

THE FUTURE ARRIVES FIRST IN CALIFORNIA

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Thirty years ago Lord Ashby, a distinguished foreign observer of U.S. higher education, commented that much of the thinking about higher education's future in the United States was dominated by two topics--how to finance higher education and its research programs, and how to equalize the opportunity for a college education among all qualified students, regardless of socioeconomic background. These are still two great questions facing U.S. colleges and universities. But the intervening three decades have brought enormous changes to the social and economic context in which they are being asked.

Thanks to the increasing relevance of all kinds of knowledge to the economy, the modern research university is a far more complex and challenging organization than its predecessor of just 30 years ago. The life sciences are driving a revolution in biomedical technologies and agriculture. Computer and information sciences have ushered in the Internet and entirely new pathways for communications and commerce. Multimedia technologies are creating new vehicles and new demand for the arts and humanities. We are living in a knowledge-based economy, one in which the capacity to innovate will play a critical role in determining which countries prosper in the global marketplace. This situation is placing new demands on U.S. research universities such as the University of California, which are on the cutting edge in producing the educated people and new ideas that keep the economy growing.

Another significant shift is in public attitudes about how students are selected for admission to colleges and universities. The drive to expand educational opportunity to traditionally underrepresented students was just gathering force in 1970; today, the means for attaining diversity that were developed in the 1970s and 80s are being challenged nationwide and in California have been largely abolished. And this is happening at a time when demand for higher education is expected to reach record levels.

These challenging issues--one economic, the other demographic--have far reaching implications for the future of universities and of the nation. U.S. higher education is remarkable for the diversity of its institutions, and the University of California's answers will not be the answers a private university or even another public university might give. But it is often said that the future tends to arrive first in California, so UC's experience may have relevance beyond the boundaries of its campuses. I would like to discuss what we are doing to respond to three issues: the contributions of our research to the California economy, the need to educate record numbers of students, and the initiatives we are taking to encourage diversity in a post-affirmative action era.

First, a brief profile of the University of California. UC is among the world's largest and most distinguished universities, with a \$13 billion budget and nine campuses (soon to be ten). We enroll 173,000 undergraduate, graduate, and professional students--who constitute the most diverse student body in the nation--and employ 7,400 regular faculty. We have five medical

schools and associated hospitals, agricultural field offices, a variety of research facilities up and down the state, and the world's most advanced computer telecommunications systems. The UC library collections are the most extensive in North America, aside from the Library of Congress, and UC produces more research leading to patented inventions than any other university in the nation. UC is also California's land-grant university for agricultural research and extension, and under state law its principal research agency.

Knowledge-based society

Only within the past 10 to 15 years have we begun to fully understand the impact of research and development (R&D) on economic growth. A substantial literature on this subject has evolved, which has led to a development in economics called "new growth theory." This work is nicely summarized in a 1995 report by the Council of Economic Advisors: 50 percent of U.S. economic growth since World War II has been the result of investments in R&D. Obviously, the private sector is a major contributor to R&D, but federally funded research in universities like UC is the principal driver of the R&D enterprise.

No state in the country illustrates the connection between knowledge and wealth more vividly than California. Almost all of the industries in which California leads the world--biotechnology, software and computers, telecommunications, multimedia, semiconductors, environmental technologies--have depended heavily on the contributions of university-based research. Hewlett-Packard, one of the top ten exporter companies in the United States, estimates that over half of its revenue comes from products that were developed within the past two years. More and more of these products are emerging from work done in university laboratories.

Increasingly, state and federal legislators are coming to expect that one of the returns on the public's investment in research universities will be accelerated economic growth. Like other land-grant universities, UC has a long history of such contributions in agriculture. But county extension offices and industrial affiliate groups are being supplemented by more complex and systematic efforts to bring the university's immense research potential to bear on stimulating economic growth. We are having to create and sustain more direct, more varied, and more flexible working relationships with business and industry. And of course we are having to create these relationships within the framework of what is appropriate to a university.

