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THE FUTURE OF
THE RESEARCH UNIVERSITY
Meeting the Global Challenges of the 21st Century



The Future of the Research University

Meeting the Global Challenges of the 21st Century

A volume of scholarly papers addressing the future
of the university for the entrepreneurial age, presented at the
2008 Kauffman-Planck Summit on Entrepreneurship Research and Policy
held June 8-11, 2008, in Bavaria, Germany.

KAUFFMAN-MAX PLANCK ANNUAL SUMMIT
ENTREPRENEURSHIP RESEARCH & POLICY
*2008: Rethinking the Role of the University and
Public Research for the Entrepreneurial Age*

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The Future of the University and Public Research for the Entrepreneurial Age

by Carl J. Schramm
President and Chief Executive Officer
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It is commonplace to say that we live in the Information Age—and no less true because oft-repeated. But also no less true—yet hardly ever repeated—is the fact that we live in an Entrepreneurial Age. How these two basic trends—the dominant forces of our time—intersect is the topic of this volume, and of the conference on which it is based.

Apart from fringe anti-globalization activists, nearly every observer today holds that the Information Age is a good thing. It is raising living standards, alleviating poverty, expanding opportunity, increasing the wealth of nations, improving productivity, reducing the potential for conflict, and enhancing quality of life. All this is widely understood.

The basic realities of the Entrepreneurial Age are not as well appreciated, though they are arguably even more powerful—and inarguably wholly intertwined with the fate of the information revolution. Consider: World GDP has grown more than tenfold since 1970—and four-fifths of that growth has occurred since countries in the developing world and those once behind the Iron Curtain began to liberalize their economies. This is, to say the least, not a coincidence. Where there is economic

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freedom—where individuals with ideas and drive can pursue their dreams—money is made, capital is formed, and the pie expands.

The importance of the entrepreneur was long the not-so-secret—if often insufficiently appreciated—key to the success of the American economy. Now, entrepreneurship is driving growth everywhere—from Israel to Ireland, Taiwan to Turkey, and, of course, in India and China. Even the mature economies of the Old World—long enamored of central planning and tight coordination between big business and big government—are getting into the act, under the ambitious goals of the Lisbon Agenda.

Yet there is reason for concern. In the Information Age—when wealth, progress, and success are more than ever derived from the mind rather than the soil—how well are the chief repositories of information, our universities, keeping up? How well do they understand, and incubate, and practice, entrepreneurship themselves? Are today's universities equipped to support and augment the world's burgeoning culture of entrepreneurship? And, if not, how can we help them become so?

More specifically, the twin engines of entrepreneurship and the knowledge economy have ushered in many radical innovations: new forms of technology—from IT to biotech—new patterns in society, new demands on the workplace, even new modes of living. Universities were instrumental in developing much of this radical innovation, but how well have they kept up with its transformative impact?

Rising living standards enable more and more people throughout the world to earn a university education. The demands of the knowledge economy make such an education more and more valuable.

Rising living standards enable more and more people throughout the world to earn a university education. The demands of the knowledge economy make such an education more and more valuable—and outright necessary for certain careers. A result has been massive demographic change on campuses. Vastly more students are coming to study, and their backgrounds are more diverse than ever, by every measure, whether age, ethnic group, or socio-economic status. How are the universities adapting to this fundamental change among their “consumer base,” as it were?

Finally, universities are no longer self-contained. It is not so much that the Ivory Tower has been breached; more that every individual tower is now linked to every other in ways, and to a degree, that are unprecedented. Competition—for students, for faculty, for research funds, even for attention—is at a fever pitch. And it is no longer merely regional, or intra-state, or even national. That competition is now global, and becoming more so.

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The Kauffman Foundation and the Max Planck Institute convened a conference in the summer of 2008 to explore just these issues. We brought together more than a dozen leading experts from Europe, Israel, and the United States—presidents of universities, renowned researchers, people steeped in the mission of what a university should be. They brought diverse perspectives and unique insights, but several common themes emerged.

Manuel Trajtenberg—professor of economics at Tel Aviv University—crystallized the framework for thinking about these issues by observing that “entrepreneurial university” really has three possible meanings.

For universities to fully and effectively become entrepreneurial in the second sense, they will have to embrace entrepreneurship in the first sense.

First is the extent to which universities are innovative in terms of their own institutions, how they are structured and governed, and how they adapt to change. Second is the extent to which universities can drive entrepreneurship in the broader economy by generating ideas, training entrepreneurs, and working with the business community. The third sense of universities as entrepreneurial institutions is their ability to effect broader change throughout society at large.

Few would disagree that universities have lagged considerably at entrepreneurship in the first sense—at reforming themselves. As robust as they can be as agents of change for the world around them, they remain stubbornly resistant to change within their own walls. But for universities to fully and effectively become entrepreneurial in the second sense, they will have to embrace entrepreneurship in the first sense.

Our presenters understand that. Three of Europe’s most innovative university presidents led off the conference, described the obstacles to change, and voiced their determination to overcome them. Michael Crow recounted his efforts to transform Arizona State, up to and including abolishing academic departments, creating new ones, and even helping to found entirely new disciplines. And Alan Merten explained all the ways in which his own university—George Mason—has changed over the past decade, and is now “going global.”

The second sense—explicitly fostering entrepreneurship in business—is more problematic. Universities never have been at ease embracing this role, preferring to keep their distance from the private sector and instead partner with government or

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other nonprofits. Yet, whatever misgivings its inhabitants may have, the university plays a vital role in nurturing entrepreneurship. It trains the scientists who make the groundbreaking theoretical discoveries, the engineers who find practical applications for those discoveries, the businessmen who bring those applications to market, and the managers who keep those businesses running. All this is done without any conscious plan. In some cases, universities end up as primary conduits of talent and ideas for entire industries—Stanford and the Silicon Valley being the shining examples.

All of the presenters touched on this topic to some extent, but three did so most directly. Jan Willem Oosterwijk—president of Erasmus University in Rotterdam—talked about the university’s history in fostering entrepreneurship, and described a new university and private sector partnership specifically geared to building a culture of entrepreneurship in Dutch society. Robert Litan and Lesa Mitchell—both of the

The gains of the knowledge economy are inconceivable in the absence of high quality, and widely available, post-secondary schooling.

Kauffman Foundation—raised the question of whether this direct approach is desirable, only to answer with a quick and emphatic, “yes.” The bulk of their discussion then focused on the “how:” getting the approach, and the mix, right.

Universities have clearly exhibited great facility at entrepreneurship in the third sense, changing the societies around them mostly—but not always—for the better.

Indeed, the gains of the knowledge economy are inconceivable in the absence of high quality, and widely available, post-secondary schooling. Universities also have acted as agents of social change, bringing new opportunity to formerly marginalized groups.

Several of the conference speakers explored this aspect of the university’s role. William Wulf, one of America’s leading computer scientists, showed how so many of the technological innovations that have revolutionized society, business, and everyday life originated on campuses and in labs. Manuel Heitor, education minister for the government of Portugal, made an aggressive case for greater direct involvement between universities and the societies they serve. And Frank Douglas, senior fellow at the Kauffman Foundation and one of the world’s most distinguished biotech researchers, laid out a hopeful vision of how universities could take a leading role in a revolutionary new approach to finding a cancer cure.

The papers and the discussion that follow explore these and many other facets of what it means to be an entrepreneurial university. They define the questions and

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propose answers, in the process shedding much light on one of the most important challenges facing the university in our time.

Thanks go to David Audretsch of the Max Planck Institute, and to Robert Litan and Lesa Mitchell of the Kauffman Foundation, for organizing this conference. The conference also greatly benefited from the participation of the many other experts who attended.

This volume doesn't have all the answers. But knowing the right questions, and understanding them, is the necessary first step toward wisdom.



Building an Entrepreneurial University

by Michael M. Crow
President, Arizona State University

Michael Crow is the president of Arizona State University. Prior to joining ASU in 2002, he was executive vice provost of Columbia University, where he also was professor of science and technology policy. As chief strategist of Columbia's research enterprise, he led technology and innovation transfer operations and the establishment of large-scale interdisciplinary research initiatives. A fellow of the National Academy of Public Administration, he is the author of books and articles on research organizations, technology transfer, and public policy as it relates to science and technology. He holds a BA from Iowa State University and a PhD in Public Administration from Syracuse University.

“Enterprise” is a concept sometimes wholly lacking in discussions about higher education and the American research university. “Academic enterprise” and the entrepreneurial academic culture that such an orientation instills encourage creativity and innovation with intellectual capital—the primary asset of every college and university.

Generally associated with the private sector, the spirit of enterprise is nonetheless highly relevant to the advancement of all of our nation's colleges and universities, but especially our research universities—institutions dedicated to both teaching and discovery. There are approximately 5,000 institutions of higher education in the United States and, of these, roughly 150, both public and private, are classified as “research extensive” in the classification established by the Carnegie Foundation for Higher Education. These are the institutions that increasingly fuel the national economy by producing leaders in all sectors of academia, business, industry, and government, and through perpetual innovation in products and processes.

a v i e w f r o m t h e u n i t e d s t a t e s

Since becoming the president of Arizona State University in July 2002, I have been leading an effort to reconceptualize a large public university as an academic enterprise—agile, competitive, adaptable, and responsive to the changing needs both of our constituencies and global society alike. The speed with which we now make and implement decisions and establish collaborative relationships with other academic institutions, and with business and industry, is characteristic of private enterprise. As an enterprise, we acknowledge and embrace the fact that we operate in a competitive arena. We are competing not only for research dollars and private investment, but also for the very best students, faculty, and administrators, and above all, for the very best ideas.

Instilling the spirit of enterprise into the institutional culture of a public university is only one of my objectives as the president of an emerging research institution. The larger task we have taken on is to redefine public higher education through the creation of a prototype solution-focused institution that combines the highest level of academic excellence, maximum societal impact, and inclusiveness to as broad a demographic as possible. Predicated thus on excellence, access, and impact, the paradigm is conceptually framed as the “New American University.”

The spirit of enterprise I endorse therefore must be integrated into a larger context. Academic enterprise is only one of eight “design aspirations” for the New American University. There are many ways to parse the concept of the New American

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University, but, in brief, its objectives are inherent in the following guidelines that, reduced to their essential terms, enjoin the academic community to (1) embrace the cultural, socioeconomic, and physical setting of the institution; (2) become a force for societal transformation; (3) pursue a culture of academic enterprise and knowledge entrepreneurship; (4) conduct use-inspired research; (5) focus on the individual in a milieu of intellectual and cultural diversity; (6) transcend disciplinary limitations in pursuit of intellectual fusion; (7) socially embed the university, thereby advancing social enterprise development through direct engagement; and (8) advance global engagement. Taken together, these comprise a paradigm for academic institutions, both public and private, that I advocate without reservation. All of the design aspirations are interrelated, but in the following I will focus primarily on academic enterprise. Before we consider our efforts to rethink the contemporary

American research university, the following brief historical overview of the institutional form will set the context for a discussion of its present design flaws and the imperative for its reconceptualization.

The Evolutionary Trajectory of the American Research University

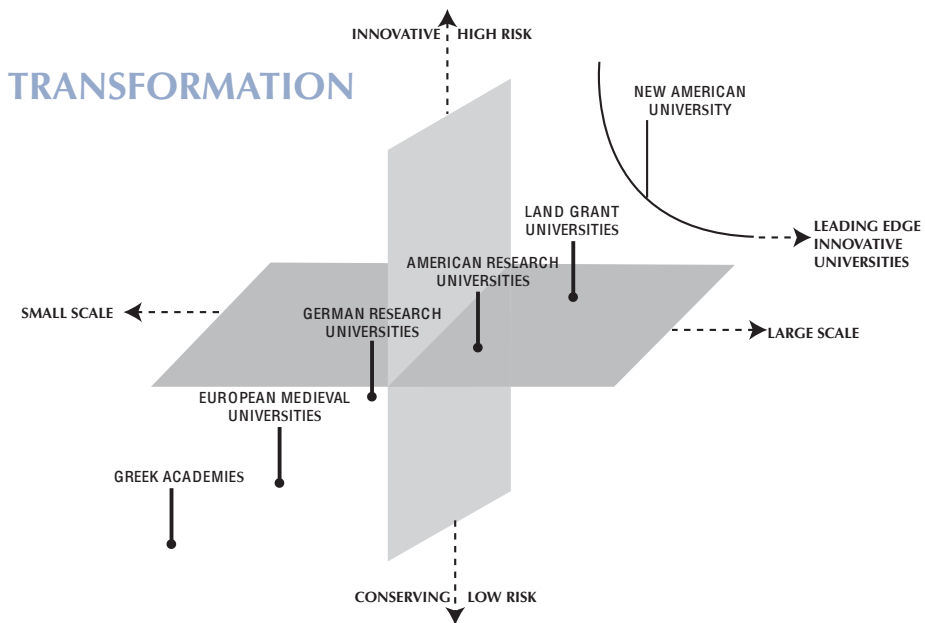
With a global population of 6.5 billion projected to increase to 8.5 billion by mid-century, we face challenges of unimaginable complexity, both as a species and, more narrowly, in terms of our standard of living and quality of life as a nation. But we strive to deny complexity in our national policymaking and planning, and, rather than learning to understand and manage complexity in the academy, we restrict our focus with ever-greater specialization and the narrowing of disciplines. Our universities remain highly static, resistant to change, unwilling to evolve in pace with real time, and focused primarily on their advancement of abstract knowledge. The organizational frameworks we call universities—this thousand-year-old institutional form—have not been designed to accommodate change on the scale we are witnessing or the attendant increases in complexity. Moreover, organizational constraints derived from the flawed institutional design of our colleges and universities prevent them from realizing their entrepreneurial potential. In order for our universities to overcome their ossification, academic enterprise must become a new organizing principle, both organizationally and conceptually. American research universities need not remain static, monolithic behemoths, unwilling or unable to advance their own institutional evolution or to catalyze positive societal transformation.

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The evolutionary trajectory of universities in the Western world can be modeled as a process visualized along two axes. The x-axis represents the scale of the institution, with scale meaning more than just size. Scale in this usage refers to the *breadth of functionality*, which measures more than just the number of disciplines studied. If the institution is a comprehensive knowledge enterprise such as the New American University, it will be committed to the traditional missions of teaching, research, and public service, but, in addition, will advance innovation and entrepreneurship. Scale thus refers to both the intellectual, or pedagogical, and

a view from the united states

functional breadth. The y-axis, meanwhile, reflects the institution's *conception of itself* as an evolving, entrepreneurial entity. At the low end of the y-axis, we have what organizational theorists call conserving institutions, those that are inwardly focused, risk-averse, and concerned primarily with self-preservation. At the upper end are entrepreneurial institutions, those willing to adapt, innovate, and take risks in rethinking their identities and roles. In the following chart, the New American University appears in the curve in the upper-right quadrant reserved for leading-edge institutions designed to accommodate innovation, rapid decision-making, and entrepreneurial behavior.



A brief historical overview of the lineage of our universities—in a sense, our institutional genetic code—demonstrates the dynamics between scale and innovation. On the hills around Athens in Greece, academies formed more than 2,400 years ago when individuals of astonishing intellect like Socrates and Plato and Aristotle assembled and began to conceptualize and advance the core pedagogical methodology that we still use to the present day. The ancient Greek academies developed the capacity to understand nature and society in complex terms, but they were tiny in scale and exclusively “conservative,” in the sense of entrusting themselves to conserve

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knowledge. The ancient academies had little impetus to disseminate knowledge beyond their small circles and no conception of the notion of risk and reward.

Fast-forward 1,500 years: The first universities begin to emerge. Bologna, probably the oldest university in the Western world, was established in the eleventh century, followed by the University of Paris and, soon thereafter, Oxford and Cambridge; institutions like Uppsala University, in Sweden, and Jagiellonian University, in Krakow, become great centers of learning. Within this ethos, universities emerged as organizations focused on discovery. Our very understanding of who we are as a species and our place in the universe is the product of scholars and scientists working in these great institutions. In the office of the rector of Jagiellonian University, an institution established in 1364, one can find the instruments that Copernicus used to determine that the Earth was not the center of the universe. The medieval European universities were slightly larger in scale and only slightly more focused on disseminating knowledge. These institutions had only the most limited concept of risk and reward.

Fast-forward again to the late eighteenth century: Industrialization in Europe begins to transform the socioeconomic and cultural landscape, spreading from Great Britain throughout Western Europe, and especially into central and northern Germany. Driven largely by industrial competition and the emergence of the notion of efficient technology-driven competitiveness, the German universities that arose in the eighteenth century focused on specialized scientific research and were thus the predecessors of American research universities, but, with few exceptions, entrepreneurship was still little in evidence.

