

Santa Cruz Remarks

Introduction

The Santa Cruz dream

UCSD was “the most significant educational experiment in the history of UC”. Original ideas goes back to the ancient Greeks, the Academy of Plato and the Lyceum of Aristotle: a place for high-level contemplation and discussion of the human experience in its manifold complexities, among small groups of teachers and students.

Kerr: “an opportunity to start fresh, to create neoclassical colleges within a multiversity”.

McHenry: “a big UCLA with a series of small Swarthmores inside it.”

(Obtaining the advantages both of large scale and small scale.)

Create smaller, face-to-face communities of faculties and students and to make greater intellectual contact across disciplinary specializations to encourage broader general learning experiences for both students and faculty.

Clark Kerr

JJD ties

Yale- Saybrook

Charles Moore

(also Caltech, Bob Sinsheimer, Karl Pister)

Focus of remarks

Implications of technology for UG education

FITRU Project

Background

As knowledge-intensive social institutions, colleges and universities will be particularly affected by the rapid evolution of digital technology. Further, if past experience is any guide, the impact of this technology on the

university and the consequence changes in its activities, structure, and environment, changes are likely to be rapid, profound, and discontinuous. The future of the university will be characterized by ever greater uncertainty.

True that from some perspectives, the university has changed remarkably little in values, roles, structure, and function over the past several decades--indeed, over the past several centuries, at least compared to most other social institutions.

But we should not delude ourselves into thinking that higher education will be unperturbed by the transforming character of digital technology. After all, even the most pronounced exponential change starts off on a very modest slope.

It was from this perspective that three years ago the presidents of our National Academies launched a project to understand better the implications of information technology for the future of the research university, and project that

The premise of the National Academies study was a simple one:

The rapid evolution of digital technology will present many challenges and opportunities to higher education in general and the research university in particular. Yet there is a sense that many of the most significant issues are neither well recognized nor understood either by leaders of our universities or those who support and depend upon their activities.

Conclusion of first phase:

Beyond the insight brought by these participants, perhaps even more striking was their agreement on a number of key issues that frame the content of my remarks this morning.

Point 1: The extraordinary evolutionary pace of information technology will not only continue for the foreseeable

future, but it could well accelerate on a superexponential slope.

Digital technology is characterized by an exponential pace of evolution (Moore's Law) in which characteristics such as computing speed, memory, and network transmission speeds for a given price increase by a factor of 100 to 1000 every decade.

Put another way, over the next decade, we will evolve from "giga" technology (in terms of computer operations per second, storage, or data transmission rates) to "tera" and then to "peta" technology (one million-billion or 10^{15}).

For planning purposes, we can assume that within the decade we will have infinite bandwidth and infinite processing power (at least compared to current capabilities).

We will evolve from "e-commerce" and "e-government" and "e-learning" to "e-everything", since digital devices will increasingly become our primary interfaces not only with our environment but with other people, groups, and social institutions.

Point 2: The impact of information technology on the university will likely be *profound, rapid, and discontinuous*—just as it has been and will continue to be for the economy, our society, and our social institutions (e.g., corporations, governments, and learning institutions).

In the words of Clayton Christensen, it is a "disruptive technology".

It will affect our activities (teaching, research, outreach), our organizations (academic structure, faculty culture, financing and management), and the broader higher education enterprise.

For at least the near term, meaning a decade or less, we believe the university will

continue to exist in much its present form, although meeting the challenge of emerging competitors in the marketplace will demand significant changes in how we teach, how we conduct scholarship, and how our institutions are financed.

Universities must anticipate these forces, develop appropriate strategies, and make adequate investments if they are to prosper during this period.

Procrastination and inaction are the most dangerous courses for colleges and universities during a time of rapid technological change.

Point 3: It is our belief that universities should begin the development of their strategies for technology-driven change with a firm understanding of those key values, missions, and roles that should be protected and preserved during a time of transformation.

They should begin by addressing the most fundamental questions:

For example, how should the research university set priorities among its various roles such as education of the young, preservation of culture, basic research and scholarship, serving as a social critic, and applying knowledge to serve society?

Which of its values and principles should be preserved, and which should be reconsidered, e.g.,

academic freedom,
a rational spirit of inquiry,
sustaining a community of scholars,
our commitment to excellence,
shared governance, and
tenure?

How will research universities define their students and faculty?

More Recent activities

Presidents workshop
Provosts workshop
Carnegie Mellon (cognitive environment)
USC-UCLA (gaming and entertainment)

First, set aside some myths

Distance learning and disappearance of campus

It is not surprising that the early efforts to utilize digital technology in higher education simply replaced the broadcast of lectures over television with passive lecture courses distributed either on CD-ROMs or streamed from Internet websites. Although there was usually some opportunity for student interaction and feedback through e-mail or chatrooms, the pedagogy was still very much based on the transfer of knowledge in a lecture format. The aim was to use digital technology to perform ordinary tasks more efficiently, such as providing course syllabi and readings or linking students with instructors.

