

The Relationship Between Business and Higher Education: a Perspective on the 21st Century

Apple's Chairman of the Board discusses the future of three core technologies—hypermedia, simulation and artificial intelligence—and the role each will play in education. The following speech was presented to an audience of teachers almost two years ago. Its message, however, is as timely and inspirational today as we prepare for a new era.

John Sculley

We are privileged to live during an extraordinary time. It is the turning of an era. The world is in passage from the industrial age to the information age. This is a time of profound changes, in which the key economic resources in the world will no longer be capital, labor, and raw materials, but rather knowledge, individual innovators, and information.

Technologies which are emerging today will give us the ability to explore, convey, and create knowledge as never before. This has enormous implications for us as individuals, as well as for our institutions. Our colleges and universities will take on especially heavy responsibilities as we make this transition.

We have an opportunity that is given only to few generations in history. I believe that if we respond with our best creative energies, we can unleash a new Renaissance of discovery and learning.

In our global economy, we are moving from a hierarchical order to one of interdependence. Not long ago the United States stood unchallenged at the top of the world's economic hierarchy. Drawing on the consuming power of an affluent population, this country built a strong industrial base. Our manufacturing companies added value to natural resources through technological know-how. Economies of scale favored the development of large, highly structured institutions.

Today, however, we are not at the top of a pyramid, but rather one node along a network. Our once exclusive know-how is available in many newly industrialized nations, such as Korea, Taiwan, Singapore, Mexico and Brazil. What is at risk, as the United States loses

economic primacy, is not simply our own standard of living, but also the health of the world economy. The global economic system functions like a biological ecosystem. An unbalance in one sector can affect the whole.

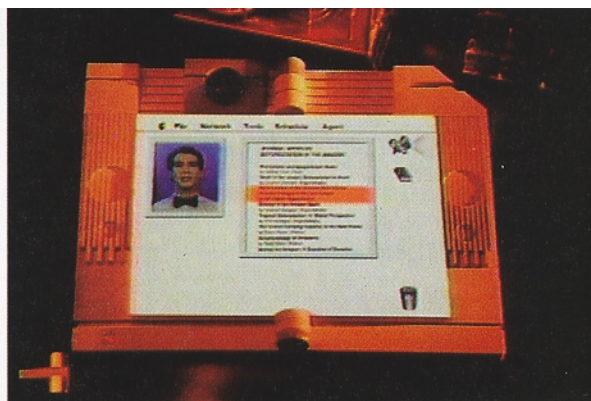
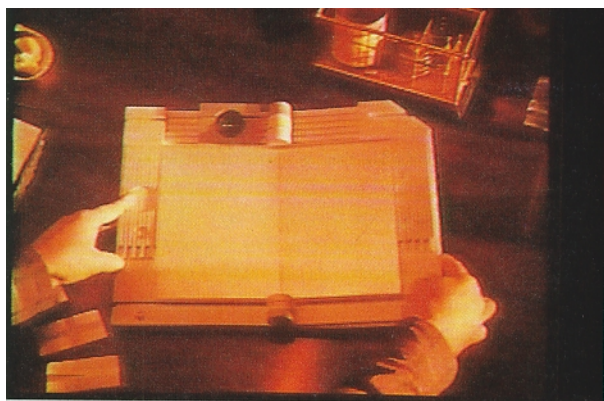
A good analogy can be found in the shrinking rain forests of Brazil. Eighty percent of the world's oxygen comes from the Brazilian rain forest. Yet we lose every year, through the cutting of trees and the clearing of land, a land mass the size of the state of Nebraska. If we keep doing that long enough, the decreasing amount of oxygen in the atmosphere will alter the entire ecosystem of the planet.

The United States participates in the world economy not simply as a producer, but also as a marketplace. If our population loses the ability to afford our own products, it also will not afford Japanese automobiles, electronics from the Pacific Rim countries, and so forth. And that would have a tremendous impact on the macroeconomic ecosystem of the world.