The prototype for the American research university was established in 1876 by Johns Hopkins University, which combined the traditional American undergraduate liberal arts college with the German model of the elite scientific research institute offering specialized graduate training. The American research university thus came into being in the decades between 1876 and 1915. During this formative period, existing mature universities redefined themselves as research-grade institutions and new institutions were established on the Hopkins prototype. The roster includes institutions that set the standard for the American research university, including Harvard, Columbia, Michigan, Illinois, California, Stanford, Chicago, MIT, and others. Some of these were land-grant universities established under the Morrill Act. With their connection to large-scale agricultural research, these were among the first universities to explicitly take on a broader functional mission, that of advancing the “agricultural and mechanical arts” for the growth of the country. Rather than focus on teaching the classics to the privileged,

the land-grant institutions became involved in production agriculture and thus further advanced the model of the entrepreneurial university. The land-grant schools had the capacity to create products and processes and other forms of capital that could be sold and used by consumers outside the university system, and entrepreneurship came to the forefront. Following the example of these pioneering institutions, universities like Stanford and MIT committed themselves to entrepreneurial risk-taking and prospered.

The establishment of the prototype of the American research university was a critical evolutionary step in the growth and development of universities, setting the pattern for intense and focused discovery across all disciplines, the emergence of American-style graduate study leading to advanced degrees, including the PhD, and the emergence of the professoriate as both teachers and practitioners. The important point in this sketchy historical overview is that institutions of higher learning, like all organizations, are evolving entities. To the extent that they can adapt to a changing environment or, better yet, lead the change, they survive and flourish. Like other organizations, they also must be wary of institutional inertia, the resistance to change that almost certainly would bring about their demise.

Institutional inertia is nowhere more evident than in the academic valorization of increasingly specialized knowledge. In our effort to produce abstract knowledge without regard for its impact, many universities have lost sight of the fact that they are also institutions with the capacity to create products and processes and ideas with entrepreneurial potential. Prestige always will attach to the pursuit of the unknown, but I would argue that we must reprioritize our practices and rethink our assumptions if we are not to minimize the potential contributions of academic enterprise. Through some

Institutional inertia is nowhere more evident than in the academic valorization of increasingly specialized knowledge.

strange elitist logic, the concept of entrepreneurship has been eradicated from institutions of higher education in this nation. I would argue that we have been excessively attached to our lineage from the academies of ancient Greece and the medieval European universities. We must instead design some of our institutions to allow us to be competitive and address the challenges that will confront global society in the decades ahead. Our universities must recover an entrepreneurial edge if they are to be relevant and useful on a global scale. Yet, however significant the potential of their contributions to societal advancement, entrepreneurial universities must first expand access to a broader demographic if their impact is not to be diminished.

Dilemma: Excellence or Access?

Research universities both in the United States and around the world are the primary sources of the knowledge and innovation that have driven the global economy and provided those of us in advanced nations with the standard of living that we have come to take for granted. But in America and elsewhere, leading institutions tend to be *exclusive*—that is to say, they define their excellence based on exclusion. It generally is taken for granted that there are two types of universities: those that focus on academic excellence and discovery, and those that focus on access—providing a base level of higher education. Institutions that focus on academic excellence generally admit only the finest students, most of whom come from privileged socioeconomic backgrounds and have enjoyed undeniable advantages. All others are expected to attend less competitive schools. In terms of societal outcomes, this implicit calculation not only is shortsighted, but also may, in the long run, be a fatal error. There is growing social and economic stratification between those with access to a quality higher education and those without. More and more students who would most benefit from access to this most obvious avenue of upward mobility—those whom we might categorize as “disadvantaged” or “underrepresented”—are denied access for lack of means or choose not to pursue for lack of understanding of a high-quality university education.

Higher education is the means by which a skilled workforce is produced and the source of new knowledge capital and, thus, economic growth and advances in society, for the benefit of both the individual and the collective. The global economy requires skilled workers, and the wage gap between those with education and skills and those without continues to widen. More and more knowledge inputs are increasingly required to perform almost any job in the new global knowledge economy. The economic success of individuals contributes to the success of a society—in fact, it is the main driver.

If we continue to exclude a high proportion of the population from reaching their prosperity potential by excessive and sometimes arbitrary “culling,” we deprive countless individuals of opportunities to attain prosperity. We need to make more of an effort to understand how to educate greater numbers of individuals successfully, but we also must educate people to be successful. This economic dimension is intrinsic to the societal mission of colleges and universities. Individuals deprived of higher education through lack of funds represent not only personal opportunity lost, but also the loss of societal economic prosperity. Individuals deprived of college educations likely will earn lower wages and generate fewer jobs than they would have as graduates. A lack of

higher education is not only a personal loss; it is a loss for all of society and the global economy.

We reject the conventional wisdom that excellence and access cannot be achieved in a single institution and have committed ourselves to building a university that combines the highest levels of academic excellence with access to a broad demographic, and to accomplish this at scale. Such an institution seeks to provide the best possible education to the broadest possible spectrum of society, embracing the educational needs of the entire population—not only a select group, and not only the verbally or mathematically gifted. Its success will be measured not by whom the university *excludes*, but rather by whom the university *includes*, and from this inclusion will come the diversity necessary for the advancement of society.

Our mission, as we have conceived it, is to build a comprehensive metropolitan research university that is an unparalleled combination of academic excellence and commitment to its social, economic, cultural, and environmental setting. Excellence, access, and impact are thus integral to our mission and integrated in a single institution. Of the 150 major research institutions in our nation, both public and private, ASU alone has sought to redefine the notion of egalitarian admissions standards. Our approach has been to expand the capacity of the institution to meet burgeoning enrollment demand, and provide expanded educational opportunities to the many gifted and creative students who do not conform to a standard academic profile, as well as offering access to students who demonstrate every potential to succeed but lack the financial means to pursue a quality four-year undergraduate education. Our admissions standards are determined by our assessment of a potential student's ability to do university-level work, not by test scores or some other arbitrary indicator.

In the rapidly changing and highly competitive global knowledge economy, the value of a university education has never been greater. Higher education is the means by which a skilled workforce is produced, and is the source of economic growth and advances in our society, for the benefit of both the individual and the collective. Our colleges and universities play a key role in ensuring that, as a nation, we will continue to lead the world in innovation, maintain our competitive advantage, and weave the fabric of our economic prosperity. Without an increasingly highly educated citizenry, we as a nation may face a reduction in our quality of life in the next generation, something unheard of in the past. In order for America to remain competitive, it is imperative that our universities prepare our students to learn rapidly, and make them capable of integrating a broad range of disciplines in a rapidly changing world. But the institutional

design of our universities may itself represent an inherent obstacle. Our reconceptualization of ASU has been undertaken to correct a number of inherent design flaws in American research universities.

Demographic Challenges to Excellence, Access, and Impact

Arizona State University is at once the youngest and largest and fastest growing of all major American research institutions, enrolling more than 64,000 undergraduate, graduate, and professional students in twenty-one colleges of equally high aspiration configured across metropolitan Phoenix. ASU is the only comprehensive university in a metropolitan region with a population that already exceeds four million and is projected to merge into a megapolitan corridor with a population that could approach ten million in the coming few decades. As one of the fastest-growing states in the nation, Arizona will continue to experience large increases in its college-age population but lacks a sufficient four-year college infrastructure to accommodate that growth. Arizona's economy is insufficiently diverse to accommodate its population expansion, and the state has major challenges associated with its environment, health care, social services, immigration, and the performance of P-12 education. As is the case in California, where minorities already constitute a majority, within the near term, no single demographic category will comprise a majority of the population in Arizona. The rapid population growth is accompanied by rapid cultural diversification, and the unprecedented transformation of the regional demographic profile requires ASU to offer access, promote diversity, and meet the special needs of underserved populations.

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At the same time that the greater Phoenix metropolitan region matures and becomes the heart of a vast megapolitan region, ASU has set a course to evolve from a regional university to a national research institution of top rank. In response to demographic pressures, and because we believe that the university can best accommodate the needs of the region by facilitating the broadest possible distribution of its teaching, research, and community service, we plan to increase enrollment from the current level of 64,000 students to approximately 100,000 by 2020, thus providing expanded educational opportunities—both on-campus and online—to qualified students. To accommodate enrollment increases from 35,000 students in 1975 to 100,000 in 2020 is no small feat. In terms of resources and infrastructure, during the past five years we have added nearly seven million square feet of new academic space,

including more than one million square feet of new research space. The infrastructure required to accommodate such growth requires billions of dollars in capital investment and, in the past five years, we have invested \$ 1.5 billion in new facilities. There remain \$ 3.5 billion of additional facilities yet to come, and the government will finance less than one-third of those. Investment has come from private sector partners, donors, and multiple municipal governments. A master plan is redefining the relationships between the four ASU campuses, the clusters of colleges and schools that comprise each campus, the university community and its academic programs, and the university and surrounding metropolitan region. The intent of the master plan is to create campuses whose buildings and grounds reflect the scope and stature of a world-class institution and provide for our students a vibrant living and learning environment. Among the most important planning principles we observe is the integration of the campus into the community, which is consistent with our design aspiration of “social embeddedness.”

Consistent with our design aspirations to focus on the individual and transform society, ASU proudly champions diversity, and the enrollment of students of color since 1996 has increased by 81 percent. And, while the freshman class has increased in size by 36 percent during the past five years, enrollment of students of color has increased by 40 percent, with students from Hispanic backgrounds now comprising more than 14 percent of undergraduate enrollment. And, in addition to our Latino students, ASU enrolls roughly 1,500 students from Native American backgrounds, one of the largest such enrollments in the nation. In Arizona, our twenty-two Native American tribes speak different dialects that often are correlated with one another, but have no correlation with either English or Spanish.

Demographic diversification among ASU students is accompanied by differentiation in wealth. The average family income of the upper quintile of our students exceeds \$ 200,000 per year. The bottom quintile has a tenfold lower level of income, less than \$ 20,000 per year. Our institution thus enrolls students from families that are wealthy, even by American standards, and others from families that have virtually no income. The current level of investment in undergraduates through scholarship and gift support is approaching \$ 100 million annually and, for graduate students, exceeds \$ 50 million. We have greatly expanded both our investments in general financial aid, and in specific programs designed to help low-income Arizona students attend and graduate. The number of students enrolled from families below the poverty line has risen by roughly 500 percent, a number we expect will continue to grow, and we have increased the number of Pell Grant recipients by one-third, from

9,200 to 12,300 recipients. A program called ASU Advantage provides tuition, fees, room, board, and books (via merit- and need-based grants and scholarships, and work-study) for students who meet all normal admissions standards and whose family incomes do not exceed \$25,000. And all other students at all income levels pay only about 2 percent of the cost of tuition after merit-based scholarships and need-based grants. Although we expend university resources for programs like ASU Advantage and receive no support from the state, we are overcoming financial barriers to access.

As a public metropolitan research university, the profile of the student body, the character of the research enterprise, and the scope of community engagement differ from that of other institutions. ASU is a public asset that belongs to all the citizens of Arizona, and is an active partner with the private sector in initiatives to enhance the social well-being, economic competitiveness, cultural depth, and quality of life of metropolitan Phoenix and statewide. Consistent with our design aspirations associated with community engagement and societal transformation, ASU offers more than 1,000 outreach opportunities in partnership with more than 500 community organizations across Arizona. ASU is investing in the future of the many diverse communities beyond our campuses.

Institutional Redesign to Facilitate Access to Excellence and Academic Enterprise

Arizona State University is mid-point in a decade of unprecedented change and decisive maturation, positioning itself to emerge as a prominent global university and comprehensive knowledge enterprise committed to teaching, discovery, creativity, and innovation. To promote access to excellence despite the challenges of burgeoning enrollment, we have adopted a distributed model, operating from four differentiated campuses of equally high aspiration, with each campus representing a planned clustering of related but academically distinct colleges and schools. We term this empowerment of colleges and schools “school-centrism.” The school-centric model produces a *federation* of unique colleges, schools, academic departments, and interdisciplinary institutes and centers (“schools”), and a deliberate and planned clustering of programs on each campus around a related theme and mission. Predicated on devolving intellectual and entrepreneurial responsibility to the level of the college or school, the model calls for each school to compete for status, not with other schools within the university, but with peer schools around the country and around the world. Consistent with the design aspiration of academic enterprise, schools are encouraged to grow and prosper to the extent of their individual intellectual and market limits.

a view from the united states

The reconceptualized school-centric organization has produced a federation of twenty-one unique interdisciplinary colleges and schools that, together with departments and research institutes and centers, comprise close-knit but diverse academic communities that are international in scope. Consistent with this school-centric model, we have conceptualized and launched sixteen new interdisciplinary schools, including the School of Global Studies, the School of Human Evolution and Social Change, the School of Materials, and the School of Earth and Space Exploration. Although we are first and foremost committed to educating the students of Arizona, we are equally a cutting-edge discovery organization, focused on contributing to regional economic development through enhanced research and academic programs, including major interdisciplinary research initiatives such as the Biodesign Institute, focused on innovation in health care, energy and the environment, and national security; the Global Institute of Sustainability (GIOS), incorporating the world's first School of Sustainability; and the Center for the Study of Religion and Conflict.

Consistent with our objective of creating differentiated learning environments that address the needs of individual students, we have designated one of our campuses, for example, to emerge as one of the nation's leading polytechnics, with programs that provide both a theoretical and practical learning experience, preparing graduates for direct entry into the workforce. We are advancing two differentiated schools of engineering, one focused on research and the theoretical aspects of technology, and the other on practical application. Similarly, we have established three schools of education and three schools of management or business, each of which is built on a different learning platform. Some are focused on research, some on cultivating leadership skills, and some on practical application through learning-by-doing. We are overlapping and merging these programs to achieve maximum leverage.

At our four campuses, we have instituted a model with no campus-level governance—neither chancellors nor provosts, but only deans heading colleges and schools. Deans are responsible for the emergence of individualized learning environments. We also have made efforts to eliminate the hierarchization or “tiering” of campuses. We do not observe a distinction between a “good” campus, a “not-so-good” campus, and a “still-lesser” campus. Although not always explicit, that tiering process is very common in American universities, and perhaps in some European institutions, and it is a pernicious structural obstacle to student success. The historic Tempe campus used to be known as the “Main Campus,” but now we simply refer to it as Arizona State University at the Tempe campus.

a view from the united states

To fill out the picture of our organizational reconceptualization to maximize academic enterprise, I would like to consider some more complex and even radical modes of innovation. The first is an example of what we call “system innovation.” The goal is to have impact on a major social system through innovation in multiple yet interrelated ways, and the system we are targeting is the P-20 education system. This is a term used in the United States to refer to the whole spectrum of formal education, with the “P” standing for pre-kindergarten and the “20” standing for the last year of formal instruction in graduate school. However, I will summarize what we are doing as an institution to transform education through the twelfth grade.

First, we are building up our institutional capacity to deal with education. For instance, we now have not one but three schools of education, each with a different learning platform for the teachers and prospective teachers who enroll. One school has a focus on preparing leaders in education, another has a focus on technology and innovation, and the third is our more traditional school, the highly ranked Fulton College of Education. At the same time, we are building new collaborative partnerships with entities outside the university. These range from independent, nonprofit groups concerned with education to public school districts in Arizona. We also are becoming more active in education policy, working with public policy makers in our state government and with national organizations.

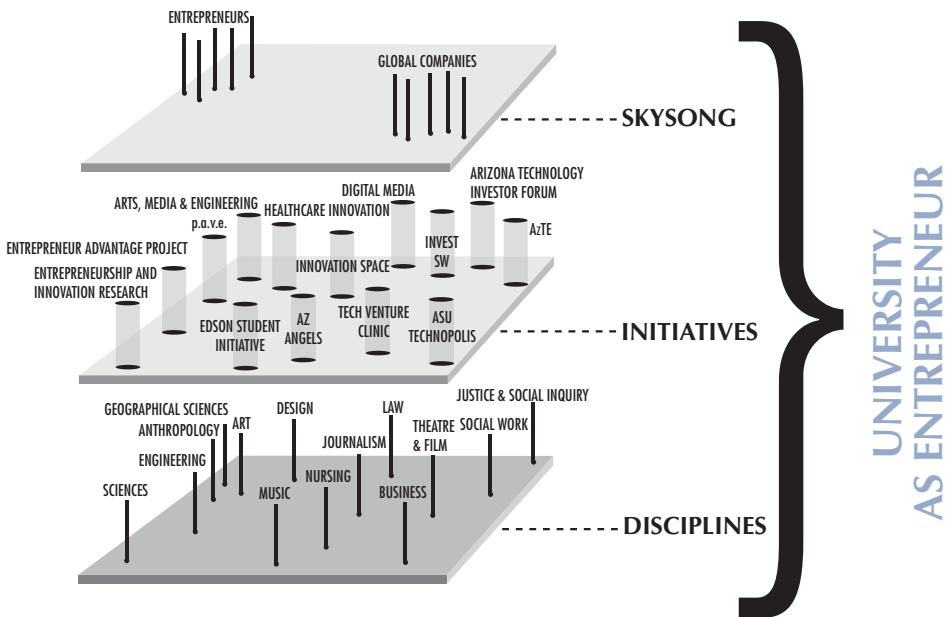
Finally, we are launching a number of strategic initiatives. One is a nonprofit enterprise called University Public Schools, Inc., through which we will operate our own schools to implement new ideas in education. Our first prototype, an elementary school, opened in August 2008. Our schools will not be elite schools for the children of professors, by the way. They will be for students from all backgrounds, including low-income families and immigrant households where the primary language is not English. We want to demonstrate how education can work for every student. We believe that, when education falls short, the main obstacle is not resource constraint, but, rather, idea constraint. So we are working across multiple dimensions—from redesigning the structure of our own university to starting actual new schools in the field—in order to create an entire system of innovation for transforming this social system.