The real power of digital technology can only be achieved when we take advantage of the shift from the one-to-many character of broadcast media to the many-to-many ability of digital networks. To this end, the most productive early applications of digital technology in higher education involved using computer conferencing, electronic mail, list-serves (threaded discussions), and other computer-based collaboration technology to link together both students and faculty in highly interactive learning communities, unconstrained by geographical location or time.

The most significant advantage of such computer-mediated learning is access, the degree to which it frees learning opportunities from the constraints of space and time. It is understandable why the convenience of anytime-anyplace learning technologies is important to adult learners whose work or family obligations limit access to the residential college experience. But an increasing number of on-campus students now use online learning to augment their classroom experiences, since they too seek both the convenience and the learning resources provided through the Internet.

In this sense, then, we should substitute “distributed” for “distance” learning, since the powerful new tools provided by information technology have the capacity to enrich all of education, stimulating us to rethink education from the perspective of the learner. The rich resources and new forms of social interaction enabled by information technology create the possibility of the objective of “better than being there” for distributed learning environments. Imagine, for instance, conducting a course on the public health implications of AIDs with the online participation of students from African countries. Or a course in archeology augmented by virtual reality tours of various excavation sites around the world.

The attractiveness of such computer networked based resources is obvious for adult learners whose work or family obligations prevent attendance at conventional campuses.¹ But perhaps more surprising is the degree to which many on-campus students are now using computer-mediated distance education to augment their traditional education. Broadband digital networks can be used to enhance the multimedia capacity of hundreds of classrooms across campus and link them with campus residence halls and libraries. Electronic mail, teleconferencing, and collaboration technology is transforming our institutions from hierarchical, static organizations to networks of more dynamic and egalitarian communities.

Commercialization?

Some of the world's leading universities are also learning what happens when the promise of these digital technologies is misjudged, leading to risky investments that fail to deliver the expected dividends. A decade ago, the promise of e-learning seemed irresistible—faculty would teach differently, students would learn at their own pace and in their own way, electronic learning would make a university education available to everyone by offering electronic instruction any-time-any-where. Respected agencies predicted the rapid expansion of the market for e-learning to embrace millions of students and billions of dollars. Universities would be able to replenish their coffers from the profits their new e-learning enterprises earned. And, to be sure, efforts such as the Sloan Foundation's Asynchronous Learning Network project and Carnegie Mellon University's cognitive tutor software demonstrated that such technology could create effective learning environments.

With that level of market anticipation at hand, a uniquely American stampede toward exploiting the commercial potential of instructional technology was ensured. Columbia University launched Fathom; New York University nearly matched those efforts with NYU.online. Cardean University became the model of a for-profit/not-for-profit collaboration in which some of this country's and Europe's best known universities partnered with Unext to launch a high cost-high prestige program of international business education. Individual states made similar investments, choosing to focus instead on providing low-cost, but ready access to the educational assets already available on publicly funded university campuses. California's brief fling with its own electronic university and the better known Western Governors University were probably the two best known examples, though efforts in Massachusetts, Maryland, and Michigan in the end demonstrated more staying power.

Not surprisingly, perhaps, the reality never matched the promise. There has been no pedagogical revolution—most faculty who use the new technologies have not changed how or what they teach. Most of the commercial e-learning enterprises founded by major universities have closed. There has been no real burgeoning of distance education—the limited number of successes owe more to their past market triumphs—as in the case of both University of Maryland's University College and the University of Phoenix—than to the effectiveness of the new technologies.

Through it all, the new educational technologies have retained a core of true believers who argue, still forcefully and at times persuasively, that a revolution is

at hand—that the computer will do for learning today what printing did for scholarship in the 15th century. Don't be fooled by the failures and false steps, they proclaim, the best is yet to come. More quiet and also more numerous are the pragmatists in the middle. They point out that *e-learning* is alive and well and has in fact spurred a host of important educational changes probably best symbolized by the wide spread adoption of course management tools like Black Board and WebCT. Money is being spent, smart classrooms are being built everywhere, and university faculty are successfully integrating electronically mediated learning into literally thousands of courses focusing on both traditional and non-traditional subjects.

What is clear is that the story is still unfolding. The underlying information technologies on which *e-learning* depends are themselves too ubiquitous and the people attracted to having them serve as learning platforms are too smart for universities not to take seriously the prospect that major changes will flow from their efforts. The best guess is that the decade ahead will be one of continued experimentation as universities and their faculties get better at anticipating how the new technologies will impact their basic operations, both within and without the classroom. The danger is that universities will be inclined to delay, deciding to wait and see how e-learning involves before making further investments.

