming responsibility in a world of incredibly rapid change. Will television and the Internet be distinguishable in ten years? Will the U.S.
As our students enter the workforce, the ability to deal with complex and often ambiguous information will be more important than simply knowing a lot of facts or having an accumulation of knowledge.

period of such advanced data-manipulation capability that photography can no longer be trusted. For example, in the movies, Forrest Gump shader looks no different from Wesley Johnson, Nicole Buxton, a young professional, virtual reality simulation (such as a flight simulator or a holo-graphic tour of a city) may be as real as the real experience. (For an outstanding novel focusing on this perspective, read Orson Scott Card’s Ender’s Game.)

This issue of reality has a more sinister side, which every user of an e-mail address can interpret “real” in two ways: text we can interpret “real” in two ways: the sender of the message is who he or she claims to be and the content of the message is accurate. User authentication (prov- ing who we are who we say we are) is a major challenge and is vulnerable to attack. It is easy to create an alias and use it to send e-mail. As more and more of our communications and transactions are conducted electronically, it will be increasingly important to be sure that the content of a message is accurate. An e-mail virus hoax can play as much havoc and be as dis-ruptive as a “real” virus. Just like the viewer of a sketch three centuries ago, we will be able to distinguish what is real from what is not.

Microsoft Corporation, and the “Nintendo” generation by how they view the world. To them, technology itself is a body of facts accumulated in a time frame, with the half-life of information being measured in months and years. From this perspective, what a person can do is more important than what they have obtained. (Bill Gates, a college dropout, is an icon for many in the information age.) As our students enter the work-force, the ability to deal with complex and often ambiguous information will be more important than simply knowing a lot of facts or having an accumulation of knowledge.

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they approach a new software package. Do they check out the menus and manual first, or do they begin typing and then search for what they want whenever they need it?

This observation leads to an entire set of difficult questions: How does trial-and-error apply to identifying trends and penetrating inconsistent data? What happens when students can’t derive “the answer” from trial-and-error? Are they prepared to engage in more in-depth analysis? What are the implications of such a risk-adverse perspective toward events in general? Does this attitude transfer to other situations?

Trial-and-error learning may provide a more thorough understanding of a market, but what are the implications. However, it should not be the only approach used. A balance is needed between didactic and discovery approaches.

Multitasking Way of Life

Many young people today are accustomed to watching TV, talking on the phone, doing homework, eating, and interacting with their parents all at the same time. There is no concentration on one activity at a time. When I was a kid (don’t you hate that phrase?), if we didn’t like what was on TV, we had our choice of two or maybe three other channels. Today there are dozens or hundreds of channels, depending on the provider. If we don’t like the web site, we click to another. Our students have an exposure, albeit very thin, to a breadth of places, ideas, and cultures that previously only appeared in the mid-twentieth and outstanding “writers?” prefer keyboards to graphite, and why shouldn’t they? We installed our first home computer in 1985, and they “typed” everything from then on. The hundreds of hours my generation spent practicing penmanship were spent by our children at the keyboard. And maybe even more important, typed prose is always easy to read, even weeks after being typed; it can be checked for spelling errors, searched for key words, retrieved after filing, and easily manipulated for reuse.

But the power of the word-processing package goes well beyond simple improvements in legibility, spelling, and filing. Word-processing holds the power to easily manipulate the data—the words—to obtain a significantly better output. In many ways it becomes an extension of our own memories, enabling us to capture and retain material for use in more critical problem-solving and decision-making situations. For example, I could never compose at the typewriter (I’m definitely not a linear thinker). However, I can bounce all over the screen with a word processor. I can put down an idea, expand it, take it apart, and then reassemble it in a more meaningful way. Similarly, spreadsheet applications enable us to create models to evaluate situations, solve problems, and make decisions. It’s not the “typing” but the power behind the “typing” that is so important today.