Fostering an Entrepreneurial University: Toward an Ecology of Innovation

To foster the entrepreneurial potential of our institution, ASU also is trying to innovate more effectively by improving core processes that lead to innovative output. The obvious example here is technology transfer or intellectual property

a view from the united states

commercialization. A good bit of what we are doing in this area draws on the work of the Ewing Marion Kauffman Foundation, which has studied the issues extensively. At ASU, we are experimenting with several new approaches at once. To simplify the licensing process, for example, we have introduced the use of licensing templates and master sponsored research agreements, which can reduce the need to negotiate over terms and conditions. In terms of strategic objectives, we are managing our IP for deal flow density rather than for revenue—in other words, to maximize the number of inventions and discoveries actually moved into use, instead of trying to maximize near-term income from fewer and bigger deals. We also are experimenting with faculty entrepreneurship incentives, allocating the income so as to give faculty inventors a greater incentive for starting companies.



A systems innovation approach is reflected in our institution-wide campaign, called “University as Entrepreneur.” The overarching objective of this initiative is perpetual institutional innovation. Toward this end, we seek to inspire and enable both students and faculty members to innovate. In practice, we actually generate new enterprises—whether for-profit startup companies or new ventures in research or education, or useful new projects of any kind. As you can see from the chart, creating

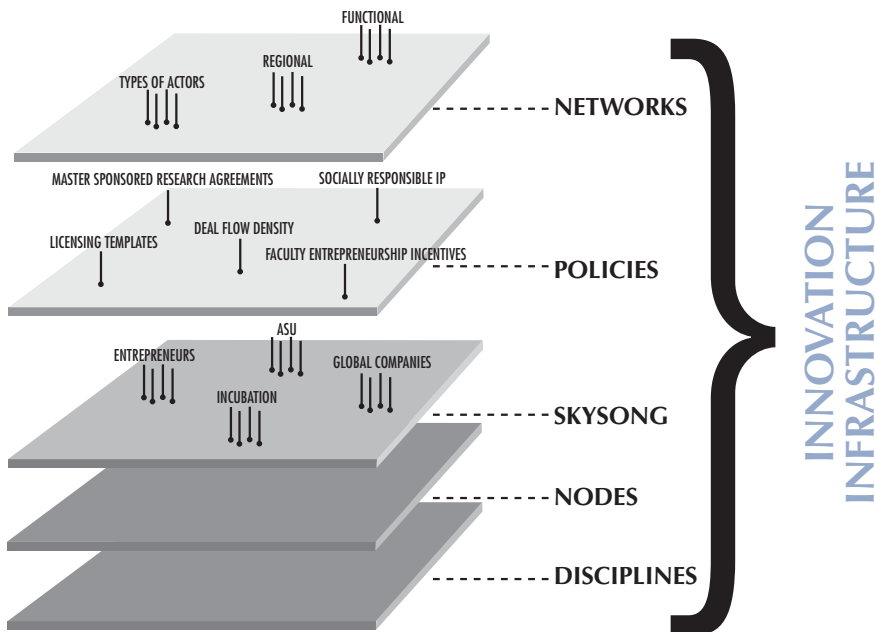
an entrepreneurial university is a multi-level task. We start at the foundation with our academic disciplines. We want to engage all of them, from the arts and humanities and social sciences, to the natural sciences and engineering and the professional schools. Instead of just teaching courses in entrepreneurship that would reach all of the disciplines, we have decided to embed entrepreneurial opportunities and learning environments within each of them. So our nursing college now has an innovation and entrepreneurship center. Our journalism school has a major industry-funded center for innovation in the news media. In every school and discipline, there is now a set of dynamic mechanisms for making innovation something that lives habitually within the context of the discipline.

At the next level up, we launch and facilitate a series of initiatives geared to assisting entrepreneurial ventures that come out of work in the disciplines. We believe there is value in fostering large numbers of initiatives because, inevitably, some will fail. In this manner, we allow natural selection to demonstrate which have merit. One that has shown particular merit is the Edson Student Initiative. Here we have raised an endowed fund to finance companies started by students. The students own the companies and the university expects no return other than seeing the companies take off. This is an idea we picked up from Tec de Monterrey in Mexico, and it is working well in metropolitan Phoenix: We are incubating about eighty student-led companies right now. Another initiative that has worked well is ASU Technopolis, which brings together entrepreneurs, venture capitalists, and creative thinkers in the Phoenix region. ASU Technopolis encourages innovation and economic development by providing fledgling technology and life sciences entrepreneurs with skills and strategies necessary to convert ideas into commercially viable businesses. Guidance is available for product development, business infrastructure development, proof-of-concept capital formation, revenue development, and access to funding. Technopolis stimulates economic development by offering a series of rigorous programs that educate, coach, and network local entrepreneurs. Through this program, approximately 500 early-stage companies have received coaching and mentoring, and they have raised about \$75 million in private investment capital.

The top level in the chart is labeled “SkySong,” which requires some clarification. It is not uncommon for universities to establish research parks, which begin as entrepreneurial ventures but often turn out to be more about real estate. We decided to make our enterprise more than the typical real estate project by expanding the vision. To position metropolitan Phoenix and the state of Arizona as competitive in

a view from the united states

the global knowledge economy, ASU conceptualized and designed a hub for knowledge-driven industries, technology innovation, and commercial activity. In collaboration with the City of Scottsdale and the ASU Foundation, ASU established SkySong, named for an iconic shade structure that is the signature architectural element of the complex. We enlisted a public-sector partner and a private-sector partner and, instead of just providing space for locally grown companies, decided also to recruit large global and foreign-based companies that could engage in beneficial exchange with the university and its startups. SkySong is a \$500 million world-class assembly point for knowledge and technology research and commerce. With 1.5 million square feet of densely packed and creative educational, research, cultural, retail, and residential space, SkySong will be the nucleus for an entire open-ended community of entrepreneurs dedicated to innovation and learning.



We have instituted a number of institutional policies that promote entrepreneurship and make it easy to move ideas into action, consistent with the policies mentioned earlier relating to intellectual property commercialization. Conversely, policies that discourage entrepreneurial behavior should be minimized. Unfortunately, many

universities have a wide range of such constraints—the kinds of policies that can inhibit decision-making, deaden creative thinking, and turn deans into paper-pushers. Changing the policy structure of the institution is an ongoing project that goes hand in hand with changing institutional culture. There have certainly been individuals who have disagreed with the objective of fostering an entrepreneurial university, or who did not see the value in it, and we have resolved the issue in a number of ways. We have conducted meetings and discussions to resolve concerns, and, as we advance, we attract new faculty and staff who are aligned with the vision and want to be part of it. In my six years as president, we have been able to move forward significantly.

Finally—and this is very important—an entrepreneurial university is highly *networked*. It has contacts and working alliances with entrepreneurs and industries, and with all sorts of individuals and groups concerned with innovation and growth. Along with cutting-edge research, universities that aspire to have broad impact are marked by a very high degree of connectivity, both internal and external. Such an ecosystem of networked connectivity creates many pathways for people to move ideas from conception to reality. When all of the elements are working together, one perceives a well-rounded *innovation infrastructure*, and the university becomes part of a larger *ecology of innovation*.

An Investment Model for Academic Enterprises

Along with organizational redesign comes the need for reconceptualization of the institutional mindset. Like other public institutions, ASU derives the majority of its operating budget from the State of Arizona, which has led it in the past to conceive of itself as an agency of the state government. But as universities reinvent themselves as academic enterprises navigating in the competitive academic marketplace, it is imperative that they assume responsibility for their advancement consistent with the paradigm of an investment model. With the investment model at ASU, we make the case that if either the private sector or the public is willing to lend us financial or political support, we promise to work to deliver a specified return on investment. The simple argument for investment of taxpayer dollars in a public university proceeds according to the following logic: If the appropriations committee of the state legislature invests specified resources, the university promises to work to deliver an agreed-upon return. Without such an investment, there can be no return on investment. Here is the negative impact from not making that investment. Here is the impact of that non-return on the overall enterprise—the state—that is in your charge. The same argument can be made for investment from the federal government, business and industry, and foundations and individuals.

When we have made requests for tuition adjustments, we present it as an argument for investment. This past year, we published a sixty-page white paper on the return on investment to a family making investments in tuition for their children, or students making investment in themselves, and we calculated the annual rate of return to the individual over his or her lifetime at 12 percent. A college education is the most significant investment that anyone can make over that time frame. When we requested \$233 million from the City of Phoenix to establish an ASU campus downtown, we made it on an investment basis. We went to the city with our vision of what we want the university to become, and said, “If you make this investment in us, we will be able to start a campus on twenty-two acres of land in downtown Phoenix. Here is what we will commit and what our schools will be able to achieve with these new facilities.” It is difficult to refute such sound logic.

When one considers the effort required to build this new kind of university, one perfectly reasonable question that may arise is: How do you pay for it? The answer to that question has several parts. We have had to rethink and make adjustments to our overall financial structure, as one would with any major program of reconceptualization. In some cases, new initiatives have been launched on an entrepreneurial basis—that is to say, they receive initial seed funding, but beyond that they must raise or generate their own funds. But here is the best part: We have found that this model of the entrepreneurial university *attracts investment* from others. It is a model that invites wide-ranging participation and promises and delivers wide-ranging benefits. If an institution can put forth an entrepreneurial model of this type, individuals and corporations and foundations and governments will validate it by investing in the vision.

To summarize a few major investments: The Kauffman Foundation has given us a \$5 million grant for our effort, which we leveraged to attract another \$25 million in matching funds. Entities of regional government, with whom we had no financial relationship in the past, have put in significant funding: the \$233 million grant from the City of Phoenix and a \$100 million grant from the city of Scottsdale. Private individuals have invested hundreds of millions of dollars to create endowments for venture funds, for other initiatives, or for particular schools and colleges at the university. Altogether, in advancing this model, we have been able to generate about \$1.2 billion per year of new resources for the institution in the last six years.

This model puts us in a much better position to compete for major research funding because, in addition to basic research capability, we can demonstrate the *entrepreneurial* capability to move the research forward and develop it for application.

This is valuable to sponsors who want to see not only the discovery of new knowledge but also real-world results. Recently, for example, we have attracted significant investment for new approaches to attacking cancer. The government of the Duchy of Luxembourg is partnering with us on a \$200 million effort targeted to lung cancer, and we were one of three institutions to win highly competitive grants for new cancer research authorized by the U.S. Congress. Also, the U.S. Army has funded a \$110 million project to develop a thin-film flexible display that would be wearable on the body or disposable like paper. Again, they chose ASU because they believe that our faculty—working with the thirteen companies that we have brought into our facility with us—will be able not only to determine the scientific pathway to this technology but also be able to actually develop it.

Toward Entrepreneurial Universities Capable of Perpetual Innovation

The very identity of the university is at stake today and each institution must focus on establishing its own unique and differentiated identity. The question, “What is a university?” is one that every speaker at this conference is in some respect addressing. What are these institutions called universities, and how are they different from other institutions and organizations in our society? And, more to the point, why do universities need to assert their difference from other institutions and insist on their status as enterprises? The greatest universities that exist on the planet have emerged in America during the past several hundred years, and especially during the past century. All of these institutions share a set of characteristics that are consistent with the great universities that have emerged in the past. A principal characteristic of great universities is that not one of these institutions conceives of itself as either a corporation or an agency, by which I mean a standardized unit of government. All of them have emerged as enterprises. Some are public and owned by collectives such as the State of California or the State of Michigan. And some are private and self-perpetuated by groups of committed stewards who, over the course of centuries, have guided their institutions to greatness.

A number of environmental forces are, or should be, influencing how each of us redesigns our universities going forward. Different institutions may succeed by responding differently, but there are some strategies that are almost sure to fail. One is to rely on existing approaches, trying to advance the university as it has been advanced in the past. Another is the insular approach, simply perpetuating the university as if it is a remote monastery immune to outside forces. The temptation is great for universities to isolate themselves in abstractions, perpetuating their institutional cultures with their own sociologies and vocabularies, focused primarily on their own dynamics and their own

constraints. It is incumbent on universities as never before to help solve the pressing global issues of our time: population growth, climate change, national and international security. The scale of knowledge transfer must increase as the demand for new knowledge increases. It is essential to realize that continued economic growth depends upon innovation and that the global economy operates according to the forces of “creative destruction,” described by the economist Joseph Schumpeter nearly a century ago. The only way to move forward is to replace what you have with something better—to innovate and to create new technologies and products and processes that replace those that already exist. We must accelerate the pace of our academic culture to move in sync with the needs of the world. And the ultimate driver is competition. The globalization of American universities is accelerating because of the rise of global competition. Globalization is the outcome of hundreds of years of connectivity through trade and the transfer of knowledge between cultures, and, as the nations of the world become more deeply entrenched in the process of globalization, universities have no alternative but to embrace it.

The industrialized nations peaked some time ago in their capacity to continue to enhance capital creation, both in terms of raw numbers and access to that capital creation process by all segments of our society. Several decades ago, the United States was the world’s dominant economic force. But now we face a challenge to our identity because we must look toward the future as only one of a number of major economic powers, each interrelated and cooperating with others, but, at the same time, competing in completely new ways. Continued economic growth must remain an overarching objective, because if we stop growing economically the social outcomes will be dire. If we do not embrace perpetual innovation—and by this I mean innovation in university design itself—not just the products of the university but also our collective standard of living will decline, our way of life will be threatened, and opportunities for the success of future generations will be diminished. The scale and speed of knowledge transfer is unprecedented, but we must ask ourselves where the new entrepreneurial institutions are that will teach our students how to thrive in this new environment. Where is the next great entrepreneurial university that will prepare the next generation for perpetual innovation?



Building a Global University

by Alan Merten
President, George Mason University

President of George Mason University since 1996, Alan Merten has championed global development throughout his career—often while working across the disciplines of technology, business, and education. After earning a PhD in computer science at the University of Wisconsin, he held positions at several universities in the United States, Hungary, and France. He has served on many boards and commissions for governments and industries; in the United States, he was chair of the National Research Council’s Committee on Workforce Needs in Information Technology, and a member of the Virginia Governor’s Blue Ribbon Commission on Higher Education. During his presidency at George Mason, the university hosted the inaugural World Congress on Information Technology and has expanded its global presence in all fields.

In the summer of 1974, my family and I lived in Budapest. At the time, I worked for the United Nations Development Program, teaching Hungarians how to teach computer science. About two months into our stay, our then-two-year-old daughter asked her mother and me to buy her a cat. We declined, saying that she could get a cat “when we were home.” Her response was simple: “We are home.”

Nearly thirty-five years later, I still smile at that memory, but I also have come to realize that Melissa was right. We were home. Sally, our son Eric, Melissa, and I were living our lives in Budapest and carrying on our business much as we had done in the United States. From the perspective of a two-year-old child, there was no difference.

I am fortunate to be the president of an institution of higher learning in the United States that boasts more than 30,000 students, offers more than 150 degree

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programs, has campuses in three locations within the state of Virginia, is establishing a fourth campus in the United Arab Emirates and a branch campus in East Asia, and has reciprocal and exchange agreements with sister institutions throughout Asia and other parts of the world. George Mason University is, indeed, a global university. Consequently, whether I am sitting in my office in Fairfax, Va., or meeting with faculty in the UAE, I consider myself to be at home. At all of our locations, we strive to provide students with the best education we can, and help enhance the economic strengths of our various regions.

I wish to address today the challenges and merits of becoming what I call the “global university.” By this I mean a university that is engaged in many or all key areas of the world, and uses a wide range of technologies and communication channels that link individuals, localities, national units, multi-national businesses, and trans-national regions. Such a university draws upon faculty, students, and administrators who are knowledgeable and adaptable enough to embrace this new paradigm, and who are willing to lead and cooperate at all levels. A global university does not exist in the ivory tower of yesterday. It is an entity with ever-growing and reciprocal linkages to other entities of equal influence and growth potential, including corporations, domestic and foreign municipalities, and governments.

At George Mason, we strive to have all these attributes. But, we neither embarked on the mission nor reached our present stage overnight. Our process has been long and complex. I will try to describe it briefly here from several perspectives, including the fundamental steps that universities generally should take if they want to become global—as I believe many want to do—and the challenges of implementation.