Open source movement

The New Literacy

Media

Elizabeth Daley has made a convincing case for rethinking the nature of literacy in a world increasingly shaped by digital technology.

Literacy was read-only until the 20th Century. Composition is a very recent skill. Literacy used to be oral, rhetoric.

Forms of communication

- From literacy in the oral tradition
- To the written word
- To the images of film and then television
- To the computer and multimedia

The new literacy, demanding not only critical viewing but composition.

What is new with the new media?

What is the impact of the new literacy for the university?

THE FUTURE

Yet why stop here?

The media of communication are continuing to evolve, from the single dimension of text to the two-dimensional world of graphics to the three-dimensional world of simulation and role-playing. With virtual reality, it is likely that we will soon communicate with one another through simulated environments, through “telepresence,” perhaps guiding our own software representations, our digital agents, to interact in a virtual world with those of our colleagues.

As William Wulf puts it, “Don’t think about today’s teleconference technology, but one whose fidelity is photographic and 3-D. Don’t think about the awkward way in which we access information on the network, but about a system in which the entire world’s library is as accessible as a laptop computer. Don’t think about the clumsy interface with computers, but one that is both high fidelity and intelligent.”ⁱⁱ It is only a matter of time before information technology will allow human interaction with essentially any degree of fidelity we wish--3-D, multimedia, telepresence. Eventually, we will reach a threshold of fidelity sufficient to allow distance education (and most other human activities) that will be comparable to face-to-face interaction.

This is a very important point. A communications technology that increases in power by 100 to 1000-fold decade after decade will soon allow human interaction with essentially any degree of fidelity we wish--3-D, multimedia, telepresence, perhaps using neural implants to directly link our minds into cyberspace, a merging of carbon and silicon.

Perhaps William Gibson has it right in his *Neuromancer* trilogy, with the ultimate multimedia as “sim-stim”, simulated stimulated, in which neural implants allow the simulated stimulation of all of the senses both as the medium of communication and entertainment.

But wait a minute, there are many other forms of literacy

Art, poetry, mathematics, (science itself)...

But there is something deeper here. The university has survived other periods of technology-driven social change with its basic structure and activities intact.

But the changes driven by evolving information technology are different, since they affect the very nature of the fundamental activities of the university: creating, preserving, integrating, transmitting, and applying knowledge. More fundamentally, because information technology changes the relationship between people and knowledge, it is likely to reshape in profound ways knowledge-based institutions such as the university.

Creativity

The professions that have dominated the late twentieth century—and to some degree, the late-twentieth century university—have been those that manage knowledge and wealth, professions such as law, business, and politics. Yet today there are signs that our society is increasingly valuing those activities that actually create new knowledge and wealth, professions such as art, music, architecture, and engineering. Perhaps the university of the twentieth century will also shift its intellectual focus and priority from the preservation or transmission of knowledge to the process of creation itself. After all, the tools of creation are expanding rapidly in both scope and power. Today, we have the capacity literally to create objects atom by atom. We are developing the capacity to create new life-forms through the tools of molecular biology and genetic engineering. And we are now creating new intellectual life-forms through artificial intelligence and virtual reality.

The university may need to reorganize itself quite differently, stressing forms of pedagogy and extracurricular experiences to nurture and teach the art and skill of creation. This would probably imply a shift away from highly specialized disciplines and degree programs to programs placing more emphasis on integrating knowledge. Universities might form strategic alliances with other groups, organizations, or institutions in our society whose activities are characterized by great creativity, for example, the art world, the entertainment industry, or even Madison Avenue.

But herein lies a great challenge. While we are experienced in teaching the skills of analysis, we have far less understanding of the intellectual activities associated with creativity. In fact, the current disciplinary culture of our campuses sometimes discriminates against those who are truly creative, those who do not fit well into our stereotypes of students and faculty.

Constructionist learning

What is new with the new media?

- Active, not passive
- Not just learning, but creating knowledge
- Play becomes important
- Collaborative
- Multitasking
- Bricolage

John Dewey to Marie Montessori to Jean Piaget to Seymour Papert!

- Constructionist learning
- Discovery (inquiry) based learning
- Work becomes play
- And Learning becomes RESEARCH!!!

Chinese proverb:

I hear and I forget.
I see and I remember.
I do and I understand.

Idit Harel (MaMaMedia)

The new media will shift us from the 3R's to the 3X's:

The fundamental new media literacy skills we must foster in children are the three Xs, exploring, expressing, and exchanging ideas with new digital media.