Typing Rather Than Handwriting

A mother recently gave her high-school-age son a gift from his grandmother and asked him to write a thank-you note. He said he would type it. She said, “No, it’s not as nice, as possible hand-write it.” (This represents an industrial-age mindset clashing with an information-age mindset.) When she pressed him a couple of days later, he said, “Mom, I don’t know how to write.” Listening to this story, I realized that my children (both in their mid-twenties and outstanding “writers?”) prefer keyboards to graphite, and why shouldn’t they? We installed our first home computer in 1985, and they “typed” everything from then on. The hundreds of hours my generation spent practicing penmanship were spent by our children at the keyboard. And maybe even more important, typed prose is always easy to read, even weeks after being typed; it can be checked for spelling errors, searched for key words, retrieved after filing, and easily manipulated for reuse.

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Judy Estrin
Technology visionary Judy Estrin, chief executive officer of Packet Design, Inc., a company focused on technologies to scale the Internet, until recently was chief technology officer and senior vice president for Cisco Systems. She co-founded Bridge Communications Systems, a pioneer in internetwork routers, bridges, and communications servers. She is a member of NAI in 1987.

David Halberstam
Through his trilogy on power in America, David Halberstam, Pulitzer Prize-winning author of The Best and the Brightest, The Powers That Be, and The Reckoning, has helped shape our understanding of the latter half of the 20th Century more than any other contemporary author.

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a more fundamental change in concepts of distance and location. Living in a fully connected world means that individuals can participate in real-time dialogues from anywhere, at any time, communicating using beepers, telephones, the Net, chat rooms, and teleconferencing. Where one works or studies—in the classroom, in the office, in the home, in a library, or on the road—will be determined by pedagogical, social, motivational, or biological factors, not by yesterday’s synchronous constraints.

**Zero Tolerance for Delays**

It is human nature to want the immediate gratification of our desires, not just physical but informational as well. Having grown up with automatic teller machines, information-age students expect banking services 24X7. We’re all vulnerable to this desire for immediacy. Where one works or studies—in the commercial sector, in the educational, or by biological factors, not by yes—no, we’re not going to respond, both in terms of acknowledgment and content, in real time. People apologize for not responding to e-mail immediately. They feel compelled to answer questions and provide information, often without taking adequate time to think through the consequences of their actions. The whole concept of time (and time compression) has changed dramatically. When one speaks of an Internet year like a “dog year” (i.e., one human year is equivalent to seven dog or Internet years), this is time compression at light speed. Voice mail and e-mail are more efficient and less formal, which implies “I want a quick response.” On the other hand, they create time-expansion capabilities. We can store and retrieve messages until we’re ready to reply, which also implies “at your convenience.”

**Consumer/Creator Blurring**

When one of my students wrote a term paper in the late 1980s, she typed some material into the computer directly from an encyclopedia. When I told her that one of these days we would have the encyclopedia on a disk, she replied, “Do you mean I could then just cut and paste?” The updated version of this timeless story occurred in my class this past year when a student asked, “Rather than rewrite what I’ve found on a Web site, can I just put in the link and you can read the original?” These situations are clearly the forerunner of the current MP3 fiasco. In today’s parlance, there is no distinction between the owner, the creator, and the user of information. Web protocols are such that if you see something you like, you just cut and paste it from the Web page. After all, the tools for doing this are built into the Web editors. The entire structure of HTML supports this sharing/borrowing/taking (dare I say “stealing”?) of others’ intellectual property. In the physical world, dual-cassette recorders make copying an audio- or videotape easy. Why should copying a CD, a computer application program, or material from an encyclopedia be any different?

There is an interesting twist to this concept in the commercial world of computer programs. A common practice of software vendors is to release a product that is known to be “buggy” and have the users “de-bug” it (by calling it a “beta-test version”). The open-source movement blurs the creator/user relationship even more by formally extending the development process to the entire programming community.

**So What Does All This Mean for Higher Education?**

Given the mix of new attitudes and behaviors—the information-age mindset—what should we as individual educators, and collectively in our institutions, do (if anything)? I would like to answer this question by sharing a vision for higher education. In this vision, we will combine the potential of computer, communication, and information technologies with the pedagogical changes that need to occur in light of the prevalence of the information-age mindset.

To develop the vision, I would like to draw on an important lesson from the commercial sector. During the 1970s and the early 1980s, the business world experienced an interesting paradox: companies that invested heavily in information technology went out of business at about the same rate as those that did not invest in information technology at all. Those that did not invest were as successful as those that did invest. How could this be explained?