At UC we are responding in several ways. Recognizing that in the new economy virtually every field will require lifelong learning, we have established an innovative master of advanced study degree (MAS) for those in the workforce. This program will offer advanced professional education and advanced liberal studies at times and in formats that are convenient for working adults. Unlike traditional master's degree programs, the master of advanced study will concentrate on a coordinated set of coursework with culminating projects or papers rather than emphasizing student research. We will also provide a number of interdisciplinary offerings to meet the changing needs of California's workforce. MAS programs can be proposed for any discipline and offered either independently by UC academic departments or in partnership with University Extension. In either case, regular UC faculty will supervise the curriculum and conduct a significant portion of the instruction. Pilot programs are being established in fields ranging from criminology to digital telecommunications to urban and regional planning.

Although the ultimate number and scope of MAS offerings are difficult to predict, every UC campus has expressed an interest in developing these programs in a wide range of disciplines. This is an important addition to UC's service to society in a world in which new professions are emerging, career changes are becoming increasingly common, and workers are expected to renew their skills continually.

Another example is California's need for engineers and computer scientists to keep its high-technology industries vital in a fiercely competitive international marketplace. A few years ago, a number of business leaders came to see me to express their alarm at the gap between California's need for educated people in these disciplines and the inadequate number we are producing. Our own studies have substantiated this concern. As a result, between now and 2005-6 we are planning to increase enrollments in engineering and computer science at the undergraduate and graduate levels by 50 percent across the UC system. Student interest in these disciplines is high and there is no shortage of qualified applicants.

Yet another effort is the Industry-University Cooperative Research (IUCR) program, now in its fourth year. The IUCR builds research partnerships involving industry and UC faculty. The program targets promising early stage research likely to result in new technologies, products, and jobs. Industry investments--which total \$65 million since the program was launched in 1996--are partially matched with university funds. In just three years, the investments by industry and UC have totaled more than \$100 million for new research undertaken by university faculty and students.

Two-thirds of the 323 companies participating in the IUCR are small businesses. A particularly valuable benefit for them is the opportunity to work with UC faculty on multidisciplinary research that would be difficult or impossible to pursue in the private sector. Research supported by IUCR lays the foundation for next-generation technologies and products and provides hundreds of UC students participating in the research a window on future career opportunities. The six industrial sectors that currently participate--biotechnology, communications, information technology, microelectronics, multimedia, and semiconductor manufacturing--are all important to the California and the national economy.

Managing relations with industry

As the research university has become an active participant in the economy, the explosion of university research with commercial applications has rendered some of our mechanisms for working with industry out of date, others in need of re-examination. Research administration costs, for example, are substantially increased by the need to manage research agreements with private industry. Such agreements contain complex intellectual property matters and may involve conflict of interest issues that do not typically arise in government-sponsored contracts and grants.

In 1997 I convened a universitywide retreat to discuss and report on the rewards and risks of industry-university partnerships, the structure and principles that govern those relations, and new directions in which they might go. Participants came from a range of academic disciplines, primarily science and technology, but also the humanities and social sciences. The retreat

produced a report with several conclusions, including these two: UC should remove some of the obstacles it presents to entrepreneurial and established companies that seek cooperative research opportunities, and it should make its policies more user-friendly through actions such as integrating the offices for technology transfer, contracts, and grants.

The report also emphasized that technology transfer must be faculty centered. That is, we seek cooperative research relationships with industry not simply to generate royalty revenue and stimulate economic growth but to create relationships with industry that will help faculty in pursuing their own research and in training graduate students.

But the idea of industry-university partnerships is not without its critics. Some argue that private funds bias the university's research agenda and jeopardize its position as a place in which knowledge is pursued without regard to profit. Others believe that faculty involvement in industry-university partnerships tends to create a conflict of commitment between faculty members' responsibilities to those sponsoring research and their responsibilities to the university--or at least a distraction from academic responsibilities. Human nature is such that we cannot dismiss these concerns. With respect to individuals, a UC task force has looked into what kinds of rules are needed to deal with such potential conflicts, and what should happen when they arise; these are not easy issues to resolve. With respect to ensuring the integrity of university research, it is clear that we have a responsibility to create a climate that promotes open discussion within the academic community to protect the quality and independence of our missions of research and education. My own view is that one of the best ways to protect the independence of university research is to encourage a variety of funding sources--state government, federal agencies, private corporations, foundations, and individuals.