Why Go Global?

To begin, why should a university go global, and why does the world need such global institutions? I can answer these questions by drawing on our experience at George Mason.

Our transition to a global institution began in the early 1980s when the university leadership made concerted efforts to think beyond standard academic organizations. In the early stages, this meant developing cross-disciplinary programs. One graduate program in international commerce, for example, linked culture, politics, management, economics, and law. All of the academic disciplines were encouraged to build more links across existing boundaries. At the graduate level, this often meant exploring “niche” zones between disciplines for new programs.

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These efforts helped to open the way for the next stage of the metamorphosis. As we reached across disciplinary lines, we realized that it also was necessary to reach across national borders. We saw the world becoming more “flat,” in the words of Thomas Friedman, and, of course, more competitive. Also, we recognized that issues were emerging that go beyond the concerns of any one country or continent. Issues of this kind, whether they are economic, environmental, or communicative, are global challenges that only can be addressed from a coordinated, cooperative global perspective. Confronting them adequately would require the combined efforts of leaders, thinkers, scientists, educators, communicators, and scholars in all disciplines throughout the world. In short, we realized that, to become a significant institution of higher learning in the twenty-first century, our strengths and vision needed to match the needs of the global community. We needed to be active partners rather than simply good neighbors.

Since the early 1980s, of course, much has been written and said about global competition. Yet even this competition requires greater cooperation if it is to persist as a force for the good of all. As nations throughout the world strive to advance their economies by producing new and increasingly complex goods and services, they need highly qualified workers who understand global markets. For competition among nations to be sustained in a healthy way, new trans-national agreements, regulations, and procedures must be established. All of the crucial work demands individuals who are well-educated for it, by colleges and universities.

This dynamic has never been truer than it is today. Universities are at the forefront of major social changes. And, increasingly, when it comes to global change, universities are expected to be at the forefront. We at George Mason feel the urgency of globalization from our state and federal governments, in terms of their funding decisions and the programming they wish to support. We feel it in our interactions with local businesses and technology communities. We feel it in the requests from students and their families for programs of study that provide understanding of, and competencies for dealing with, many global issues.

The question is not whether an institution should respond to these signals from its major stakeholders, but how and when.

The Path to Becoming Global

From our experience, the primary steps in any transition to a “global university” need to include:

- (1) establishing new priorities that recognize the importance of global understanding;
- (2) realigning resources to promote growth in the appropriate places;
- (3) providing the intellectual leadership for academic research and scholarship that seeks real solutions to global problems;
- (4) ensuring that the institution’s global efforts are well-coordinated; and
- (5) embracing the wave of globalization so that any individuals or programs that are not initially part of this movement have opportunities to adapt. When necessary, people must be given opportunities to reinvent themselves so they are not left behind.

Let me cite a few examples of how George Mason has attempted to ride the wave of global education. These are outlined in a forthcoming book by our provost, Peter Stearns.¹

Our general education programs now require courses in global understanding. We have geography courses that are taught in Spanish, Arabic, and other languages. We offer education courses to foreign teachers of Chinese and Arabic. We offer electronically shared sociology courses with the Higher Economics School in Moscow. We offer global courses in management, health, and environmental science and policy. Nearly 20 percent of our undergraduates study abroad, and our school of management has a very successful study-abroad MBA program.

Other examples include a memo of understanding with a university in Northern Nigeria in the area of conflict resolution; a one-two-one agreement with Chinese universities whereby undergraduates from China come to Mason for two years, then return home for a dual degree; and an intensive two-week visit by communication students to England each January to work with public relations professionals and gain a broader understanding of this industry.

These programs and numerous others operate within an environment in which 6 percent of our students, or nearly 1,800 young men and women, are from other

1. Stearns, P. (2009). *Educating Global Citizens in Colleges and Universities: Challenges and Opportunities*. Routledge: NY, NY.

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countries. Collectively, they represent 125 nations. We are one of the most diverse universities in the United States. This is, without question, one of our great strengths. The diversity of our students adds an invaluable richness to our classes. With their different histories, life experiences, and knowledge, they bring perspectives that otherwise would not be present. In particular, our American-born counterparts, including teachers, are the better for it.

But the transition to a global university is not necessarily an easy one. It requires an uncompromising institutional commitment that calls for the buy-in of everyone. Assuming this is achieved, other hurdles remain. They range from funding the various initiatives and changes, to administrative realignments, to dealing with uncontrollable environments created by international politics and tensions. These are realities, but they are not insurmountable. George Mason University is less than forty years old, yet we have moved to a point where our connectivity is not just with our own region or state, but with the world.

I often am asked about the role of the president in such a transition. It is vital that the university president set the tone for the institution to accept the mantle of “global.” The president should be a combination spokesperson, cheerleader, and architect. He or she must be active and visible in lending support, so that the staff and faculty can see high-level commitment to moving the institution in a global direction. Words are important, but they must be complemented by action, as people pay close attention to what the president actually does and even where the president goes. At George Mason, for instance, the Office of International Programs and Services has an annual program called International Week, and I always make a point of attending as many of the events as I can. It also is vital that the president bring together the right team of scholars and professionals to implement and facilitate global initiatives. Mason is blessed with a strong provost and set of academic deans who play important roles in this movement.

George Mason University now has made the transition to being a global university. Yet this shift is not something that can be done and then simply crossed off a to-do list, the way one does a list of errands on a weekend. Maintaining this commitment requires as much effort as the initial decision to make it. At the same time, the realities of our ever-shrinking and ever-challenging world demand it. I would defy anyone to name one global challenge that does not have education as part of its solution. This is why universities must become leaders in helping connect as many entities throughout the world as possible.

United in Diversity

I began my talk with a story about my daughter. I'd like to close by giving equal time to my son. In 1983–1984, my family and I lived in Fontainebleau, in France, where I was a visiting professor at INSEAD, the international business school. On the flight back to the United States following our time there, I asked Eric, who was then sixteen, what he had learned during the past year. He thought for a moment and then said, "I learned that two things can be different from each other without one being better than the other."

My son, like my daughter, was right. The same holds true for colleges, and universities, and countries, and cultures throughout the world. They are different, yet they share similar challenges, and their people need to be provided with guidance and resources to address these challenges. Global universities can help do this.

The author wishes to acknowledge the following individuals for their assistance with this article: Sharon Cullen, executive assistant to the president; John Paden, Robinson Professor of International Studies; Daniel Walsch, press secretary; and Ming Wan, Professor of Government and Politics.



The Futures of Universities in Europe

by Thomas Andersson
President, Jönköping University

Thomas Andersson is president of Jönköping University in Sweden and a professor of economics at Jönköping's International Business School. Previously he was deputy director for science, technology, and industry at the Organisation for Economic Co-operation and Development (OECD), and the head of the Structural Policy Secretariat in Sweden's Ministry of Industry and Commerce. Published widely on international economics and industrial organization, he has been a visiting fellow at Harvard University, the Bank of Japan, Hitotsubashi University, and the University of Sao Paulo.

We all know that universities in Europe are subjected to pressures for change. My purpose here is to outline some major economic and social trends and to indicate what is required for the universities to cope with them in the years ahead. I will start with a few words about my own university, which is a relatively independent institution, and thus has had a good bit of freedom to prepare for the future that I see coming.

Jönköping University is one of only three universities in Sweden that are not public authorities (the Stockholm School of Economics and Chalmers Institute of Technology in Göteborg are the others). Because we are not public, we can design our organizational structures differently, and I would say that at Jönköping we have a mix of favorable characteristics: the ability to make strategic decisions among the board members, coupled with a fairly decentralized organization that places high

accountability in the different schools. These schools include engineering, health sciences, education, and communication, and a young international business school that specializes in business renewal and entrepreneurship.

The ingredients for success in our case, as we see it, are:

- being a “foundation” university with high autonomy;
- having a unique governing structure;
- dedication to specialization—including entrepreneurship; and
- strategic partnerships locally and globally.

As one illustration of the importance we attach to partnerships, we have been able to enlist about 850 small and medium-size enterprises to serve as mentors for each of our students in engineering and business. Worldwide, we have developed 380 university partnerships. While admittedly we are not in a position to work closely with this large a number, nonetheless our large network has helped serve as a platform for student exchange. We also work seriously on research collaborations with a smaller number of the international partners.

We have worked systematically to integrate our Science Park, which is a local hub for business development, with activities at our university. In that Science Park, we have rented space for a “business lab” where our students can tinker with ideas for creating new companies. We find it to be essential that the students also be able to meet with more sophisticated and experienced entrepreneurs, and for that we will need both a proper incubator and a section for growth companies. Currently our students are creating about seventy companies per year through the business lab; our main challenge is to put better conditions for growth into place.

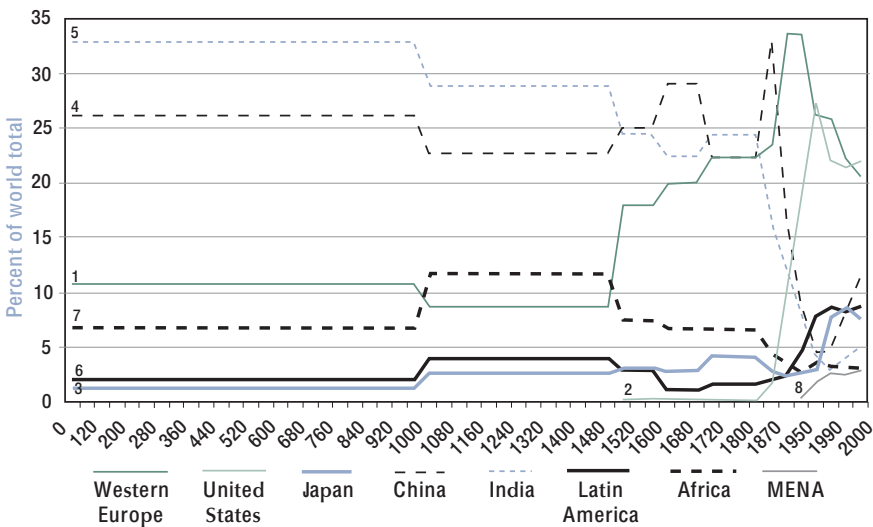
The few highlights I have just given you imply that Jönköping University is gearing up to form its specific part of a new kind of economy and society. Let’s now pull back to consider the larger picture.

A Changing Economy

We all are experiencing a set of massive changes in the world economy. If we were to look at shares of world GDP between 1980 and the present, we would see the relative decline of Western Europe, a stagnation of the share of the United States, and the rise of new players such as China and India. But to see how dramatic these developments really are, let’s take a more long-term perspective and go back to the

year zero A.D. Of course, we cannot retrieve actual economic figures for that whole time span. But just by looking at various estimates based on what is known about history, we can clearly see dramatic changes, as shown in Chart 1.

1. Shares of World GDP, 0–2000 A.D.



Source: The World Economy, OECD, 2001

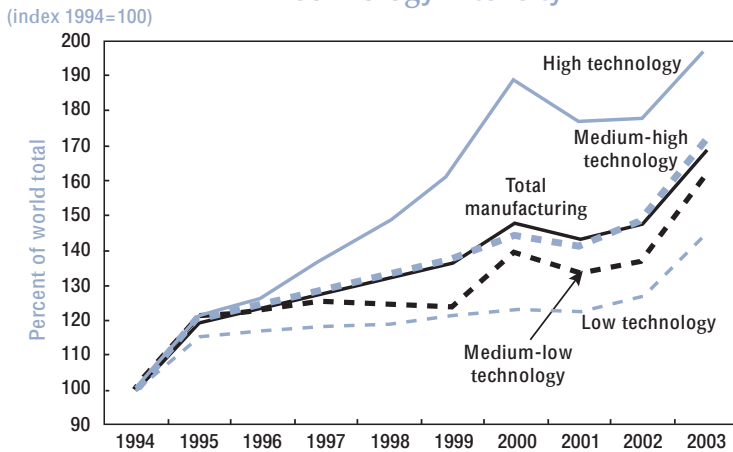
For a very long time, the dominant economic powers were elsewhere, in China and the far East. Then comes the rise of Europe, and later the United States, over the past two centuries. In the last few decades, many of the old players are reemerging. Clearly, further changes lie ahead.

It also has been shown that economic growth tends to go hand-in-hand with the quality of national governance—that is, the more vibrant economies usually are found in countries that have stable and effective governments, the rule of law, relatively low corruption, and so forth. But there are changes on this front as well. The nation-state is starting to lose its standing as the pre-eminent unit of governance. We now have a movement of responsibility to the super-national level on the one hand, and to the regional and local levels on the other hand.

Clearly, these processes are far from complete. At the super-national level, for instance, certainly the European Union has made major strides. It is revamping the European landscape in many ways. But the multilateral institutions need further work. We still are far from where we would like to be globally, on international trade, climate change, and other subjects. Nor, despite many efforts, do we have a good multilateral framework for protection of foreign investors. In this area, as in many others, what we have instead are a plethora of bilateral treaties—China, in particular, has a multitude of them. So the old pattern of important conditions being slugged out bilaterally, country by country, still is going on.

Of course, there are other drivers of change. A big one is the rise of a more knowledge-intensive economy, as shown in Chart 2.

2. OECD¹ Manufacturing Trade² by Technology Intensity



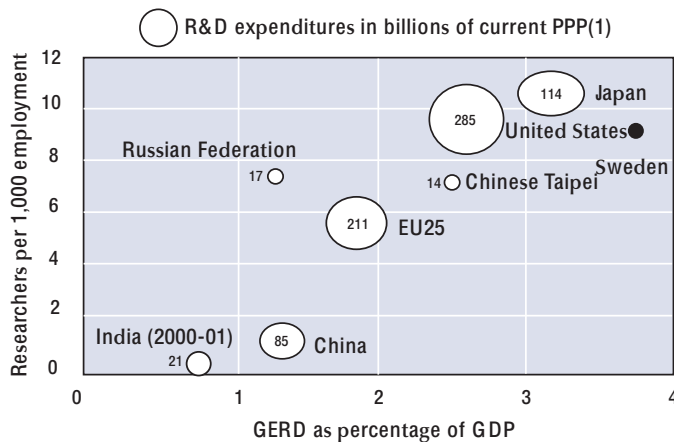
1. Excluding Luxembourg and Slovak Republic
 2. Average value of total OECD exports and imports of goods
 Source: OECD, STAN Indicators Database, March 2005

In this chart, drawn from the OECD’s (Organisation for Economic Co-operation and Development) sector classifications, it is evident that trade in the “high technology” sector—the most knowledge-intensive sector—has grown tremendously in significance. But important changes also are occurring within sectors, such as in medium- or low-tech industries where firms used to be able to compete on the basis of low cost and

standardized production. Even in those industries, it is becoming essential to innovate and to add value through knowledge work. There's less room for surviving merely by being a low-cost producer.

As a result, nations are paying far more attention—bordering on obsession—to research and development. The European Union and others now are in a race to match the R&D lead of the United States and Japan, in particular. Chart 3 shows who is leading—and who is still lagging—in two measures: total R&D investment as a percentage of GDP, and researchers per capita.

3. R&D in the OECD and Non-OECD Area, GERD in Million USD, 2003



Source: OECD, STI Scoreboard 2005

In economies with high R&D intensity, the private sector is driving it to a large extent. Sweden, which ranks high on Chart 3, has less than ten private companies that account for around 80 percent of its private-sector R&D. Nevertheless, the public sector is very important for the innovation system, too, especially in what we used to classify as basic research and basic science. A country such as Sweden invests heavily in academic research—more so in proportion to its size than the United States, for instance. Sweden, Switzerland, and some other European countries also score high in terms of scientific publications relative to the size of the country.

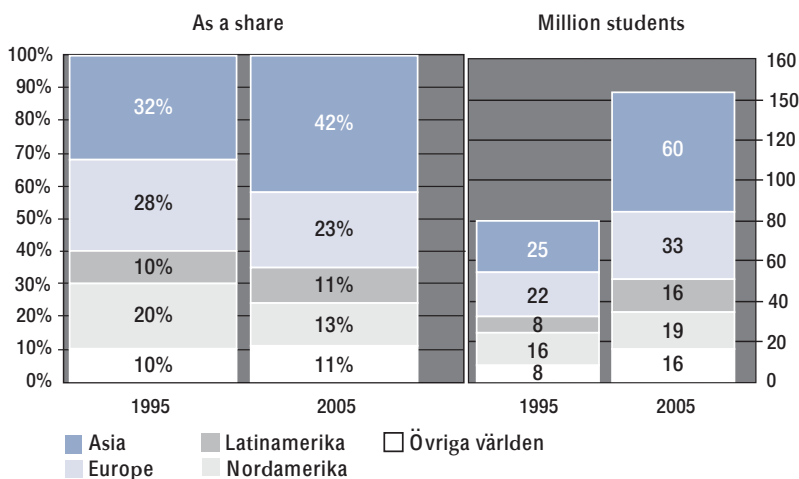
But none of these input measures, in and of themselves, really capture innovation and the economic growth that results from it. Nor do other factors, such as the traditional measures of human capital by education level.