The research findings are very revealing. As computer, communication, and information technologies entered businesses, companies concentrated their initial investments on gaining efficiencies with traditional processes. For example, companies replaced bookkeeping clerks with computerized accounting systems and replaced stock clerks with automated inventory systems. But these investments had no positive impact on the bottom line. By the late 1980s, however, a few major breakthroughs not only yielded a positive return on information technology investments but previewed the changing dynamic that has since swept the entire business world. A couple of pioneering successes were American Airlines’ frequent flyer program and American Hospital Systems’ customer-controlled inventory management system. In each case, the value added came from changing the nature of the relationship between the company and its customers. The company no longer did things differently but did different things. The focus of these programs was external effectiveness rather than internal efficiency. They created new partnerships between their organizations and their customers. They changed the rules of transaction from mass marketing to one-to-one marketing and from mass production to mass customization. These changes are being reflected in every business today: for any company to compete, it must be willing to challenge everything that has gone before and to completely rethink the relationship between the company and its customers—to reconsider its customer services, its organizational structure, and its business processes.

Higher education is experiencing a similar paradox. If teachers continue to teach in the same way that they have always taught, there will be little value added from classroom and campus networks. If students approach learning in

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the same way that they always have, computer labs and laptop programs will be unnecessary expenses. Until the nature of the educational relationships change in the classroom and at the institutional level, we will not realize the full value of the computer, communication, and information technology investments that we are making today. We need to think in terms of transforming the educational experience so that it is meaningful to the information-age learner.

This conceptual change must embrace a substantial modification in the nature of the relationship between the student and education and, therefore, between the student and the institution. Let me give an analogy. University computer networks today consist of nodes at every office, classroom, and library seat. But this network concept can be expanded. We need to build an extended educational infrastructure that parallels our physical network infrastructure. When viewed from the perspective of a human network—a community of lifelong learners—the educational infrastructure becomes a means for broadening and deepening the educational experience of students and for enhancing and extending the educational experience of alumni. Each of our current and past (and future?) students is a “node.”

Baccalaureate students spend about four years on campus and then perhaps another forty years or so in their various occupations. So for less than 10 percent of their student and professional life, they are in direct, physical contact with our schools. But throughout their entire career, they can benefit from that 10 percent of time on campus. From this perspective, one goal of higher education is to “learn” (memorize) and repeat back in some format. Evolving educational techniques, such as the studio approach to learning mathematics and writing, have shifted the emphasis away from faculty-centered lectures to cluster learning environments intensely supported by computer, communication, and information technologies. The use of e-mail dialogues for students in basic language classes forces real-time use of the language, greatly enhancing students’ acquisition of language skills.

Field-based research projects, which include peer-review components (analogous to faculty peer-review processes) before “publishing” on the Web, force students to engage real-time data from a comprehensive multidisciplinary perspective. This is not to say that we should replace all our current practices with something new (“new” meaning different, not better). There will always be a role for the lecture format, and there are learning situations in which computer use is totally inappropriate. The goal must be to match the appropriate use of technology with the content, the instructor’s personal style, and the students’ learning style.

The outlook of those we teach has changed, and thus the way in which we teach must change. The world in which we all live has changed, and thus the content we teach must change. The industrial age has become the information age, and thus the way we organize our institutions must change, as must the meaning we attach to the terms “student,” “teacher,” and “alumni.” The challenge will be for educators and higher education institutions to incorporate the information-age mindset of today’s learners into our programs so as to create communities of lifelong learners.

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Notes

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1. I recognize that these are broad generalizations, not all of which apply to each individual.
3. I remember getting our first television when I was thirteen, so for me, television was a technology by Kay’s criterion.
4. E-mail correspondence with Professor Joel Cull, Oc- tober 10, 1996.
5. Bill Weiglhotlz, keynote speaker, AACSB annual meeting, Atlanta, Georgia, April 1999.
6. Even for those disciplines for which the half-life of information is longer, students’ information-age mindset requires change in traditional perspectives.
8. The institutions of education and commerce are dif- ferent, and there are very good reasons for not asking for a “business case” when undertaking educational or research projects. However, that doesn’t mean that our educational institutions cannot learn from the commercial sector.