Yet it is clear that as a nation, we are living beyond our means. We are no longer creating enough value to sustain our lifestyle, we are falling deeper into debt. There is a compelling need to find new ways to continue to create value in the world.

I believe that in order to do that our businesses and universities must be designed to foster innovation. Yet innovation has never come through bureaucracy and hierarchy. It has always come from individuals.

There is a dangerous timelag built into even the most successful institutions. They are created at one time in response to some particular opportunity in a given historical context. And then as the context shifts, the insti-



tution finds itself carrying excess baggage that is no longer useful.

How will the organizations designed to thrive in the 19th and early 20th centuries learn to contribute to the 21st? Only by reinventing themselves through refocusing on *individuals*.

The key strength of 21st Century organizations will be not their size or structure, but their ability to simultaneously unleash and coordinate the creative contributions of many individuals. Unleashing and coordinating may sound like contradictory actions—and in older models they would be—but we must develop new patterns of organization that promote alignment and collaboration while avoiding rigidity and stagnation.

A LIFETIME OF LEARNING

Communication in the new organization will be more fluid, action more spontaneous. Think of the speed and agility of basketball versus the massed force of football. Think of a jazz combo trading solos, versus a marching band in lock step. The individuals who will succeed as contributors in these new organizations also need to change. In fact, change will be the one constant in their careers.

Over-specialization and a limited perspective can be a dead-end trap. Students today cannot count on finding one smooth career path because jobs that exist today will change radically (by the millions) tomorrow. Individuals will need to have tremendous flexibility to be able to move from one company to another, or from one industry to another. Those who are best prepared to do that will be the most successful.

We used to talk of “taking a position with the firm.” Those are revealing words: *Position* and *firm* belong to a static model of rigid hierarchy. If you are only going to take one position, you can get by on only one point of view. In the information age, however, a diverse educational experience will be the critical foundation for success. What tomorrow’s student will need is not just mastery of subject matter, but mastery of *learning*. Education will not be simply a prelude to a career, but a lifelong endeavor.

Let me list some of the requirements of this new paradigm for lifelong learning:

- It should require rigorous mastery of subject matter under expert guidance.
- It should hone the conceptual skills that wrest meaning from data.
- It should promote a healthy skepticism that tests reality against multiple points of view.
- It should nourish individual creativity and encourage exploration.
- It should support collaboration.
- It should reward clear communication.
- It should provoke a journey of discovery.
- And above all it should be energized by the opportunity to contribute to the total of what we know and what we can do.

Higher education has traditionally defined itself in terms of two missions: instruction and research. In the past, these have been seen as very different activities. Research, which is primarily the domain of faculty and graduate students, is the process whereby we increase the world’s store of knowledge. Instruction, which involves all students, is the process whereby we transfer some subset of that knowledge to *individuals*.

But, as we have seen, it is no longer enough to simply transfer knowledge to students. It is not as though we can give young people a ration of knowledge that they can draw on throughout their careers. Instead, we need to give them *access* to the unbounded world of knowledge. That means we must prepare all students, not just professional scholars, to embark on a lifetime of learning and discovery. Which means that our students will not simply be passively absorbing subject matter . . . but be more like researchers actively exploring their environment.

To work in research is to recognize that knowledge does not reside privately in individual minds, or text books, or journals, or libraries, or laboratories, or databases. Knowledge resides in a complex web that encompasses all of these. To work in research is to recognize that knowledge is not static. Everyone in the research community shares the responsibility to test our knowledge and to enlarge it.

The challenge for higher education will be to find ways of bringing to the process of instruction the passion for discovery that drives research. Students today

should master the skills and tools of research as part of their basic education. To give our students this mastery, we must create a learning environment in which research and instruction are integrated.

I believe we all can make important contributions to that process. If we succeed we will have found new ways of empowering individuals—not in isolation from each other, but with pathways for rich communication and effective collaboration.