On balance, we have learned enough from the experience of the past 15 years to work out relationships that serve industry's need for technology transfer and universities' needs for open inquiry. We haven't learned how to eliminate instances of poor judgment, heedless self-interest, or simple error. When these happen, the fallout is serious; one well-publicized misstep can eclipse hundreds of productive and academically impeccable cooperative research projects.

Nonetheless, it would be a mistake for universities to draw back from partnerships with industry because of the risks. Not only are these risks manageable, but they are worth taking; working with society to apply knowledge is integral to the U.S. land-grant tradition. Many countries in Europe and Asia that do not have the experience of university-industry ties or the cultural framework to encourage them are struggling to create opportunities that we take for granted.

Perhaps most important, ensuring economic growth has implications beyond simple dollars and cents. The nation faces tremendous problems--deteriorating inner cities, homelessness, degradation of the environment, the prospect of a huge number of baby-boomers retiring with a far smaller workforce to support them in their retirement. How are we going to deal with these problems? There is only one way: We must have substantial economic growth. This requires a public investment in knowledge on an entirely new scale.

The humanities

Although the increasing role that universities play in expanding society's economic productivity can prove beneficial, we should also be careful that the university's traditional functions continue to flourish. Research universities depend on scholarly investigation along a broad spectrum of disciplines, including the humanities, to remain intellectually vital. And one of our most important and enduring responsibilities, providing students with a liberal education, depends heavily on the humanities. Yet changes within and outside universities have created a difficult climate for these disciplines. In recent decades humanists have faced a tough job market, dwindling enrollments in some fields, and declining support for research from the federal government and private foundations alike. Evidence indicates that morale among faculty and graduate students in these disciplines is low--a problem not unique to UC, but national in scope. We are appointing a universitywide commission on the humanities to look at how these fields are faring and give us guidance about how we can protect the vitality of our programs. Should humanities graduate programs, for example, focus on helping students prepare not only for faculty positions but also for jobs outside academic life? Are there ways we can support, financially and otherwise, the increasingly interdisciplinary research many humanities faculty and graduate students are undertaking? Is there a need to do more to involve humanities faculty in addressing the major issues facing the University and society?

Educating students

Demographic realities are creating another challenge for colleges and universities. The next 10 years will bring a dramatic upswing of high school graduates throughout the nation, as the children of the Baby Boomers--Tidal Wave II--enter higher education. Just as their parents in Tidal Wave I made access to college a defining issue of the 1960s, so this new generation of students is about to make the next 10 years the "decade of higher education." During this time the number of public high school graduates is projected to increase by approximately 20 percent nationally and by 30 percent in California.

There is no single national solution to the coming enrollment surge. According to the *Chronicle of Higher Education*, in North Carolina, where an enrollment increase of 31 percent is expected over the next decade, the legislature is considering the biggest bond issue in the state's history. Nevada is looking at building joint facilities with high schools, for both cost-saving reasons and to stimulate student interest in taking college-level courses.

In California, the state's public colleges and universities are projected to enroll 2.7 million students by 2010, "the largest number of students that any state, any time, any place has faced," according to the director of the California Postsecondary Education Commission. This scenario portends a major public policy shift for California, where the K-12 system has dominated the state's agenda for years. With the number of high school graduates soaring over the next decade, California's attention is now focused on how this state's colleges and universities will accommodate many thousands of additional students.

Tidal Wave II will create the most challenging decade in UC's history. Estimates are that within 12 years we will need to increase our enrollments by a staggering 43 percent--an additional 63,000 students, the equivalent of UC's total enrollment growth over the past 30 years or of

today's combined enrollments at UC's two largest campuses, Berkeley and UCLA. We will need to hire some 3,000 new faculty members for enrollment growth alone.

The University's planned new campus in the San Joaquin Valley--UC Merced--will provide places for 1,000 students when it opens in 2005, growing to an enrollment of 5,000 by 2010. But that leaves us with 55,000 students to be accommodated at the other general campuses. We will have to expand by 5,000 students annually to keep up with demand.