Today, computers and the Internet are not just about information. Rather they offer young children an expanded toolbox for creating, as well as expanded opportunities for saving and sharing ideas and projects. This, in turn, offers more opportunities for playful, meaningful learning through design and through the creative use of technology.

The best learning does not happen by guessing right or wrong. Children learn best, indeed we all learn best, through the process of learning by doing. When learners (in all ages and stages) engage in playful exploration in which they actively plan, design, and build their own projects, try out ideas, and tinker with notions—their own and those of others.

As new information and methods of learning with new media technology are emerging, it is even difficult to differentiate between teachers, parents, and students when it comes to asking who is doing the learning and who is teaching, who is in control and who is confused and overwhelmed.

A problem: We didn't grow up with technology, and so we often don't know how to do teaching or parenting with new media technology. It took thousands of years for us to understand the importance of reading and writing and literacy. It is hard to fully understand the importance of new media literacy skills that are less than a few decades old.

Suppose we were able to use IT to essentially shift the paradigm of undergraduate learning in the research university from the lecture format of the classroom to the discovery environment of the research activity or the experiential environment of professional schools. There is ample evidence that "inquiry" or "discovery-based learning" is felt to be far more effective anyway than classroom lectures. Furthermore, this approach not only appeals directly to the research interests of faculty but it could involve the human resources represented by graduate research assistants and teaching assistants not only to provide technical support but moreover leverage the faculty member's time. Utilizing graduate student assistants and software automation, we might be able to actually scale this approach to size of the undergraduate programs at most research universities.

The New Students

Yet, to date, there has been relatively little attention given to the way that information technology might reshape the cognitive process of learning. Furthermore, few seem to recognize that information technology may break the long accepted linkage between economic measures such as expenditure-per-student or students-per-faculty and educational quality. There seems limited awareness of just how different a generation of students raised in a world of interactive electronic media are from their parents—and their teachers.

PARC studies: Plug and Play generation

The traditional classroom paradigm is being challenged today, not so much by professors, who have by and large optimized their teaching effort and their time commitments to a lecture format, but by our students. Members of today's digital generation of students have spent their early lives immersed in robust, visual, electronic media--Sesame Street, MTV, home computers, video games, cyberspace networks, MUDs and MOOS, and virtual reality. Unlike those of us who were raised in an era of passive, broadcast media such as radio and television, today's students expect--indeed, demand--interaction. They approach learning as a "plug-and-play" experience. They are unaccustomed and unwilling to learn sequentially--to read the manual. Instead they are inclined to plunge in and learn through participation and experimentation. Although this type of learning is far different from the sequential, pyramidal approach of the traditional college curriculum, it may be far more effective for this generation, particularly when provided through a media-rich environment.

John Seely Brown and his colleagues at Xerox PARC have studied the learning habits of the plug-and-play generation and identified several interesting characteristics of their learning process.ⁱⁱⁱ First, today's students like to do several things at once--they "multitask", performing several tasks simultaneously at a computer such as website browsing and e-mail while listening to music or talking on a cellular phone. Although their attention span appears short, as they jump from one activity to another, they appear to learn just as effectively as earlier generations. Furthermore, it is clear that they have mastered a broader range of literacy skills, augmenting traditional verbal communication skills with visual images and hypertext links. They are particularly adept at navigating through complex arrays of information, acquiring the knowledge resources they seek and building sophisticated networks of learning resources. Some observers suggest that this may lead to problems later in life as the digital generation sacrifices qualities such as patience and tranquility. But, of course, patience and tranquility have never been characteristics of the young. Asked about their elders concerns, the typical response of the digital generation is: "Get over it!"^{iv}

Indeed, there is even research that suggests the presence of a physiological difference between the brains of the "digital generation" and those of us from 20th Century generations.^v More specifically, it has been known that early exposure of infants and young children to various stimulation can actually affect their neurological

development--the evolution of their neural networks. Children raised in a media-rich, interactive environment tend to think and learn differently because they are physiologically different from us. Their brains are wired in different ways. Our styles of learning are not theirs.

This type of discovery-based learning approaches the bricolage concept suggested by Levi-Strauss, in which the learner develops the ability to find tools or resources to address a practical need.^{vi} It combines knowledge navigation, discovery, and judgment in a highly sophisticated way, supported both by technology (computer networks) and social skills (learning communities).