Education: The New Global Growth Industry

It has long been believed that, if there is one sure driver of economic growth, it is more investment in education. But that relationship is not as strong any more—or, more accurately, it is not as much of a differentiator as it once was. Many countries have invested heavily in basic education. We now see rising literacy rates and rising enrollment in secondary education worldwide, with the traditional powers such as the United States and Europe no longer having immense leads in these areas.

In short, there is vigorous competition today in educational attainment. There is a great and ongoing expansion around the world of tertiary education and university systems worldwide, as seen in Chart 4.

4. Expansion in Higher Education and Regional Distribution



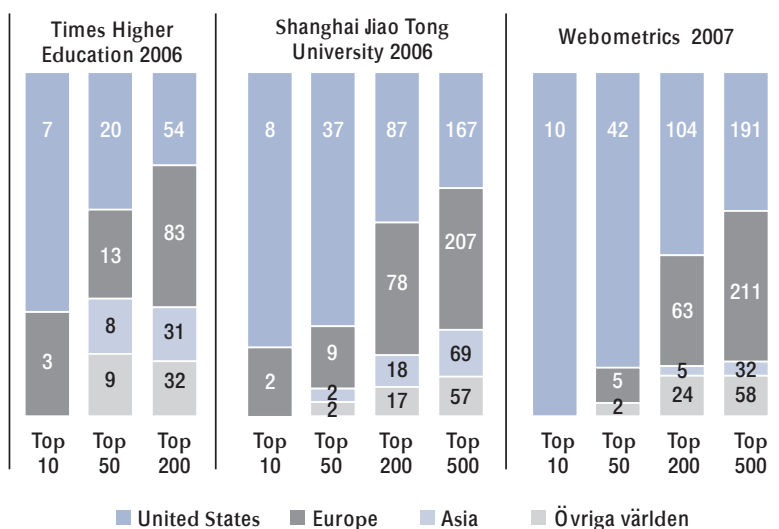
Source: Euromonitor (2007)

Chart 4 makes clear that higher education is a massive new growth industry. In just ten years, the number of students in tertiary education has risen from about eighty million to about 140 million worldwide, with especially big increases coming in Asia and

other emerging market countries. But these numbers alone do not tell the whole story. It is important not to confuse more *quantity* in education with high growth. To a very large extent, what matters is quality. What are all these students actually learning? How are their skills to be applied? And how can we measure the quality of the institutions engaged in this growth industry?

Chart 5 is drawn from three major global ranking systems for universities. By these standards, universities in the United States rank best at the very top of the scale, while European universities become comparable only when we get to the “top 200” or “top 500” institutions.

5. University Ranking, Regional Distribution



Source: Times Higher Education; ARWU Shanghai Jiao Tong Och Webometrics

Having said this, *how universities respond to the challenges facing them is not really reflected in rankings*. The changes taking place throughout the world of higher education are, again, multifaceted. Consider these additional facts and developments:

- We now are getting students who perhaps are not as well prepared, or as knowledgeable overall, as those in the past when we still had a more “elite” system. Yet, at the same time, these students are more demanding and less prepared to accept authority than past generations.

- We have a lot more nontraditional, working-adult students.
- We have an explosion in online distance education. We also have more students choosing to study and live abroad: The OECD countries now have a total of 1.3 million foreign students, 44 percent from Asia, 31 percent from Europe.
- Higher education remains publicly funded to a major extent, but private funding is on the rise, and universities are internationalizing operations.
- Finally, new entrants are getting into this growth industry. New universities and also other kinds of institutions are entering higher education and challenge the incumbents worldwide.

Key Factors for the Future

Are European universities positioned to handle all of the changes I've outlined? Rather than answer with an assessment of the present situation, let me tell you some factors that I think will be keys for the future.

One major point is that, as we train our students and as we try to be relevant to the future economy, we cannot keep working with technologies and industries in the old sense—simply by drawing on basic science and by educating students to do it. Innovation and entrepreneurship have to be present in a fundamental way. And this, in turn, means building an increased ability to respond to people's real needs. Innovations need to be pulled by the markets. We need to prepare people for that work, and also allow them to engage in such processes in diverse and flexible ways.

Technologies and innovation have grown so immensely complex that no single individual, no single organization, can manage more than a particular piece of the puzzle.

A second point is that technologies and innovation have grown so immensely complex that no single individual, no single organization, can manage more than a particular piece of the puzzle. Thus, specialization is essential, and so is collaboration—working, learning, and growing together with others, as we all attempt to do new things in new ways. Further, synergies between complementary assets and skills may be cultivated in a myriad of ways, which can only be developed and learned from gradually.

Third, having the courage to try out radical innovations is essential. Incremental innovations and marginal changes no longer are sufficient. And for this to be possible,

there must be openness to setting up new ventures and experimenting with new structures. The university system must be open-minded itself, and it must foster and educate people who can take advantage of new opportunities.

Fourth, and finally, it is not enough that universities are capable to change. Governments and public policies must learn how to embrace change as well; for this to happen, societies and companies and individuals must become more open to diversity. Let me give a couple of brief examples from our attempts to build a more entrepreneurial economy in Europe.

Seed funding for new ventures is one area where the governments in Europe still are thinking too much along traditional lines—believing that public money could perhaps be pushed in to fill the “gap” between the public funding of scientific research and the commercial funding of growing companies. But that gap is not about lack of money. It’s about agency issues, information issues, and lack of trust among the

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different actors that need to operate together: those with money, those with the ideas, and those who are entrepreneurs. We need more sources of seed funding to play their role, spanning “friends and family,” business angels, and various forms of venture capital. We need the entire chain of seed and growth to work out. We should strive to create an environment in which complementary people can truly get together to generate, and support, fruitful ideas for ventures with high growth potential.

The second example has to do with the fact that the information society is moving into a stage where we need to do much more to keep up with it. The interfaces among actors, and between us as human beings, and the technology, are growing so intense and complex that we have to be able to think and act in new ways.

Information technology is already in our cars, toys, and appliances. We are wearing it and carrying it; it’s in our houses and buildings, and there soon will be a time when it is literally “in” us, as well. The question is not whether this is going to happen. The questions are whether we want it to happen, how we want it to happen, and what people will be demanding. We need the structures and outlook to be able to deal with all this change so that what becomes “essential” technology is not for technology’s

own sake, but for the sake of people as well as society at large. Issues related to data governance and the complex of information security, privacy, and integrity already present enormous challenges and will grow in importance as technology advances. To deal with all these issues, we need more synergistic relationships between governments, the private sector, and academia. That interface should further center on people and help achieve that people are moving from ignorance to awareness, from passivity to activity, and from uncertainty to confidence.

Europe and its universities are opening up to the challenges and opportunities of the future. The main concern is that this process is too rigid, that there is too much looking back, and that it is taking too much time. We have governments and regulations that hinder adjustments and specialization; we have traditions and vested interests that favor standardization and/or fragmentation and which impede new combinations, diversity, and experimentation. We have career paths for researchers that remain too standardized and traditional—and there is still an excessive belief, in plenty of corners, that the “big” approaches that worked in the past are the key to the future. Certainly we need big institutions, but we also need more nimble and flexible players to go into new areas and try out new ideas. Without greater appreciation for pluralism and diversity, true progress will be thwarted.

In conclusion: I believe there is good reason for optimism. Europe and many of its universities are moving in sound directions. Given the obstacles we have faced, I am sometimes amazed that so much is being done so well. But much more has to be achieved, in multiple ways. We need to hang in and keep improving. Our potential has only begun to be realized.



For German Universities, a Time of Sweeping Change

by Axel Freimuth
Rector, University of Cologne

Axel Freimuth has been rector (president) of the University of Cologne since 2005. Previously, he was dean of the Faculty of Mathematics and Natural Sciences. He earned a PhD in physics at the University of Cologne in 1989; then went on to become known as a researcher in superconductivity and other areas of solid state physics. Dr. Freimuth held a professorship at the University of Karlsruhe before returning, in 1998, to Cologne, where he continues to head a research group in the University's Institute of Physics.

Since our topic is the future of universities in Europe, I thought it might help to start with a look at the Lisbon declaration of the European University Association, entitled “Europe’s Universities Beyond 2010.” A central theme of this declaration is the diversification of Europe’s university systems. Other important themes are the autonomy and funding of the institutions, the promotion of research and innovation, introduction of the three-cycle higher education structure across Europe,¹ the internationalization of higher education, and last, but not least, quality processes. All of these issues are relevant for Germany’s system of higher education. Currently, Germany is engaged in the largest reform of that system since the middle of the last century. My talk will briefly address some of the major elements of this reform effort.

1. A three-cycle system has programs of study leading to bachelor’s, master’s, and doctorate degrees. This has not been the standard throughout Europe. Germany has long had a system in which the entry-level degree program at “research-oriented” universities was longer and equivalent to a master’s. The Lisbon declaration was issued in 2005 and, as of 2008, Germany was in the process of changing to the three-cycle standard.

Diversification is a central objective of reform. In the last decade or so, Germany has opened its universities to a wider public. At present, about 30 percent of college-age youth attend institutions of higher education, and the goal is to further increase this number. But, as the Lisbon declaration says, “moving from an elite system to a mass system implies the existence of universities with different missions and strengths.” It is therefore necessary to have different kinds of study programs and institutions that are appropriate for the variety of students’ talents and interests.

To date, however, only a limited amount of curricular diversification has been accomplished. A few numbers make this clear. At present, there are about 250 state institutions of higher education. One hundred of those are universities which can award a doctorate, and which all have more or less the mission of a research-oriented university. Also, there are about one hundred universities of applied science, or polytechnics, as some call them. They do not award doctorates, and provide an education with a strong practical focus. In addition, there are about fifty colleges of arts and music. In contrast to other countries, by far the most students, almost 70 percent in Germany, attend the research-oriented universities. Thus, diversification with respect to study programs and institutions is rather poor. And there is a further problem as well: Germany cannot afford to support one hundred research universities in a way that they all are able to compete internationally. In the past, the available government funds were more or less equally distributed over all one hundred schools. But equal funding works against the goal of international excellence. At present, not one of Germany’s universities is among the top twenty in the world rankings.

Accordingly, a three-pronged reform effort in Germany is now underway: a conscious effort to achieve more diversification, an increase in resources for higher education, and the distribution of funds to institutions according to their missions and their performance.

Accordingly, a three-pronged reform effort in Germany is now underway: a conscious effort to achieve more diversification, an increase in resources for higher education, and the distribution of funds to institutions according to their missions and their performance. This strategy should enable some German universities to become more internationally competitive with respect to both research and teaching. In addition, the reform effort should produce institutions that have a stronger focus on other issues, like teaching, lifelong learning, or excellence in some specialized research field.

The Lisbon declaration also accords respect for each of the different missions of universities, notably both research and teaching. Germany has not yet achieved this goal either (nor would I guess that it has been achieved in many other countries, including the United States). In Germany, the reputation of a university is more often associated with its research performance. This has to change so that excellent teaching also wins recognition. Some private universities in Germany have proven that this is possible by earning a strong reputation with an emphasis on teaching, and public universities must follow. An important requirement is a quality management process that allows us to measure the success of teaching—a subject to which I will return shortly.

Legislating for Autonomy

Diversification does not just happen. It must be brought about deliberately and with some care. But this cannot be done in a highly controlled manner; in fact, giving the universities more institutional autonomy is a key step, so each one can be freer to develop a unique mission and do what it needs to pursue excellence.

Diversification does not just happen. It must be brought about deliberately and with some care.

In almost all the states of Germany, the legal status of institutions of higher education has changed recently, or is changing at the moment. For example, North Rhine-Westphalia has had a new university law, regarded as the most innovative in Germany, since January 2007. By this law, universities are no longer state institutions but independent public corporations. This has substantially increased our university's autonomy. For example, at the University of Cologne, we now are responsible for the recruitment, salary, and promotion of our staff. We have financial autonomy. We can decide freely on the internal structure of the university, and we can decide in almost all cases on curriculum and research. My university has made use of our greater autonomy in each of these respects, which should help us considerably in our efforts to compete on an international scale.

The Science Ministry in North Rhine-Westphalia still governs some aspects of university activity. It fixes the total number of students the universities must accept, and of course, it provides public funding. This is accomplished through a process of negotiation every few years. Nonetheless, the new legal status accorded German universities has made them more attractive to non-public partners. In just the past year, for example, I have witnessed more collaborations with industry partners—with

companies, with the local industrial chambers, and so on. I am confident these collaborations will lead to more private funding of universities beyond what has already occurred.

The Role of Competition

Diversification also is brought about through increased competition between universities, which the German government also is facilitating. The public funding formula now includes a performance-based component, which has been increasing over the last few years. In our state today, for example, the performance-based element amounts to about 20 percent of the total budget, which is quite a large number if you recognize that a large portion of the university staff is permanent.

The funding formula specifically takes account of the number of graduates and PhD students, as well as the amount of third-party funding raised by the university, such as from the German Science Foundation or from programs of the European Union. These added funding parameters strengthen competition, while revealing that not all German universities are equally successful or strong. For example, 50 percent of the funding provided by the German Science Foundation goes to only 25 percent of the universities. One-quarter of the total funding goes to universities in just three regions, the regions of Berlin, Munich, and the Rhineland—the latter of which includes the Universities of Aachen, Bonn, and Cologne. Obviously, a university that does not perform well in this competition for research money has to develop other concepts and strategies. Some universities in North Rhine-Westphalia already are specializing in certain areas to distinguish themselves.

Through the Excellence Initiative the German government has offered almost two billion Euros for research to the universities, through a competitive process.

Another process that has triggered competition and the development of internationally strong research universities has been the Excellence Initiative. Under this initiative, the German government has offered almost two billion euros for research to the universities, through a competitive process. Three types of funding are available. One is for graduate schools to build high-level, well-funded doctoral programs. Another is for so-called clusters of excellence, in which universities focus on important research topics. And, finally, a few universities have been selected as Excellence universities, receiving funds for the overall development of the university with an emphasis on research.

The Excellence Initiative has helped in several ways, in addition to providing more funds. It identifies which universities are strong in research on an international standard and which are not, and thus it creates strong incentives for a university to develop a unique research profile. The Initiative also is strengthening Germany's non-university research institutions, such as the Max Planck Society and the Helmholtz Association. These institutions, which focus only on research, have a strong tradition in Germany and mainly are funded by the federal government. The Excellence Initiative has triggered a new intensity of collaboration, and new forms of collaborations, between universities and these research institutions. To give one example, the University of Karlsruhe was chosen as one of the German Excellence universities. The main concept underlying the proposal was to merge the University with the Karlsruhe Research Center of the Helmholtz Association to form the KIT, the Karlsruhe Institute of

Success in the Excellence Initiative also has turned out to be important for the national and international reputation of a university, and moreover, funding from this initiative frequently has triggered additional projects and developments.

Technology. This institution is now very well funded and has excellent infrastructure. There are many other examples in the clusters of excellence, which often rely on strong collaboration between universities and other partners.

Success in the Excellence Initiative also has turned out to be important for the national and international reputation of a university, and moreover, funding from this initiative frequently has triggered additional projects and developments. Let me give you an example from my own university. We received funding for a cluster of excellence for research on the biology of aging and aging-associated diseases. At the same time, the Max Planck Institute for the Biology of Aging was launched in Cologne. A few months later, the University of Cologne, together with the University of Bonn and the Research Center Jülich, received funding for a new Helmholtz Center for Research on Neurodegenerative Diseases with an annual budget of about sixty million Euros. The state of North Rhine-Westphalia and the federal government will most probably provide another one hundred million euros for infrastructure, buildings, and for funding several new professorships at the University of Cologne. In all, about one-quarter billion euros have been brought to the region within the last two years or so for research in the field of aging and aging-associated diseases.

Resources, Structure, and Quality

I now turn to the important topic of the overall funding of the university system in Germany. Until recently, German universities were almost wholly government-funded, and typically did not charge their students tuition. That limited the resources available to the universities for all purposes, and helps account for the fact that Germany has lagged other developed countries in spending on research and development.

But the situation is changing. Some German states, including North Rhine-Westphalia, now are allowing their universities to charge tuition fees. At my university, these fees amount to one thousand euros a year. Out of the new revenue, we now have another twenty million to thirty million euros that can be used for the improvement of teaching. Although understandably controversial, the new policy of charging tuition has sparked a long-needed dialogue between students and teachers about the nature and quality of education. This in itself is helping to improve university teaching.

An issue as important as funding is the implementation of the three-stage higher education structure within Germany. Almost all university programs are being switched to the bachelor's/master's system. This is a major challenge to be met within only a few years. For example, the new system has led the University of Cologne, which is very large, with more than 40,000 students, to implement about eighty new bachelor's programs in just the last year.² Each of them was accredited successfully. A similar change is in process for teachers' education.