Each of our campuses is different, and each will adopt strategies that work in terms of its particular circumstances. Besides increasing enrollment at a number of campuses, we will also offer an expanded summer term, with student fee and financial aid incentives to encourage students to enroll. We will also offer more off-campus learning opportunities through the University's Education Abroad Program, a new center in Washington, D.C., and several off-campus centers in California.

As the nation's leader in educational technology, we can reach even more students through technologically mediated learning. Most technologies currently used by UC faculty, such as interactive Web sites and e-mail, enhance rather than expand undergraduate instruction. But some programs are underway that improve not only the quality of our courses but also their reach. This year, for example, UCLA is offering two interactive physics courses over the Internet jointly with Japan's Kyoto University. Students and professors from both universities can see and hear one another in each classroom in real time, thanks to high-quality audio, video, and interactive data transmissions over high-speed communication links; students from other UC campuses can participate as auditors via the Internet. In recent years these kinds of collaborative courses have taken place between the University's campuses as well. The pace of such experiments will quicken dramatically over the next several years, and, in turn, so will our ability to serve students around the state and the world.

The costs of accommodating Tidal Wave II include about \$5 billion in capital costs at UC over the next 10 years for supplying equipment, constructing new buildings, and renovating old ones. This is a huge investment that will require hard public policy choices. California has historically been willing to pay for excellent public universities, but the steep economic slide of the early 1990s left UC with unprecedented shortfalls. Fortunately, the economy has recovered and the outlook for state support is brighter than anyone would have guessed a few years ago. The costs of enrolling the thousands of students entering the system are considerable, but not beyond California's means.

Diversity

The United States became a much more diverse nation in the past decade, as the number of Hispanics increased by 35 percent and Asians by more than 40 percent. In the nation's western states, the high school class of 2008--the peak year for the coming tidal wave of students--will have no single ethnic or racial majority. That has been the case in California's high schools since 1991, and today nearly half of the high school students in the state are either African-American or Latino. Minority representation in higher education has long been a major public policy issue,

and for many years UC has had affirmative action programs aimed at increasing the diversity of our student body.

In 1995, the UC Regents passed a resolution eliminating the use of race and ethnicity in admissions; California's voters approved a similar measure--Proposition 209--the following year. These events have brought about far-reaching changes in how we recruit and select students. In the four years since the Regents' action, we have revised the pool of those eligible for UC to include the top 4 percent of every high school in California, to give a leg up to those students who have excelled despite an impoverished learning environment. Although our requirements for grades and test scores continue to be rigorous, we are now looking at students' qualifications in as broad and comprehensive a way as possible to include measures that we call "opportunity to learn." What socioeconomic or other obstacles has a student overcome? What has he or she made of the educational opportunities available, whether they are many or few? What evidence of character or initiative, special talent or academic promise, does a student bring that grades and test scores do not capture? Private universities have been asking these questions of applicants for decades. Now several UC campuses, most notably Berkeley, have become more selective than some Ivy League universities because of the increasing numbers of highly qualified applicants. UC, in turn, has begun to use many of the approaches favored by private universities, including assessing applicants in a more comprehensive and holistic way.

How is UC doing in terms of diversity? Minority student enrollment, though lower than it was before the elimination of race and ethnicity as factors in admission, has not dropped as much as we had feared. But any decline is a matter of deep concern in one of the most diverse societies in the world.

We know that what we can do through the admissions process, though helpful, is limited. The hard fact is that inequities in educational opportunities--and almost four out of every five students in low-performing schools are African American, Native American, or Latino--translate into real differences in students' preparation for college. Admissions procedures and criteria can try to take these inequities into account, but they cannot correct them.

Ultimately, the answers will be found not in the admissions process but in the schools. Until we raise the level of academic achievement among all students--whatever their backgrounds--we cannot expect that the diversity of our campuses to reflect the diversity of our communities. Higher education's future is tied more than ever to the future of the K-12 schools.