Today's students are different from earlier generations. They are citizens of the digital age. Unlike earlier generations, numbed into passive submission by the vast wasteland of broadcast media, the members of the digital generation are accustomed to reading, analyzing, authenticating, contextualizing, separating useful information from junk, composing their thoughts, criticizing, and building and navigating through complex knowledge webs. They are curious, self-reliant, contrarian, focused, able to adapt, and technology savvy. They learn by experimentation and participation, not by listening or reading passively. They take no one's word for anything. Rather they embrace interactivity, the right to shape and participate in their learning. They are comfortable with the uncertainty that characterizes their change-driven world.^{vii}

To be sure, for a time, such students may tolerate the linear, sequential lecture paradigm of the traditional college curriculum. They still read what we assign, write the required term papers, and pass our exams. But this is decidedly not the way they learn. They learn in a highly nonlinear fashion, by skipping from beginning to end and then back again, and by building peer groups of learners, by developing sophisticated learning networks in cyberspace. In a very real sense, they build their own learning environments that enable interactive, collaborative learning, whether we recognize and accommodate this or not.

However, their tolerance for the traditional classroom and four-year curriculum model may not last long. Students will increasingly demand new learning paradigms more suited to their learning styles and more appropriate to prepare them for a lifetime of learning and change. There are already signs that the entire classroom experience--that is, the transmission of knowledge content associated with courses--may soon be packaged through electronic media as a commodity and distributed to mass markets, much like today's textbooks. What will happen the first time a student walks into the dean's office and states: "I have just passed all of your exams after taking the Microsoft Virtual Physics course, developed by three Nobel laureates, rather than suffering through your dismal classes taught by foreign graduate teaching assistants. I now want you to give me academic credits toward my degree!"

One can imagine the impact of millions of students from the digital generation as they seek the interactive, collaborative, and convenient learning experiences they have already experienced from other digital media. We should not underestimate the impact of the plug-and-play generation on the university. After all, their use of digital technologies such as Napster and other peer-to-peer applications quickly overloaded our IT infrastructures and threatened the recording industry. Their use of the Net and other digital resources is already far more sophisticated than most faculty and staff. They will

drive rapid and profound change in higher education since they will demand that we adapt the university to their learning needs and characteristics through market forces.

The new interactive resources provided by emerging information technology represent the wave of the future for our society. As our knowledge base expands, isolated individuals will increasingly lose their ability to know everything they need to grapple with complex challenges. We must equip our students with the ability to exploit these new technologies. They must learn the difficult art of communicating across disciplinary and cultural differences in the pursuit of common goals, discovering which collaborative tools serve us best for our different purposes. The new literacy enabled by digital technologies is rapidly becoming an essential skill in a knowledge-driven society and a responsibility of higher education.

The reality of our new students, diverse and often technically savvy, requires new educational approaches. Encouragingly, our growing base of technology has begun to create the possibility of new, more flexible roles for both students and faculty, within and beyond the classroom. Richard Lanham calls the social, technological, and theoretical challenges that these changes create an “extraordinary convergence,” catalyzing fundamental shifts in higher education, allowing more interactive learning, and giving students the ability to interrogate or even create knowledge instead of simply absorbing it.^{viii}

Carnegie Mellon Experience

Furthermore, beyond a very limited use of technology, few faculty members utilize or are even aware of the rapidly expanding scientific basis for learning from neuroscience and cognitive psychology. One of our colleagues observed that if doctors used science the way that college teachers do, they would still be trying to treat disease with leeches.

Students these days are "electrified". They are a transformative force. CMU simply reacts to this. (Uses instant messaging as an example. Developed their own cryptic language.)

Herb Simon: Humans are serial, not parallel thinkers. Multitasking degrades quality of each task. Human bandwidth is limited, regardless of data rate. How can we structure the learning environment to recognize human limitations yet take advantage of technology. The bottleneck is the human mind.

Communication: From e-mail to instant messaging to Weblogs. IT is "democratizing" access to scientific resources. IT tools increase both the quantity and the volume. We should be careful in evaluating the quality of the new forms of communication.

Not yet a consensus on where we are headed, but there is agreement that IT is changing things. What do we actually know and how can we learn it?

Stresses the importance of assessment to see what students are actually learning. Formal assessment is essential. Helps both students to know where they are and faculty how to adapt.

Interesting discussion on how students can teach one another very complex subjects (quantum tunneling as an example).

"Expert blind spot"--instructors are usually the worst people to assess learning. "The student is not like me!"

What about the interplay between formal and informal learning? All students learn differently. This is more easily handled through informal experiences.

Kevin Kelly: Students are using instant messaging and googling. THEY will determine which learning technologies work best. "A billion headed student beast", with the faculty running behind to formalize what the students have developed.

Perhaps the best approach is to turn the students loose, to let informal learning lead and shape formal learning.

Two tasks:

- i) structuring a learning environment
- ii) structuring how students learn

The faculty can do the first, but it may no longer have the ability to do the second. We should free students to pick the learning tools that help them learn the best! We should NOT constrain their choices.