The Lisbon declaration encourages European universities to ensure the employability of their graduates and, at our university, we are taking this charge very seriously. Among other things, we have launched a professional school to coordinate a study program directly relevant to employability. The professional school offers language training and other general skills for all students, and it operates a career service. We are planning for about 30 percent of the courses to be offered in collaboration with employers.

In order to monitor the quality and success of teaching, we also have installed an extensive quality management system in the last few years. The central controlling office provides key data, such as the number of graduates, the average time to earn the

2. As noted earlier, at the University of Cologne, the only entry-level degree program previously had been the equivalent of a master's, typically taking the student five years. Also, the University could not switch to the new system simply by declaring a lesser amount of work to be worth a bachelor's degree; other changes had to be made as well.

degrees, the failure rate, and so on. Professors and students comment on successes and problems, and on this basis, negotiations with the faculties are made which define the goals for improvement. Reaching these goals is rewarded by additional funding. The management system is being extended with a new IT structure on the campus. It will be possible to add a regular evaluation of all curricula by the students. We next plan to include alumni in the evaluation to obtain better information on topics like employability.

I have provided only a glimpse of the many important changes now taking place throughout the German system of higher education, and at our own university. I am convinced that these changes will lead to substantial improvement in both research and education. Personally, I find it very challenging, but I can tell you without hesitation, that if there were ever a time to be the president of a German university, it is now.



Tertiary Education Institutions in Times of Change: A Systems Approach to Institutional Transformation

by Manuel Heitor

Secretary of State for Science, Technology, and Higher Education, Portugal

Manuel Heitor is the Secretary of State for Science, Technology, and Higher Education in Portugal. Previously, he was founding director of the Center for Innovation, Technology, and Policy Research at the Instituto Superior Técnico (IST), the Technical University of Lisbon. He has been a professor at IST and was its Deputy-President in the period 1993-1998. He is also a Research Fellow of the Innovation, Creativity, and Capital (IC2) Institute of the University of Texas at Austin, and is a globally known scholar in technology management and public policies on research and innovation. He is co-editor of the book series on "Technology Policy and Innovation," Purdue University Press.

Manuel Heitor graduated from IST in mechanical engineering and earned his doctorate at the Imperial College in London. He has done significant engineering research in combustion and fluid mechanics, publishing papers and co-editing books on these topics. In 2003, he coordinated a national exhibition on "Engineering in Portugal in the 20th Century," which won the Dibner Award of the Society for the History of Technology. In 2004, he received the Research Excellence Award of the IAMOT, the International Association of Management of Technology.

This conference is about the future of universities, but in my presentation I often will use the term tertiary education institutions (TEIs), which also include colleges, technical schools, and other schools beyond the secondary level. They all are important; all are part of society, and many of the issues I will discuss apply to them all. Indeed, my central theme is the necessity of taking a "systems approach" to the task of transforming our TEIs.

That theme, of course, lies at the heart of this conference. The reason that we in Europe and elsewhere are changing our tertiary education systems so profoundly is to meet the needs of a changing society. We want our TEIs to be in tune with the larger systems and forces that surround them. We want these institutions to flourish and be useful in the new age of global competition, technological change, and knowledge-intensive work.

I will raise a number of issues and questions that need to be addressed in systemically changing our TEIs, and wherever I think I have good answers to the questions, I will provide those as well. In many cases I will draw on what is being done in Portugal.

In terms of taking a system view, I will talk about some important practical matters such as building “system linkages” with other institutions and actors. But I also will go more deeply, inviting you to think about *science itself as a social process*, and about research and education as social processes. We must do so in order to structure

TEIs also must strengthen their own institutional integrity, find ways to become more entrepreneurial, and establish more and deeper relationships with outside parties.

and operate our institutions optimally—and this, too, is where the theme of societal trust comes in. If our TEIs are to fulfill their functions in society, they need public support for their work and their policies. They need students who see the real value of tertiary education, and will engage in it as active participants and trusting colleagues. But they also must strengthen their own institutional integrity, find ways to become more entrepreneurial, and establish more and deeper relationships with outside parties. In particular,

TEIs should explore linkages with public and private research organizations, businesses within their regions, and vocational training institutions.

System effects also can be obstacles. In Europe, most TEIs and their staffs have seen the need for change for many years, but the way the institutions have been organized—both internally, and through their traditional links with society and their incentive structures—have long delayed reforms. The major reforms that now are emerging include needed changes to organizational structure, and I will touch on these matters (such as institutional autonomy) as well.

Framing the Discussion

We must start by recognizing that scientific progress is a key source of development, and that tertiary education institutions play a critical role in this process.

The challenge is then to define, and achieve, the optimum role or roles. For context, I would refer you to the work of John Ziman, whose influential books, starting with *Public Knowledge: The Social Dimensions of Science*, emphasized the nature of science as a complex whole. In his last book, *Real Science*, Ziman reminded us that “science is social,” referring to “the whole network of social and epistemic practices where scientific beliefs actually emerge and are sustained.”

The role of TEIs in scientific progress must therefore go beyond producing discoveries and inventions. It must include strengthening, and expanding, the social basis for progress in science and technology.

TEIs also must strengthen their capacity to make the critical internal changes for modernizing their systems of teaching and research within a path of diversity and specialization, without compromising quality. Furthermore, by strengthening their institutional integrity together with enhancing their external links with society, tertiary education institutions can carefully improve their relationships with economic, social, and political actors, thereby creating “new” reinforced institutions that have gained societal trust. And this must be achieved in a way that will promote new leadership for our institutions. In particular, we must promote an international market of excellence for university leaders, so that we can attract and retain the best researchers to lead our universities.

The entire science-and-technology system of the United States often is taken as the global standard, both in terms of actual scientific achievement and in terms of having the appropriate social culture and institutions in place.

The entire science-and-technology system of the United States often is taken as the global standard, both in terms of actual scientific achievement and in terms of having the appropriate social culture and institutions in place. Likewise, within that larger system, the U.S. university system is seen as a role model because of its rapid responsiveness to economic and technical change, and its contribution to the creation of wealth. However, one must emulate with care. For instance, analysis has shown that key elements in the overall scientific success of the United States are a diversity of policies, increasing “institutional specialization,” and a mix of public and private incentives for science and technology—all of which, along with massive past investments, are not easily replicated in societies of smaller scale and different complexity.

More to the point for TEIs, especially those in Europe, care must be taken in striving to emulate the very strong and useful role that American universities play as

engines of economic development. There is the perception that very high private funding in the United States stimulates a very dynamic academia, with more direct links to the economy and with greater impact on economic growth. Also, the prospect of getting funds from private-sector income streams—such as intellectual property rights—is very appealing to European universities faced with financial constraints.

Such thinking creates the expectation, in European universities at least, that linking research more closely to its application in society will translate directly and immediately to cash flows. In some cases, it may; in some cases, it may not. The real danger is that this perception can lead to an “institutional convergence” between what universities do (and are supposed to do) and what firms and other agents do. In earlier work, I’ve shown that this convergence is a potential threat to the institutional integrity of the university and to the future of scientific research, because of the commoditization of knowledge.

The issue here is not to “save the university.” It is to understand—and to assure that someone will play—the fundamental and unique role that universities have played in the overall, cumulative system of knowledge generation and diffusion. It appears that the United States is trying not to let this role be jeopardized. There is a grave danger that European university policy will destroy these basic functions, through misunderstanding American policies toward university-based research. Not only would that harm the development prospects of Europe, it would be detrimental to the global production of knowledge.

Perhaps the most important American dictum to follow is that of Charles Vest, the former president of MIT. In his recent book, *The American Research University—From World War II to the World Wide Web*, Charles Vest pointed out “what is best about American higher education:”

“We create opportunity. That is our mission. That is our business. That is first and foremost what society expects of us.”

It is in this context, and in this spirit, that I now will address some further issues in the reform of tertiary education in OECD countries. I will focus on four selected and interrelated sets of issues:

- 1) funding and equity issues (both for research and for the expansion of access to tertiary education);
- 2) strengthening knowledge production (including through international knowledge networks);

- 3) improving the substance of learning and teaching; and
- 4) maintaining institutional integrity while diversifying, and extending, the nature of the institution.

I consider all of these issues central to the TEI's evolving role in social systems and knowledge systems. Let us begin with the items at the top of the list—which happen to address the foundations of the whole effort.

Funding, Equity, and Access

Arguably the greatest need in tertiary education worldwide is to strengthen the “base of the knowledge pyramid” by opening up access to a university or college education. In Portugal, our underlying assumption is that “students matter,” and that the main reason for increased funding of tertiary education is to increase participation rates.

But the needs to modernize funding mechanisms, and to strike a good balance between “institutional” and “competitive” funding for tertiary education, are leading topics of discussion in governments everywhere.

The desire to increase participation is not, of course, the only motive driving these discussions. Countries also want their universities to do world-class research and be globally competitive in recruiting talent. In addition to new financial mechanisms at the national level, this also may require—as recently argued by Paul David and Stan Metcalfe—new and increased patterns of competition and collaboration among funding agencies at an international level. In Europe, we certainly need to strengthen the role of the European Research Council and foster other transnational funding arrangements.

Countries also want their universities to do world-class research and be globally competitive in recruiting talent.

By and large, the financing of tertiary education (and of science and innovation) has thus far been done along rather traditional lines, at least in Europe. Governments directly undertake R&D, or they subsidize R&D and innovation either directly or indirectly, through tax measures. The governments raise—or forego—revenue to pay for this support. Yet the history of science is rich with varied means of financing science and technological innovation. And today, new developments in global capital markets present the opportunity to think about even more financing possibilities. These include the channeling of resources from global liquidity pools to science and

technology, and the use of enhanced risk management tools that are just as important to “financing” as the channeling of money.

The main questions here are: To what extent can the innovations developed in modern financial markets be expanded and adapted to finance scientific progress, and to attract more people to tertiary education? What have we learned about experiences with loan systems, venture capital, risk capital, and tax incentives?

Meanwhile, when it comes to financing educational access, most governments now are weighing how to arrive at a good national system that increases the funds available while balancing loans, grants, and a wide variety of other mechanisms. At a

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recent international conference in Lisbon on “Increasing Accessibility to Higher Education,” Nicholas Barr of the London School of Economics reminded us that the goal is to provide free education to all *students*, by guaranteeing that graduates share the costs. The question is the correct shares to be borne by taxpayers and by *graduates*, as well as by other private sources.

In Portugal in the autumn of 2007, we introduced an innovative system of student loans with mutual guarantees underwritten by the State, which complements the system of public grants. About 3,000 loans were contracted in the first six months through the banks, representing a major new achievement for Portugal and Portuguese families.

Our new student-loan system in Portugal has drawn praise which I will quote from in some detail—not just because I am proud of what we’ve done, but because the praise mentions specific qualities that a good system should have.

Michael Gallagher, the well-known Australian leader in education policy, wrote to me as follows:

“The Portuguese initiative satisfies the key policy criteria:

- It is a horizontally equitable scheme.
- It represents good value for students.
- It is financially sustainable at higher volumes of student take-up.
- It is low risk for government and financial institutions.
- It avoids the need for additional administrative infrastructure.”

Nick Barr of LSE, in his evaluation of the Portuguese loan system, “applaud[s] the facts that:

- The scheme is universal;
- Supplements existing grants rather than replacing them, hence extends students’ options;
- Has no blanket interest subsidy;
- Has a very innovative mutuality element, which is the key that makes it possible for the scheme to:
- Make use of private finance.”

The loan scheme also has academic progress requirements for the students, and incentives for improving grade-point averages.

Strengthening Knowledge Production: Issues and Approaches

Having discussed some ways to extend the base of the knowledge pyramid, let me now turn to issues at the top, in research and in graduate education.

In research, a very major issue for universities is the tension between “open science” and the commercial/proprietary approach to science. Discussion of this topic alone could fill many papers, and indeed has. To deal with the topic very briefly here: It has been confirmed that the progress of scientific knowledge is a cumulative process, depending in the long run on the widespread disclosure of new findings.

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And thus, I concur with Paul David of Stanford University, who, in a recent scholarly essay, concluded that open science is “uniquely well-suited to the goal of maximizing the rate of growth of the stock of reliable knowledge.”

Therefore, universities should behave primarily as “open science” institutions and provide an alternative to the intellectual-property approach. In public policies related to innovation, the main challenge is to keep the proper balance between open science and commercially oriented R&D based on proprietary information. A key question is: At what level should governments foster cooperative exploratory research? This research now is recognized to be vital for the sustainability of knowledge-driven economies, as a counterbalance to the demands of individuals, research units, and private firms for incentives to engage in non-cooperative, rivalry knowledge creation.

As for graduate education: Graduate schools worldwide have been developing beyond their traditional departmental structures, and have been doing so in various ways. Some focus more on building interdisciplinary programs within a single university—the model prevalent in the United States—while at the other end of the spectrum, some build subject-specific inter-university structures. A major trend here, too, is the internationalization of graduate education and research; we are seeing the development of global knowledge networks.

The common theme is flexible structures, and a common aim is to create better links between research training and research strengths. Other goals include attracting researchers and graduate students whose interests cross disciplinary lines, and—in the inter-university networks—obtaining the “critical masses” necessary to work and compete at the highest level in a given field.

Some remaining questions include: How much do we need to rely on structures beyond traditional departments in order to promote research universities? Are graduate schools improving the employability of their graduates—that is, are the students learning skills that are transferable to the marketplace, outside research and academia? And how do we address quality assurance in these new graduate school structures?

In Portugal, we have been building our capabilities in both research and graduate education, through initiatives that include making use of the “leverage” of internationalization. Scientific output in Portugal, measured by internationally referenced publications, has increased by 18 percent over the last two years. The Portuguese government’s “Commitment to Science” program fosters public and private investment in science and technology, and features a large element of partnerships with leading institutions worldwide.

“Partnerships for the Future” is a program initiated in 2006 and, by September 2007, the first doctoral and advanced-studies programs were officially launched, bringing together several Portuguese universities with universities such as MIT, Carnegie Mellon, and the University of Texas at Austin. Unprecedented in Portugal, these programs also have facilitated the creation of thematic science-and-technology networks in which a large set of Portuguese institutions are collaborating with companies and other institutions around the world.

Improving the Substance of Learning and Teaching

Among the many goals that have been set for tertiary education institutions in Europe, I now would like to focus on one that is paramount. We must change the patterns of teaching and learning, promoting more active work by the students and fostering student-centered education, while finding a better compromise between a broader and “general” education at the entrance of tertiary education and at specialized education at the post-graduate level.

This goal requires TEIs to better understand *how people learn*. Clearly, learning systems vary (and should vary) across the disciplines. For instance, some disciplines lend themselves to a project-based learning approach, while others follow a more intensely “academic” model. Clearly, too, individuals have different learning objectives and learn best in different ways. Still, there is much to be gained in tertiary education by tapping more deeply into the current base of knowledge about learning—including what has been learned about learning at the elementary and secondary levels.

One good reference is a 2000 report of the United States’ National Research Council, titled, “How People Learn: Brain, Mind, Experience and School.” Along with summarizing theories and findings about human learning, the report discusses how different curricula, pedagogical approaches, and “learning environments” have been emerging to meet the needs of diverse student populations. It also discusses vital topics such as assessment, and how in-school learning relates to learning outside school.

I would draw your attention especially to the needs in science education. Our aims in science are both broad and high. We want to increase participation in science, and promote the culture of science, while inspiring and preparing people to be top-level scientists in a variety of fields. This calls for education that spurs active engagement with, and a deep appreciation of, scientific activity.

New developments in science education (and indeed in all aspects of education reform) have been influenced by the constructivist view of learning, advanced by Jean Piaget and others. As Piaget put it, people are best taught by using “active methods which require that every new truth to be learned be rediscovered, or at least reconstructed, by the student.” In other words, people must literally learn by “constructing” their knowledge, repeatedly. Others emphasize that skills are augmented by learning to “produce” things—and, therefore,

New developments in science education (and indeed in all aspects of education reform) have been influenced by the constructivist view of learning, advanced by Jean Piaget and others.

education in all fields, at all levels, must consider that learning a new practice requires moving through discovery, invention, and production not once, but many times, in different contexts and combinations.

To achieve this kind of education, we must learn from new research and also foster *evidence-based, project, and experimental work*. But there are a host of other needs as well. We need to reduce drop-out rates in tertiary education, focus on transferable skills and employability, serve growing numbers of non-traditional (older) students, and diversify our programs of study.

The drive for diversification in Portugal has led us to promote a “binary system” of tertiary education, with polytechnic education concentrating on professionally-oriented and vocational training, while university education is further concentrated on postgraduate education. Non-university TEIs are seen in many countries as closer to the labor market, and the more flexible arm of higher education. But questions then loom, such as: How exactly are we to identify labor-market needs and then provide the necessary skills? Are non-university institutions more regionally focused—and thus in a better position to promote local and regional clusters of innovation?