K-12 outreach

Outreach--helping potential students aspire to and prepare for higher education--is central to our strategy for achieving diversity in the post-affirmative action era. Just as the growing complexity of our economy has transformed UC's relationships with industry, so the challenge of achieving diversity in a post-affirmative action world is transforming our longstanding partnership with the K-12 schools. We are forging new relationships with schools and community colleges, exploiting technology to provide larger numbers of students with highly individualized instruction, and adopting different approaches for different communities.

A task force appointed several years ago to develop UC's strategy estimated that we would need to double what the university was then spending on outreach--about \$60 million a year--to \$120 million within five years. Thanks to strong support for our outreach programs from the governor, the legislature, and the private sector, we will be spending \$178 million next year on outreach--well ahead of our five-year schedule. Each of our campuses is working with disadvantaged schools to motivate students, share what we know with teachers, and address the differences in academic achievement that emerge as early as kindergarten and are firmly entrenched by the third or fourth grade. With today's communication technologies, we can work with the schools on a scale that would have been impossible even a few years ago. UC Links, for example, is a computer-based after-school program for children in the elementary grades, in which UC undergraduates work with disadvantaged young people to develop mathematics, science, and literacy skills. UC Nexus, another computer-based initiative, brings together UC faculty, staff, and students with their counterparts in the K-12 schools to develop ways of using computers and the Internet for learning outside as well as inside the classroom.

No single institution, however, can address the enormous problems that face California's K-12 schools and their 5.7 million schoolchildren. Thirty years ago, California's schools were the best in the nation. Today, California invests less per pupil in K-12 education than the majority of other states do. This lower investment translates into higher pupil-teacher ratios; fewer counselors, librarians, and computers; and more underprepared teachers. Although we have schools that are among the best in the nation, we also have schools in which basic literacy is the ceiling rather than the floor of academic achievement.

The good news is that the state's new governor has made education his highest priority for California. Soon after his election in November 1998, Governor Gray Davis announced a set of legislative proposals for improving K-12 education, and he asked the University of California and the California State University to play leading roles in this effort. Last summer, for example, UC sponsored training institutes for over 6,000 K-3 teachers at 33 colleges and universities around the state. Seven hundred of the state's elementary schools sent teams of novice and experienced teachers and school administrators to be trained in how to teach beginning reading skills. The emphasis on reading will expand to include the teaching of algebra next summer. This initiative represents an unprecedented level of cooperation among our institutions, our faculty, and leading school teachers. All universities must prepare to play a bigger role in K-12 education.

Conclusion

UC faces challenges in areas beyond the ones I have described. Our student faculty ratio, 14.7 to 1 in the mid-1960s, is much too high at today's 18.7 to 1. Our libraries are in the midst of an acquisitions crisis: due to limited budgets and skyrocketing costs, they purchase 20,000 fewer serials today than they did 10 years ago. Despite financial constraints, UC must ensure that we are creating the kind of environment that will attract the very best faculty in every field. No other success can compensate for failure in this fundamental task.

The opportunities facing universities far exceed the problems, however. We are on the brink of a revolution in scholarly communication with the advent of digital publication, raising fascinating

questions not only about how we share knowledge but also about how we evaluate the faculty who produce knowledge. The California Digital Library, which now includes over four thousand electronic journals and other items from the University's vast collections, is pioneering innovative and collaborative ways of producing, disseminating, and preserving knowledge. Many of the CDL's holdings are available to the public, and more will be in the future. We are approaching the time when Erasmus's dream of a library without limits is within reach.

Economic, demographic, and technological realities are transforming the American research university. They are accelerating a distinctively American trend--the involvement of universities in solving society's problems and serving its goals--that was important in the nineteenth and twentieth centuries and will be more important than ever in the twenty-first.

Recommended Reading

"Supporting Research and Development to Promote Economic Growth: The Federal Government's Role," The Council of Economic Advisors, October 1995.

"The University of California's Relationships with Industry in Research and Technology Transfer," Proceedings of the President's Retreat, January 30-31, 1997.

"New Directions for Outreach," Report of the University of California Outreach Task Force, July 1997.

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