We are building a global knowledge network that students must learn how to use. This is revolutionary!!!

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Mike Smith comes back to the question of what we know in a deep way about what it really happening. Some discussion about using technology to shift away from mass education to tutorial/research/professional practice education.

Back to a discussion of assessment. Universities really don't spend much effort trying to understand (and improve) what they are doing. We need to focus more on this.

There is also a gap between what we know from cognitive science and what we are actually applying. Some success with SOAR, etc. Attempting to do some measurement, e.g., tutoring vs the classroom yields a 2 standard deviation advantage, while cognitive tutor vs classroom yields a 1 standard deviation.

What technologies are really changing things:

- e-mail
- instant messaging
- weblogs
- constant connection (always on)

People are changing work habits to adapt. Also social software such as Friendster.

What about gaming? Certainly for some younger students. (Male-dominated? 60% of Sim Online is women, a lag not a gap.) Primary function of online gaming is for social interaction, socialization. The technology provides different ways to interact socially. IT is having its most effect on social interaction, in work and play. Solitary activities are not so affected, but community activities are being reshaped. People are learning how to balance this.

Why is this important to us? Because this is another form of community. Universities are intrinsically communities. IT is useful to the degree it supports learning, knowledge generating communities.

What is next? Cyberinfrastructure that becomes functionally complete for specific knowledge communities. A merger of the real and virtual world. "Better than being there" experiences.

Do we need to think more systemically about "learning ecologies" that respond, adapt, and evolve? Is there any point at this early stage to begin to consider more comprehensive strategies? (Several believe absolutely!)

Key for institutions to provide a rich infrastructure where these ecologies can grow. Don't depend on the faculty to do this, however.

Unknowns (importance of rigorous assessment)

The New Realities

Challenge of a global knowledge economy

Outsourcing

Lifelong learning

Perhaps part of our difficulty in reconceptualizing the college experience is that we still tend to think of the baccalaureate degree as a well-defined learning experience that prepares a student for life. But today learning has become a lifelong activity. Today's students will need to continue to learn, through both formal and informal methods, throughout their lives.

Of course, a college education was never intended to provide all of the knowledge needed for a lifetime. But in years past, most of the additional knowledge necessary for a career could be acquired informally, through on the job learning or self-study. Today, however, both rapid growth of knowledge and the multiple career transitions facing graduates demand a more strategic approach to lifetime learning. We need to rethink educational goals from this lifetime perspective. We should view undergraduate education as just one step--an important step to be sure--down the road of a lifetime of learning. This would allow us to better match learning content and experiences with both the intellectual maturation and the needs of the learner.

In a world driven by knowledge, learning can no longer be regarded as a once-is-enough or on-again/off-again experience. People will need to engage in continual learning in order to keep their knowledge base and skills up to date. Given this need, the relationship between a student/graduate and the university may similarly change. Just as we have suggested that the word *student* is no longer appropriate to describe an active learner, perhaps the distinction between student and *alumnus* is no longer relevant.

Perhaps the relationship between a university and its graduates that is more appropriate for our future is conveyed by the term *lifelong member of a learning community*. Perhaps enrollment should be viewed less as participation in a particular degree program and instead as a lifetime contract with the university, in which the university agrees to provide whatever learning resources are required by its learners or members throughout their life, whatever, whenever, and wherever their educational needs. Clearly, the rapid evolution of distance learning technology will increasingly facilitate this. We also see increasing interest on the part of alumni in remaining connected to their university and to learning opportunities throughout their lives.

The New Imperatives for Undergraduate Education Student to learner (to consumer?)

Students already make extensive use of digital technology for informal learning, typically without the involvement or even the awareness of the faculty. They build study groups, in some cases spanning several academic institutions, working together to seek information, answer questions, and develop learning skills. In a very real sense, such study groups based on computer networks are providing students with greater control over their educational experiences. They also represent a trend in which students construct their own consortia of learning resources—and academic institutions—just as the faculty build their own research consortia. And, of course, these network-based student groups represent an important step toward active student learning. (In fact, when students are asked how they could best spend time on their college academic programs, they invariably rank student study groups at the very top, far above individual study or class attendance.)

Even more important, it stimulates students to become more actively involved in the learning process, with the potential to significantly transform the way that learning occurs in the university, enabling the faculty to design and implement learning processes and environments that are far more effective than the traditional classroom lecture based paradigm. Computer based simulations and roll-playing exercises give students hands on experiences in any subject. Networks provide ready access both to vast knowledge resources as well as original materials. The flexibility of network-based communication allows faculty members to tailor teaching styles to each student's needs, shifting the faculty member's role from a source of information to a supervisor or coach of the learning process. But perhaps most significantly of all, it has moved the consideration of learning once again to center-stage in higher education, even in those research universities long dominated by concerns of scholarship rather than teaching.