Portugal has made progress in tertiary education on many fronts, in accord with the Bologna process and other European guidelines. But in Portugal, as elsewhere, there is still much to be done, and many questions remain to be answered in the realm of *education*.

Preserving Integrity and Autonomy, While Building System Linkages and Being Responsive

How to maintain autonomy and integrity while being part of society is an age-old human dilemma, and it is increasingly faced not only by persons, but by universities. The issues involved are complex; I will briefly summarize some main threads of analysis and debate, adding my own observations.

According to many authors, both companies and universities have evolved in a social context, to the point of attaining what these authors call “institutional specialty.” Thus, whereas companies want to obtain private returns for the knowledge they generate, universities have traditionally made it public. This specialization, or “division of labor,” is valuable, because by means of it, knowledge has accumulated at a rapid pace.

At the same time, it is also widely agreed that universities (and other TEIs) should have many linkages with industry and society—by which they can exchange ideas, be partners in projects, and be aware of one another’s activities and needs. One obvious problem I alluded to earlier is that those who think and act together can tend to start thinking and acting alike, thus leading to a “convergence” of missions that erodes the university’s specialized roles in society. Extending the university’s links with society can also, if excessive, lead to resources being spread too thinly. But more serious dangers (which are not always so obvious) can arise as TEIs take the path of “privatizing” the ideas they produce and the skills they develop.

The university may therefore feel justified in raising the direct price of education to students, as a way of increasing its income.

Consider the higher-education function of teaching, which imparts skills that each student can profit from in the future. The university may therefore feel justified in raising the direct price of education to students, as a way of increasing its income. Meanwhile, *state support* of education, which is present in virtually every country, has long been justified by the positive externalities that result—the benefits that accrue to all, from the skills acquired by individuals.

But public funding for higher education now is being reduced in many countries, while tuition fees go up. Tilting the financial model toward a fee-for-service (tuition) basis effectively privatizes teaching and learning. If the trend continues, it could lead to a reduction in the resources that really are in short supply in knowledge-based economies: the skills to use and interpret ideas.

As for the research function: The great majority of the ideas generated in universities are of a public nature. Incentives for the production of these public ideas come from a complex system of reward and prestige within the academic community. The privatizing of research results could thus threaten fundamental aspects of the way universities work and their essential contribution to the accumulation of ideas.

One conclusion I draw is that in order to preserve the institutional integrity of TEIs, state funding of TEIs should not be reduced. But this measure is not enough. In striving to be ever more responsive to the needs of their economies and societies, TEIs are building many new linkages, extending the definition of accountability, and diversifying in many respects. New ways must be found of preserving institutional integrity amid all this diffusion and diversification.

Fortunately, a highly diversified system allows us to make useful distinctions. In terms of preserving research integrity, for instance: If we analyze the universities' research functions, we find that they actually consist of various sub-functions, which can and should be subject to distinct public policies and forms of management. Each of the sub-functions can be described as a different form of "Research and ...," as follows:

- *Research and Development (R&D)*—This the most common form. It aims for the accumulation (and use) of ideas through convergent processes of learning and knowledge codification.
- *Research and Teaching (R&T)*—Here, research functions as a way of developing teaching materials and enhancing the skills of the teaching staff. This form also is associated with convergent processes of knowledge codification.
- *Research and Learning (R&L)*—In this form, the main value of the research lies not necessarily in the creation of new ideas, but in the development of the researchers' skills and knowledge. Research thus appears here as a divergent function, associated with processes of interpretation.

Of course, it is not always easy to separate these different functions. But with the foregoing distinctions in hand, a diversified university (or university system) could maintain research integrity while responding to the different demands made upon it—for instance, by being "selective" in the performance of R&D and R&T, and "comprehensive" in R&L. Indeed, R&L should be extended beyond the university to permeate the whole education system as a way of promoting learning skills.

I could go on in much more detail about the challenges of maintaining institutional integrity and autonomy for TEIs while moving to more flexible structures and highly diversified activities. I have studied the issues myself and, of course, have read much of the literature produced by others. What I have tried to do here is briefly show how concepts from the literature can be used to analyze the challenges and think about solutions.

My essential conclusions are these: It is good and necessary for a tertiary education institution to expand its activities and extend its networks. In preserving institutional integrity, the key requirement is *maintaining the academic character of the institution's basic functions of teaching and research*.

Summary

Reform of tertiary education institutions is accelerating, in Portugal, across Europe, and elsewhere. Key issues that I touched upon here are: funding, equity, and access; strengthening research and graduate education; strengthening teaching and learning generally; and the implications of institutional integrity as TEIs become more flexible, diversified, and inter-linked with the rest of society.

Becoming flexible, diversified, and interlinked is a much-needed set of developments for TEIs in Europe. We already are seeing our institutions, and our societies, grow more dynamic as a result. Much work remains to be done, and one need I have not mentioned is the need for excellent institutional leadership.

As our universities and other TEIs undergo a metamorphosis, they will need leaders who can manage ongoing reform, and also can manage the new types of institutions that ours are turning into—ever-evolving nodes in global networks for the creation and transmission of knowledge. Specifically, attention has been called to the need for two kinds of mechanisms: an international market of excellence for university leaders, and a “critical path” mechanism for attracting and preparing our best people to take the lead.

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A topic I perhaps haven’t said enough about is promoting the culture, the learning, and the *public understanding* of science. This has to be done not only in our institutions of tertiary education, but system-wide. A number of countries already have national science initiatives for this purpose, such as “*La Main a la Pate*” in France and the “*Ciência Viva*” program in Portugal. Various reports from the European Commission have noted progress on this front, but point out that there is still a difficult climate in Europe for promoting the notion of “science for all.”

But as people do come to know and appreciate science more fully, my hope is that they also will know and appreciate the role of our TEIs more fully, thus reinforcing societal trust in these institutions. I look forward to continued progress in re-shaping our institutions for research and higher education in the exciting times that lie ahead.



The Future of the European University: Issues, Entrepreneurship, and Alliances

by Wolfgang Herrmann
President, Technical University of Munich

Wolfgang Herrmann has been president of the Technical University of Munich (TUM) since 1995. Previously, he served as chair professor at both TUM and the Johann Wolfgang Goethe University of Frankfurt am Main, and as a professor at the University of Regensburg. His scientific research focuses on organometallic chemistry and molecular catalysis, and his work has produced more than 720 original publications in journals such as Journal of the American Chemical Society, Chemical Reviews, and Angewandte Chemie. In 2007, he received the Bayerischer Verdienstorden (Bavarian Order of Merit), the highest civilian honor awarded by the Free State of Bavaria.

Let me begin by defining a term. When we talk about universities, what do we mean? In our definition at the Technical University of Munich, a “university” educates the coming generations by involving them in scientific research, to learn and to see how scientific progress works and where it comes from. We believe that an atmosphere of creativity contributes most effectively to scientific progress. And we try very hard to maintain the Humboldt principle, which means that the university is to teach and conduct research with the same people at the same time. This has become difficult, of course, because when Humboldt¹ created his new idea of the university in 1809, which is now ubiquitous worldwide, there were approximately 50,000 students in all of Germany. Now we are talking about 1.5 million university students in Germany alone, plus 700,000 students in the polytechnics, or Universities of Applied Sciences.

1. Wilhelm von Humboldt, an esteemed scholar, was the Prussian Minister of Education. His brother was the natural scientist and explorer Alexander von Humboldt.

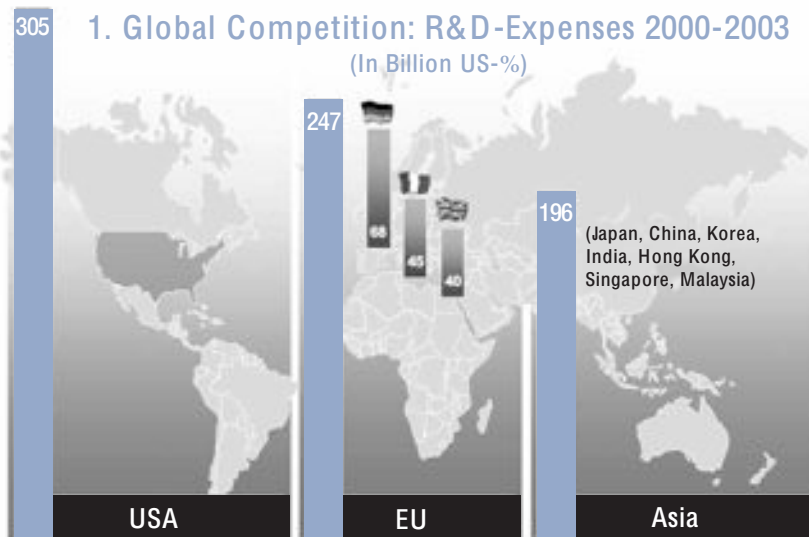
So this task, this Humboldtian task, which I deeply believe is the right approach to higher education, has grown much more difficult. In order to cope, I believe that universities have to become entrepreneurial. They have to take responsibility for their institutions; they have to form their own scientific and educational profiles, and—this is extremely important—they have to select their own students for admission. That has not been the case in Germany for many decades. In our state of Bavaria, we have started by having initiated the amendment of the Bavarian university law and, in the meantime, we are selecting our students in more than 50 percent of our study programs, applying a two-stage selection process. This has been more successful than we had expected. Our students nowadays hardly quit their courses before graduating, whereas before, we had failure rates of between 20 percent and 50 percent, depending on the discipline.

The Global Context

Before I invite you to look at issues for the future of universities in Europe, I would like to highlight some global developments. First, intellectual capacities now are spread all around the world with ever-disappearing barriers. European universities compete in a global market with universities that directly serve fast-growing economies calling for innovation, like those in China, the far East and India, the up-and-coming Middle East, and, above all, the United States—which is at the top of the list of countries most attractive to scientists and students.

Europe, by contrast, is in a process of phasing out industrialization, shifting its manufacturing to relatively low-wage economies elsewhere. The unemployment rate among university graduates is a major concern in a number of European states. Besides, countries like Germany, England, and France are going through demographic changes that are simply frightening: growing populations of older people whose retirements are supported by a stable or shrinking work force.

Meanwhile, if we define innovation as the response to market opportunities, through organizational changes and new ways of developing high-value products and services, then clearly Europe's universities are lagging behind. One of the most important challenges for the universities is to better translate research into commercial opportunities, especially by networking. The “pull” on the research base by business in Europe has become rather weak, as we can see in the accompanying chart by the relatively low spending on R&D.



Quelle: Human Development Report, 2006

Overall, in the United States, the spending on higher education from private sources is seven times higher than in Europe. Of course, differences in cultures play an important part in explaining this pattern. But there is more to it than that.

The world-renowned universities in the States and elsewhere have some key advantages. They operate with relatively little bureaucracy. They have multiple sources of funding. They accept only the best-qualified candidates, on the staff side as well as among the students, and they do not tenure every single professor from the first day. Last, but not least, they proactively network through alumni groups, which is very important but missing in many places in Europe. Nevertheless, in Europe we can count more than 4,000 universities, which have seventeen million students and about 1.5 million employees, with 435,000 scientists—an enormous potential. However, these capacities are not being used to the fullest.

Five Issues for Europe's Universities

There are a number of reasons why Europe is falling short in the competition for knowledge and market innovation. I will single out five:

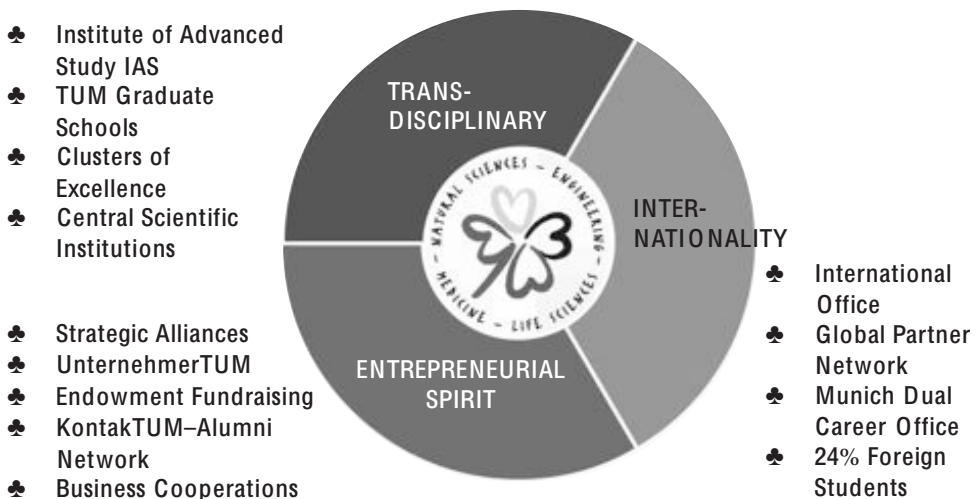
- 1) fragmentation in systems;
- 2) ignorance of business opportunities and needs;

- 3) lack of flexibility, especially in terms of university structures;
- 4) over-regulation, a most severe problem; and
- 5) serious underfunding.

Fragmentation in systems can be explained from a historical context. Member states in the European Union have traditionally valued their universities highly, so they have tried to preserve their systems on a national level. Naturally, according to country-specific political structures, various systems and subsystems of higher education now exist in parallel. In Germany, in addition to the federal framework for universities, we have the *Länder* decision-making process. Germany is a federal republic shared by a number of states, the so-called *Länder*, having their own parliaments and governments. The *Länder* have responsibility for their cultural affairs, including universities. Thus, for example, differently from other countries, decisions relating to the bachelor's/master's program structure lie in the hands of the *Länder* government—while implementation has to be performed by the universities themselves.

Under the Excellence Initiative of the German federal and state governments—an initiative to promote science and research—my university has proposed, and is taking, a number of steps to overcome the fixed structures and subsystems. I don't have time to go into details on the new structures we are building, but Chart 2 provides an overview of some major components that are now in place or underway:

2. Some Examples for the TUM Response



Diverse centers and clusters of excellence have been formed, and will go on being formed. The whole structure is trans-disciplinary and highly networked, with a multitude of partners and alliances. With all of these stepping stones, we are paving the way to our concept for the future, which we call The Entrepreneurial University.

One problem that the Entrepreneurial University must fix is the prior pattern of ignoring business opportunities and needs. The entrepreneurial age dictates that universities can no longer achieve leading positions if their excellence is cultivated in isolation from the market.

Fortunately, there are promising corrective initiatives underway. More than sixty European universities, including TUM, have developed technology transfer offices. There is also an important initiative at the European level, the European Institute of Innovation and Technology. The EIIT is forming Knowledge and Innovation Communities or KICs,² which are designed to bring together the best brains and the most successful companies in a world-class environment, but with a distinctively European character. The first KICs in the fields of climate change, renewable energy, information, and communication technology are planned to be formed in spring 2009, followed by KICs in medical technology and nanotechnology. Our participation is ranked a top priority for the strategic positioning of our university. And there are many more things we can do:

There are four keys to success: good education, excellence in research and innovation, knowing that education and research cannot be separated from one another, and providing greater flexibility.

TUM is a big university with more than 420 professors and 8,500 staff altogether, so we have a broad scope in natural sciences, engineering, medicine, and life sciences. It is absolutely necessary to bridge these traditional fields of research.

In my view, there are four keys to success: good education, excellence in research and innovation, knowing that education and research cannot be separated from one another, and providing greater flexibility. Success also requires us to form strong alliances, as we do with the research institutions outside the university—the Max Planck Institutes, the Helmholtz Association and so forth—to enhance the research power of our university. Because alongside research—notice that I do not say “aside from” research—our cultural

2. According to the EIIT, these Communities will be “partnerships between universities, research organizations, companies, and other innovation stakeholders. ... They will promote the production, dissemination, and exploitation of new knowledge products and best practices ... [with a goal of] transforming the results of higher education and research activities into commercially exploitable innovation.” KIC member institutions are to be chosen on a competitive basis by the Governing Board of the EIIT, with the KICs having initial contractual lifespans of seven to fifteen years.

commitment is to educate excellent young people and to do so in a research-minded way. This double commitment will certainly lead to a readjustment of the entire university system in Germany and in Europe, both in the types of universities that concentrate more on graduate education supported by research, and in the universities that focus more on a highly qualified bachelor's education.

I cannot stress enough the importance of addressing our current lack of flexibility, or its flipside, over-regulation. Structural flexibility is instrumental for every single university to participate in alliances. Achieving structural flexibility means that we have to overcome the strict state regulations that currently bind universities not only in Germany but elsewhere in Europe. I am convinced that the university in Europe will have a future only if it moves from the status of an institution controlled in every detail by the government, to become an Entrepreneurial University that takes its own agenda into its own hands. That is the basis of our corporate concept in the Excellence Initiative—and it will take more than just “autonomy” to realize success. Many people ask for autonomy every day. Autonomy is simply the *freedom* to have your own agenda. Success comes only if you develop the mechanisms to carefully and successfully handle autonomy.