A LESSON IN HISTORY

The transformation I am calling for—shifting focus from the institution to the individual—has a close parallel in history. In medieval Europe people were subservient to the institutions of the church and feudal hierarchies.

Then came the Renaissance, which redefined the individual as the epicenter of intellectual activity. It did more than change people's perspective of the world, it literally invented perspective. The medieval painter depicted great religious events with the most important figures appearing the largest. Composition reflected ideology. Then drawing styles changed. The Renaissance artist drew figures and buildings in perspective, the way they appeared to an individual observer. For the first time, point-of-view came into the world.

The many forces which converged to bring about the Renaissance galvanized around one key technology: printing. The rise of printing led with astonishing speed to an explosion of literacy. The result was a new self-esteem for the individual. A wealth of invention.

An excitement of the power of wonderful ideas. Today, we are in need of a second Renaissance, which like the first can also be galvanized by technology.

We are on the verge of creating new tools which, like the press, will empower individuals, unlock worlds of knowledge, and forge a new community of ideas. These core technologies and the tools they support will help create a new environment of lifetime learning.

We believe the tools that show the most promise for the new learning environment build on three core technologies: hypermedia, simulation, and artificial intelligence. Each of these technologies alone can enrich the educational process. Each gains additional strength when learners can share resources over networks. And when these technologies are fully integrated with each other, they will fuel a 21st Century Renaissance—an outpouring of new learning and achievement.

TECHNOLOGICAL TOOLS

Hypermedia is a new word for many of us. Yet this term and its definition will become increasingly important the more we rely on personal computers to store, manage and retrieve information.

In broad terms, hypermedia is the delivery of information in forms that go beyond traditional list management and database report methods. More specifically, it means that you do not have to follow a predetermined organization for information. Instead you can make instant choices about where to go next. What this means

for instruction and research is that content is not bound by particular choices of organization. Instead content and organization become complementary tools that act on each other to deepen our understanding of the world around us.

Hypermedia lets us use a type of cross-reference that can be used to span courses that present related material, like physiology or microbiology. It gives us the capability to explore deeper, linking one idea with another as the student or researcher pursues his own personal learning path.

In a sense, hypermedia is nothing new at all. A researcher using a card catalog and reference materials

In the information age, a diverse educational experience will be the critical foundation for success.

traditionally had the opportunity to pursue ideas according to insight and interest. Hypermedia does not change that process, it merely *accelerates* it.

It's a natural way of working, but until recently, personal computers were too limited to address it. Today, however, desktop computers can have more information on line than the largest mainframe managed 10 years ago. We are coming to expect high-capacity magnetic hard disks, optical media such as CD-ROM, and high-speed networks as standard in our installations.

Once we have experienced hypermedia, established methods of finding related pieces of information seem cumbersome. Hypermedia can also be seen as a new form of publishing. There are now readily available tools that enable faculty in any discipline to create richly branching presentations. The major obstacles still to be cleared are not technological, but social and economic. We have not yet devised licensing procedures for the electronic formats of the textbook or journal abstracts.

We must all work together to address such issues as copyright and royalties, and access and security in the information age. Just as hypermedia offers a new paradigm for exploring vast amounts of information, the second core technology, simulation, pushes the boundaries of experimentation. Simulation takes us beyond the "what" to the "how and why." We move from a static picture to dynamic visualization—from limited experience to diverse, multiple experiences.

The excitement in educational simulations today comes from generalized programs which allow professors and students to design their own simulations in particular disciplines, simulations that permit virtually all dynamic phenomena to be modeled and visualized.

Just as the spreadsheet allowed us to ask "what if" questions about financial calculations, this new class of software allows those "what if" questions to act on a dynamic graphic system, whether in physics, chemistry, electronics or economics.

Stanford Courseware Puts World at Students' Fingertips

The Courseware Authoring Tools (CAT) Project at Stanford University is chartered with providing an environment in which faculty members can develop instructional software. Many of the programs are built upon Apple's authoring environment, HyperCard, and all are designed exclusively for the Macintosh II.