The Role of the faculty

Shift from lecturer model to learning model. Technology makes this possible by empowering the learner. Faculty should determine learning objectives and organizing content. Increasingly, however, students will be involved in creating the learning environment.

The new knowledge media may fundamentally change what it means to be a professor and a student at our universities. Faculty members may soon become more like coaches or consultants than didactic teachers, designing learning experiences and providing skills instead of imparting specific content. Even our introductory courses may take on a form now reserved for only the most advanced seminar classes, thereby allowing more personal interaction. Not only do these new technologies create educational opportunities; they also represent the literacy of our future. The medium of intellectual communication is in the process of evolving from the journal article to more comprehensive multi-media and even interactive documents. These shifts portend vast changes in the ways information is manipulated and interaction is structured in our society. Universities cannot call themselves successful unless they provide students with

the fundamental skills they will require as they enter the world of the twenty-first century.

In these new learning paradigms, the word *student* becomes largely obsolete, because it describes the passive role of absorbing content selected and conveyed by teachers. Instead we should probably begin to refer to the clients of the twenty-first-century university as active *learners*, since they will increasingly demand responsibility for their own learning experiences and outcomes. Further, as we noted in the previous section, our students will seek less to “know about” (after all, in many ways they are more sophisticated at knowledge navigation in the digital age than their teachers) and more to “know how”. There is strong evidence that the traditional class lecture approach to college education is one of the least effective forms of learning. Studies show that the more one is involved in the learning experience, the more one learns. One such study^{ix} found that only 5% of the information content conveyed by a lecture is retained, rising to 20% when augmented by audiovisual presentations and only 30% even when demonstrations are used. In contrast, when students learn by doing, they retain 75%. When they teach others, they retain 90%!

In a similar sense, the concept of a *teacher* as one who develops and presents knowledge to largely passive students may become obsolete. Today, faculty members who have become experts in certain subfields are expected to identify the key knowledge content for a course based on their area of interest, to organize and then present the material, generally in a lecture format, in this course. Frequently, others, including graduate teaching assistants and professional staff, are assigned the role of working directly with students, helping them to learn, and providing them with guidance and counseling. In a future increasingly dominated by sophisticated educational commodities and hyperlearning experiences, the role of the faculty member will shift. In these new paradigms the role of the faculty member becomes that of nurturing and guiding active learning, not of identifying and presenting content. That is, they will be expected to inspire, motivate, manage, and coach students.

More specifically, faculty members of the twenty-first-century university will find it necessary to set aside their roles as teachers and instead become designers of learning experiences, processes, and environments. In the process, tomorrow's faculty members may have to discard the present style of solitary learning experiences, in which students tend to learn primarily on their own through reading, writing, and problem solving. Instead, they may be asked to develop collective learning experiences in which students work together and learn together, with the faculty member becoming more of a consultant or a coach than a teacher.

Rip learning out of classroom?
Learning communities are the key (JSB)

Many believe that effective computer-network-mediated learning will not be simply an Internet extension of correspondence or broadcast courses. John Seeley Brown and Paul Duguid of Xerox PARC believe that this model of the virtual university overlooks the nature of how university-based learning actually occurs.^x They suggest that

it is a mistake to think of learning as information transfer, the act of delivering knowledge to passive student receivers. Brown and Duguid see the learning process as rooted both in experience and social interaction. Learning requires the presence of communities.

This is the value of the university--to create learning communities and to introduce students into these communities. Undergraduates are introduced to communities associated with academic disciplines and professions. Graduate students and professional students are involved in more specialized communities of experience and expertise. From this perspective, one of the important roles of the university is to certify through the awarding of degrees that students have had sufficient learning experience with a variety of communities.

Once we have realized that the core competency of the university is not simply transferring knowledge, but developing it within intricate and robust networks and communities, we realize that the simple distance-learning paradigm of the virtual university is inadequate. The key is to develop computer-mediated communications and communities that are released from the constraints of space and time.

In true learning communities the distinction between teachers and students blurs. Both groups become active learners, working together to benefit each other. While this duality is commonplace at the level of graduate education, where graduate students frequently learn more about a specialized subject than their faculty advisors, it is far less common in undergraduate education. Yet, we have long known that some of the most significant learning occurs when one also serves as a teacher. Advanced undergraduates should be encouraged to assume such teaching roles, not only to other undergraduates, but even on occasion to faculty members themselves.

Such learning communities seem better aligned with how learning really occurs in a university. The classroom paradigm is usually dominated by one-way information flow from the faculty member to the student. But learning is not simply information transfer. It involves a complex array of social interactions in which the student interacts not only with the faculty member, but with other students, the environment, and possibly objects as well, for example, books! The role of the university and the faculty is to facilitate the formation of learning communities, both through formal academic programs and through social, extracurricular, and cultural activities that contribute to learning in the university. When students and faculty join such communities, they share the ideas, values, and practices that lead to learning.

Conclusion

The digital age poses many challenges and opportunities for the research university.

While the university campus as a physical place, a community of learners, and a center of culture, is likely to remain at least for the near term, the nature of its activities, organization, management, and funding are likely to change quite rapidly and dramatically.

Emerging competitors in the commercial sector could threaten our current financial models.

We will be challenged to attract and retain outstanding students and faculty members in the face of competition from institutions with superior technology environments (including the commercial sector).

The status quo will certainly be challenged by this “disruptive” technology.

Yet, while the challenges will be significant, so too will be the opportunities to enhance the important role of these institutions in our society.

University leaders should approach issues and decisions concerning information technology not as threats but rather as opportunities.

Creative, visionary leaders can tap the energy created by such threats to lead their institutions in new directions that will reinforce and enhance their most important roles and values.

They can use digital technology to help their students learn more effectively, to help their faculty members to become better teachers and scholars, to enable their institutions to better serve society.

It is our collective challenge as scholars, educators, and academic leaders to develop a strategic framework capable of understanding and shaping the impact that this extraordinary technology will have on our institutions.

Back to UCSC dream

Although we feel confident that information technology will continue its rapid evolution for the foreseeable future, it is far more difficult to predict the impact of this technology on human behavior and upon social institutions such as the university. It is important that higher education develop mechanisms to sense the changes that are being driven by information technology and to understand where these forces may drive the university. Because of the profound yet unpredictable impact of this technology, it is important that institutional strategies include : 1) the opportunity for experimentation, 2) the formation of alliances both with other academic institutions as well as with for-profit and government organizations, and 3) the development of sufficient in-house expertise among the faculty and staff to track technological trends and assess various courses of action.

In summary, for the near term (meaning a decade or less), it is likely that most colleges and universities will retain their current form, albeit with some evolution in pedagogical and scholarly activities and in organization and financing. This is the period we have addressed in this book. While change will occur, and while it is likely to be both profound and unpredictable, it will at least be understandable.

But what about the longer term, perhaps a generation from now? After all, if the pace dictated by Moore's Law continues to characterize the evolution of information technology, over the next several decades we would see the power of this technology (and related technologies such as biotechnology and nanotechnology) increase by factors of one-thousand, one-million, one-billion, and so on, likely reshaping our society and most social institutions into unrecognizable forms. The speculation concerning these longer term possibilities we must leave to futurists (and perhaps science fiction writers).

Clearly the classroom will not disappear. Nor will the residential campus experience of undergraduate education for young adults be overwhelmed by virtual universities or "edutainment." These traditional forms of pedagogy will remain valuable opportunities for learning for many in our population at certain formative times of their lives.^{xi} The university will remain a place where future leaders are shaped and educated. The broader intellectual development of the young, preparing them not simply for careers but for meaningful lives as contributing citizens, will remain a fundamental purpose of undergraduate education.

However there will be strong pressures on universities to shift away from being faculty-centered institutions in which faculty determine what to teach, whom to teach, how to teach, and where and when to teach. Instead universities will likely evolve into learner-centered institutions, in which learners have far more options and control over what, how, when, where, and with whom they learn. This should not be surprising. In our increasingly democratic, market-driven world, the concerns of individuals ... or customers ...or clients ...have become the focus of most successful organizations.

In the near term, at least, traditional models of education will coexist with new learning paradigms, providing a broader spectrum of learning opportunities in the years ahead. The transitions from student to learner, from teacher to designer/coach/consultant, and from alumnus to lifelong member of a learning community seem likely. And with these transitions and new options will come both an increasing ability and responsibility to select, design, and control the learning environment on the part of learners. The only real barrier will be the limit of human imagination brought to bear on the ways in which information technology can benefit learning.

4. For an excellent example of such virtual universities, see the website for the Michigan Virtual Automotive College at <<http://www.mvac.org>> and the article by Scott Bernato, "Big 3 U," *University Business*, September–October 1998, 20–27.

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10. Richard Lanham, *The Electronic Word: Democracy, Technology, and the Arts* (Chicago: University of Chicago Press, 1993).

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14. Gregory C. Farrington, "The New Technology and the Future of Residential Undergraduate Education," *Dancing with the Devil: Information Technology and the New Competition in Higher Education*, ed. Richard N. Katz (San Francisco: Educause and Jossey-Bass, 1998), 73–94.