The tools created at Stanford to date fall under three rubrics: social science, multimedia and engineering/physical science. One authoring environment—ALIAS—is at the core of some of the more imaginative programs for cultural, social and historical simulations.

By entering data about a certain period of history, ALIAS allows students to play the role of an individual of that culture and time. Students have a choice of simulating such periods as the evolution of French Impressionism; the politics of 16th Century Italy; or life in present-day Japan. Simulations are represented via a series of events that can be as simple as a single historical incident or as complex as an entire era. ALIAS allows four kinds of events:

- One-time events, such as Columbus landing in the New World;
- Cyclical events, such as Fall harvest;
- Opportunities, such as trying out for a baseball team;
- Complex events, such as applying for college.

Students can classify events to distinguish, for example, the

political from economic situations. They can also determine which event types to include when the simulation begins.

Using the simulation capabilities of ALIAS, one Stanford professor has designed a software program that teaches students about the factors that impinge on the life of a Japanese individual. Harumi Befu, a professor of anthropology, has created an ALIAS-based, role-playing courseware program called SHOGAI that explores the Japanese culture through the simulated life of a 59-year-old Japanese shop owner named Yoshitada Yamada and his 30-year-old daughter, Yoichi.

As Yoshitada, students must make decisions that will enable him to survive a childhood in the midst of World War II, to pursue an academic path in postwar Japan, to reconcile his personal preferences with the dictates of an arranged marriage, and to follow a career within the confines of his education and social status. Later, as daughter Yoichi, students make life decisions that focus on a cultural balance in higher education opportunities between Japan and the U.S.

In addition to personal decisions, students are taught to recognize the importance of key people in an individual's life, cultural norms, and historical accidents. The journey is accentuated by a colorful palette of graphics, text, video images, and music to embellish these actions and to impart a distinctly Japanese aura to the simulation.

HardTimes:ALIAS:Alias Demo

**Welcome to SHOGAI.
You're playing the role
of Yoichi Yamada, a
Japanese born in 1930.**

**Your father, Yoshitada
Yamada, owns a
clothing retail shop.
Your mother, Sada
Yamada, is a
housewife. You live in
Senba, Osaka, and have
one brother seven
years older than you.**



Sculley Envisions Life by 2001 P.C.

By the turn of the century, John Sculley predicts personal computers will house the type of technology and interface design that will seem like descendants of today's UNIX and Macintosh systems. He calls this futuristic PC the *Knowledge Navigator* and has described in several recent speeches the five key technologies crucial to its success.

The first feature is advanced communications technology that can link processors and databases around the world, thus providing better vehicles and broader information pathways. Secondly, real-time, 3-D color animations will become commonplace as users rely more on graphic simulations. Such capabilities will allow scientists to visualize complex numerical models with the same ease with which they now graph a column on a spreadsheet.

Improved database technology—element number three—is the key to creating intuitive and responsive information systems. One approach that Sculley claims shows great promise involves mapping and storing information into object-oriented structures.

Fourth is hypermedia which will give future PC users more intuitive ways of navigating through enormous collections of information: combining text, graphics, sound, and motion. Rounding out the essentials is artificial intelligence technology—critical to the future vision of personal computing. AI will allow future users to create agents that can recognize and anticipate strategies and preferences as well as increase productivity.

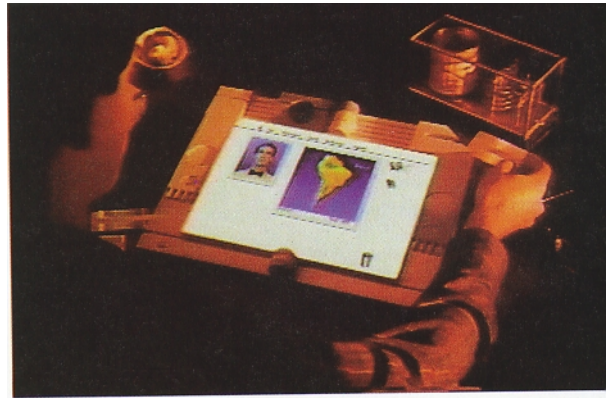
Another new application of simulation is in the humanities and social sciences, not normally what you would think of as computer-intensive disciplines. At Stanford University, a toolkit built on HyperCard has been designed in deference to a traditionally non-programming group: the humanities and social sciences faculty. (See accompanying story.)

Using this toolkit, called ALIAS, professors or students in anthropology, history or sociology can model a culture or period of history by entering their data into the toolkit. ALIAS will in turn create a HyperCard stack that allows students to play the role of an individual of that culture. It is an approach that combines simulation and hypermedia.

In fact, this very simulation has been developed by Stanford Professor Harumi Befu. It's called SHOGAI, which means *life course*. To Professor Befu, SHOGAI means a new territory for his anthropology students; one in which they can explore the richness of Japan's people, its customs, and events, by assuming the roles of characters profiled in the simulation (see accompanying story).

Using this simulation, students can make some critical decisions about school, social activities and work that will collectively dictate the character's niche in Japanese society. The point is to understand how and why the choices they make for him will determine the career opportunities he will have and the social status he can achieve. As different choices are made, different results will unfold.

Simulation and hypermedia tools exist today. As they come into more widespread use we will find two things



happening. First, authors and publishers will continue to enrich our libraries of linked subject matter. And second, developers will continue to make the underlying tools more powerful. We will have full, three-dimensional motion graphics, and stunning images on CD-ROM. But perhaps the most spectacular advance will be not in the presentation level, but will lie deeper in the programming.

SOONER THAN WE THINK

Just a short way into the future, we will see artificial intelligence (AI) emerge as a core technology. Combined with our other core technologies, AI will boost simulations and hypermedia to new levels of realism and usefulness. For example, we will move from building molecules into two and three dimensional space, to building the environment in which they combine—where each molecule understands the structure and behavior of the others.

Another important contribution of AI will be intelligent agents that can learn a user's preferences and search strategies. These agents will transform the nature of academic computing. Agents will be sent to prowl among remote databases and bring back the specific information and citations that the user requires.

These future systems are not that far away. Soon, faculty and students will be using systems that enable them to drive through libraries, museums, databases or institutional archives. These tools will not just take you to the doorstep of these great resources, as sophisticated computers do now; they will invite you deep inside its



secrets, interpreting and explaining—converting vast quantities of information into personalized and understandable knowledge.

In (a previous) keynote address, Dr. Herb Simon, professor of computer science and psychology at Carnegie Mellon, reminded "We think of revolutions as being sudden events, producing far reaching changes in a very short period of time. But the revolution launched by the steam engine took, by any reasonable account, 150 years." Changes in computing have been like a whirlwind in the last 40 years. But I think we have only begun to see what innovation and creativity can produce in this industry.

The personal computer could become as galvanizing as the printing press in stimulating change in the world, in creating an environment for innovation and new ideas. Let us remember that the printing press never wrote a single book. Authors write books. So, too, with the new technologies that I have described. This will only be achieved if we work together—universities, corporations and government—and if we recognize the role of the creative individual within these organizations.

We all have a role in making this vision of the future a reality. The technologies I have talked about are only platforms that represent opportunities and possibilities. They are, however, the tallest of platforms, the richest

of opportunities, and the broadest of possibilities that I know of.

They will allow us to set loose an avalanche of personal creativity and achievement. Once we have thousands of ideas to harvest, we may have the chance once again to create a second Renaissance, perhaps every bit as important as the first, in the early part of the next century. It would represent a rebirth and revival of learning and culture unleashed by new technologies. It would bridge the gaps between the arts and sciences. And it would signify the emergence of an integrated environment for instruction and research.

It is an exhilarating time to live. I cannot think of any other time in history in which such profound change has gripped each decade. (It is destined to) be an eventful journey to the 21st Century. And there is no place that journey will be more exciting than in higher education.

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