Achieving structural flexibility means that we have to overcome the strict state regulations that currently bind universities not only in Germany but elsewhere in Europe.

Finally, I come to the issue of under-funding. In my view, this is not the key handicap of European universities. There is a lot of money within the European Union for raising funds for research. The real problem is that there is too much bureaucracy in the way funds are handed out. Although, of course, I would like more money to come into the system, it is more important that the individual institutions in the various countries be funded according to their success, not by input measures but by the outcomes: by the successes of students and alumni, by scientific performance, and so on.

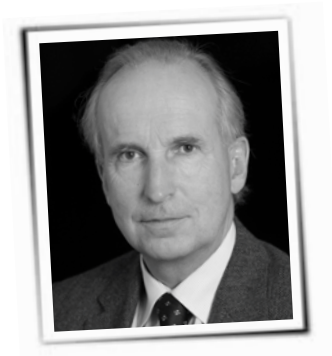
I should note here that universities across Europe are on very different funding levels, and they also can be funded in different ways. For example, my university, the Technical University of Munich, is probably the best-funded university in Germany. I don't say this everywhere, especially not to the Bavarian politicians (although some of them surely know!). Nevertheless, let's compare our university to ETH Zurich in Switzerland, which is one of our competitors, on the basis of public funding per professor or per student. When you do so, you will find three to three-point-five times

as much of that public funding at ETH. On the other hand, ETH Zurich has less income for research projects from outside, be it from governments or from industry. Our research income is currently about 120 million euros per year, which is quite a lot in relation to the four hundred million that the Free State of Bavaria has allocated for our university.

The Power of Alliance

In conclusion, major constructive changes are underway in German universities. As is to be expected, there is some reluctance to change within the universities and among the faculties. Nevertheless, there are fast-moving developments, which I think will accelerate if we continue to form strong alliances. For example, we at TUM now have alliances with the Danish Technical University in Copenhagen, with the Technical Universities of Eindhoven and Vienna and others; Imperial College London will be joining us shortly.

If we are able to form such alliances, then I am optimistic for Europe, because we have a tremendous strength—the cultural diversity of the old continent. It has not been well exploited as an advantage over the past, let's say, sixty years since World War II. But I think things are coming along. And we all should be optimistic and work together for the future of the European universities, because Europe is our future.



Moving from a Managed Economy to an Entrepreneurial Economy: The Challenge for Europe and its Universities

by Jan Willem Oosterwijk
Chairman of the Executive Board at Erasmus University Rotterdam

Jan Willem Oosterwijk is chairman of the Executive Board at Erasmus University Rotterdam. (This three-person board has the power to administer all matters relating to the university as a whole.) Before being named to the position in 2007, Oosterwijk had been Secretary-General of the Netherlands' Ministry of Economic Affairs, where he was the national coordinator for the Lisbon strategy. Previously he served as Treasurer-General at the Ministry of Finance. He is also on the Supervisory Board of The Hague University of Professional Education, and the Alumni Board of the University of Groningen. He took a degree in General Economics at Groningen University, graduating with distinction in 1975.

I'm an economist by profession, so I will deal broadly with the economic and social environment in which European universities, including Dutch universities, now operate, focusing on the emergence of an entrepreneurial economy. Then I will sketch what consequences this has for public policy and for universities, finishing with some words about the Holland Program on Entrepreneurship, HOPE.

I speak from the vantage of my position at Erasmus University Rotterdam, which is participating in HOPE. My university is a relatively young one named after the great philosopher and humanist Erasmus, born about 1466 in Rotterdam. The school started in 1913 as the Netherlands School of Commerce, an initiative of the private sector in Rotterdam at that time. Now the University has schools of economics and business, medicine, social sciences, law, and many smaller ones.

Let me begin by drawing your attention to the large diversity of students in Dutch universities, reflecting the cultural melting pot of our society. Nowadays, 25 percent of our students come from non-Dutch cultural backgrounds—they are Moroccan, Iranian, Turkish, and others, often first-generation Dutch without any experience in higher education. That reflects the open society we have, and we strongly believe that our university can help to play the role of emancipator and integrator of these new Dutch communities. By the way, these other cultures often have very different views of entrepreneurial activity. So, in that sense, they are very interesting, because our thinking about economics and society is changing all across the country.

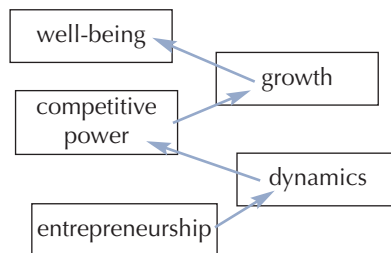
We have come a long way in that thinking, as well as in our policies, in the last forty years. I have witnessed much of this during my various tenures in the Dutch government, where I have had roles in both macro-economic policy management and in various micro-economic issues. I will try to bring some of that experience to the subject at hand.

Chart 1 shows the current understanding of what the major drivers are in modern economies.

Nobody is against well-being as a policy orientation. That always has been the goal, but our view of how to get there has changed. Now it is through growth. It used to be through equal distribution, at least in the European context and certainly in my country. Growth is driven by competitiveness—now we know that, too. But we used to think the key was the “makeability” of society,¹ a big thing in the Netherlands in the 1970s.

Competitiveness, in turn, is now thought to be driven by the dynamics of markets: by turbulence, by openness, by low entry barriers. And last, to complete the chain, we now understand that the dynamics of markets depend upon people—especially on entrepreneurs—whereas we used to think the economy was driven by

1. Current Economic Thinking



1. Literally, the belief that a society can be made the way we want it to be, through large-scale planning and intervention. Although the Netherlands was an early bastion of market capitalism, the “makeability” view gained currency during reconstruction after World War II, and some scholars say it was reinforced by the success of the Dutch in re-making their landscape to keep out the sea: If nature can be engineered on such a large scale, why not the economy? In a 2003 lecture titled, “Beyond Makeability,” Prime Minister Jan Peter Balkenende summed up the shift away from this economic policy by saying, “The government does not ‘make,’ it ‘makes possible.’”

large businesses and policies affecting them. It has taken some time since World War II for us to find the connections between entrepreneurship on the one hand and well-being on the other. This, of course, has been typical of Europe. In my view, the United States was a bit quicker to discover the essential roles of competition and entrepreneurship.

Inside Economics: the Search for the Missing Link

Up to now, entrepreneurship has hardly been considered in the economic literature explaining growth. In that literature, there is a method called “growth accounting,” which involves decomposing growth into its different components. It turns out that countries’ economic growth cannot be accounted for just by classical reasons, by increases in the supply of capital and labor. There is a remaining component, referred to as total factor productivity (TFP) or multifactor productivity (MFP). Of course, this component itself can have many components, because many things can make the economy more productive. We could go through all of ‘the usual suspects,’ but obviously, technology and innovation play important roles.

For that reason, economists often look at R&D, because there is a strong empirical relationship between productivity and R&D at the country level. One critique, however, is that it is not R&D but innovation that stimulates productivity growth. In other words, R&D is too much of an input measure; it’s the output of R&D that we are after. More and more it is thought that the link between the two might be entrepreneurship. Often, it takes a risk-taking person to turn the results of R&D into a product and then bring it to market.

Still, the formal empirical evidence of such a link, however plausible, so far has been weak. Entrepreneurship often is missing in studies that look at the long-run relationships between economic variables and growth or productivity development. One reason could be the lack of high-quality systematic data on entrepreneurship, and I know the Ewing Marion Kauffman Foundation has been active in trying to provide the world with better indicators.

I’m proud to say that some colleagues from both my old and my new working environments—the Ministry of Economic Affairs and Erasmus University—recently

2. Hugo Erken, Piet Donselaar, and Roy Thurik, “Total Factor Productivity and the Role of Entrepreneurship,” Jena Economic Research Papers, #2008–19. Friedrich Schiller University and the Max Planck Institute of Economics: Jena, Germany. To measure entrepreneurship, the authors used business ownership per capita corrected for the level of economic development. Business ownership rates alone can be misleading, because as economies advance, they may tend to have fewer small subsistence enterprises.

collaborated on a study that, in fact, shows the influence of entrepreneurship on TFP.² They used orthodox TFP models with data from twenty-five countries over thirty years. Now we think we've found at least some evidence that entrepreneurship is a significant driver of productivity growth. We are starting to have a better economic understanding of entrepreneurship, which can help us as we move away from the managed economy of the past.

Good-bye to the Managed Economy

This managed economy prospered throughout most of the last century. It was a system built around economies of scale. Large organizations like U.S. Steel, Siemens, and Philips used scale economies to leverage the traditional inputs of labor, capital, and land; also, they managed routines for innovation in their laboratories. And universities adapted to this managed economy. That is why business schools grew in importance. Their part was to train students to manage the *disadvantages* of large-scale activities, because when firms grow big, their bigness creates problems in organization, in finance, in marketing, and in other areas—and the universities responded to that.

Then came the ICT revolution, which, together with more global competition, put the large Western firms in trouble. They reacted, in part, by cutting production costs, by substituting capital for labor, and by moving production to locations with lower wages. But also they changed their products. Indeed, they moved toward knowledge-intensive products, higher up in the value chain, which were more difficult to copy by competitors in low-cost countries. For example, Philips Electronics has been reinventing itself from a manufacturing firm into what is now called a lifestyle and health firm.

In this move from mass production to a more knowledge-intensive focus on individuals, some of the advantages of large-scale organizations seem to disappear. The economic growth generated by the ICT revolution leads also to more individualistic or whimsical consumers, for whom small, specialized production is better than large-scale mass production. Further, in this “new” economy, technological innovation becomes more uncertain and unmanageable. It doesn't just live in the routines of large laboratories. It thrives in more of an open-source environment, in the types of industrial districts where entrepreneurs and SMEs come together, and become central to the economy.

There is a psychological aspect to this shift, too. A psychologist who looks at you, an individual, might say that, if your point of orientation in shaping your life is

2. Emergence of the 'Entrepreneurial' Economy

'Managed' economy

- Scale
- Predictability
- Conformity
- Obedience
- Homogeneity

'Entrepreneurial' economy

- Flexibility
- Novelty
- Originality
- Creativity
- Diversity

your resources, you are a manager. But if your point of orientation is your opportunities, then you are an entrepreneur. The same goes for entire economies and societies. As the world changes, the orientation has to change—from managing what we have in the managed economy, to creating what we don't have in the entrepreneurial economy.³

Chart 2 offers some “buzzwords” that sum up how the world has become extremely different from the one of just twenty years or so in the past:

What does it all mean? The economy has changed. Public policy should change. And universities should change. They have to move away from the emphasis on training students to take part in a managed economy. They should concentrate instead not just on R&D and human capital in general, but more and more on entrepreneurship and the small-scale environment. In my view, this is and will be like changing the course of a supertanker.

Changing the Course

Public policy has been responding. In Europe, of course, the Lisbon strategy often is mentioned as a good representative of a new policy framework—an open-coordination mechanism, as we call it in Brussels-speak. It's about free economies trying to nurture innovative and entrepreneurial behavior. But, while the policy lessons of the Lisbon strategy are fine and useful, there is still a wide gap in many countries between words and deeds.

Modern policy has to be more about getting out of the way, as much as possible, so that inputs are brought into a favorable position to create whatever is necessary and conceivable. Knowledge, of course, is an essential input, and the use of knowledge is the focus of attention. All over the European Union, I have seen my colleagues try to understand the complex machinery of the production, dissemination, and commercial use of knowledge. But we often forget that the key drivers of

3. The contradistinction between the managed and the entrepreneurial economy was first brought forward by David Audretsch and Roy Thurik in “What is new about the new economy: sources of growth in the managed and entrepreneurial economies,” *Industrial and Corporate Change*, 10(1): 267-315.

innovations are competitive markets and entrepreneurship. Both these issues should be at the top of any list of growth strategies in any country of Europe, and they're not there yet.

Entrepreneurship policies were neglected in my country for a long time, but they now are developing and I would say that they now are given top priority. Parts of these entrepreneurship policies are aimed at the role of education, including basic education—which some say is the most important, in terms of giving young people an early start and building an entrepreneurial attitude.

Universities must play a critical role in this new environment, of course. This will not be easy, because our public universities have shielded themselves too much and for too long from the private sector and the markets. In entrepreneurship education, we won't succeed without the involvement of the private sector. We also need more than money. We need the private sector's involvement in terms of content and in terms of process. I think the United States provides a shining example of how to involve the private sector without jeopardizing academic integrity. But there are still many, many lessons for all of us to learn about the best ways of engaging universities to advance entrepreneurial growth.

'HOPE' for the Entrepreneurial Age

Let me conclude with some words on how we've responded to this challenge at Erasmus University Rotterdam. The Ministry of Economic Affairs tendered a grant of three million euros, for a policy idea that was borrowed to a large extent from the Kauffman Campuses program of the Kauffman Foundation.⁴ We applied successfully⁵ and, moreover, also involved the private sector. All in all, it's an eight million euros program. It's called the Holland Program on Entrepreneurship, or HOPE.

HOPE is an initiative of my university in close cooperation with Delft University of Technology and Leyden University. We're all major institutions in the province of South Holland, the most densely populated and most highly developed part of the Netherlands. Together we have a range and depth of academic programs that I think are unmatched in our part of Europe—so it's a good base for such a program.

4. In this program, selected colleges and universities in the United States are implementing "entrepreneurship across the campus"—teaching, supporting, and practicing entrepreneurship in many disciplines and in many ways; making it an institutional priority.

5. In the application procedure, we obtained the support of the Kauffman Foundation.

The HOPE initiative has multiple aims. First, starting with new courses in September 2008, entrepreneurship is being incorporated into the academic curricula, to infuse awareness of entrepreneurship and to develop the skills. In addition, HOPE will stimulate all research staff to think in terms of commercialization. Both students and staff will work in an interdisciplinary environment, where they can come together with their various backgrounds in a new setting.

Furthermore, ties with the entrepreneurial business community will be strengthened. There's been quite a lot of interest, not only from Rotterdam entrepreneurs, but also from large companies in the Netherlands that want to come on board and be connected to HOPE. I think that's a sign that the initiative is filling a gap and, in a way, it is long overdue. We should have done this five or ten years ago, but we're doing it now. Finally, we expect all of this to contribute to the development of the province of South Holland, and because the program will attract outstanding foreign students, HOPE has a global dimension as well.

If we look at the academic design of HOPE, we find some underlying principles. The idea is to create the optimal synergy among a variety of activities, all of which are necessary for true progress to be made:

As Chart 3 illustrates, HOPE envisions a three-layered approach that we call the research-teaching-experience cycle. Research on entrepreneurship will feed the educational program, which will consist of both teaching and experience activities. At Erasmus University Rotterdam, we already have a long and celebrated tradition of entrepreneurship research, so now we are adding the next

3. Holland Program on Entrepreneurship: HOPE

Three layered approach:
research-teaching-experience cycle

Teaching and experience activities applied at four levels:



steps. Those next steps, the teaching and experience activities, will be applied at four levels, as you see in the picture.

We start by raising the students' awareness, with our lecturers teaching the economic role of entrepreneurship and the basic concepts. The students gain experience and build competence through mastery of the topics, and the ultimate aim, of course, is taking entrepreneurial action. Along the way, they progress from opportunity recognition to commitment to gaining the credibility required to take action.

That's HOPE, and we hope—no, we are certain—that it is going to be a great success. I have told you a lot here but my main messages are simple. Institutions of higher education can and must play an essential role in the changeover to an entrepreneurial economy. We at Erasmus University Rotterdam took up that challenge, and we are answering it with this initiative called HOPE. As the program gets underway, we look forward to cooperating with you and sharing our experiences in the upcoming years.



Entrepreneurial Universities: the View from Israel

by Manuel Trajtenberg
Head of the Israeli National Economic Council and
chief economic advisor to the Prime Minister

Manuel Trajtenberg is the (first) Head of the Israeli National Economic Council and chief economic advisor to the Prime Minister. A professor of economics at Tel Aviv University since 1984, he is known internationally for his research on the economics of innovation—in areas from R&D, patents, and government policy to the diffusion and market dynamics of innovation. Professor Trajtenberg is a research associate of the U.S. National Bureau of Economic Research, and of the Centre for Economic Policy Research in London. Within Israel, he has headed major study programs related to science, technology, and higher education. He earned his bachelor's and master's degrees at Hebrew University of Jerusalem and his PhD in economics at Harvard University.

I have been asked to talk about the entrepreneurial universities in Israel. But what I'd really like to do is discuss insights and lessons that can be applied anywhere. So, among other things, I want to look at what it means to be an entrepreneurial university, and then what it takes to be entrepreneurial in the fullest sense.

Israel itself is a highly entrepreneurial society, and so is its economy. First of all, we invest more than any other country in R&D as a percent of GDP, 4.6 percent. Counting defense R&D, which is believed to be another one percent of GDP, altogether about 5.6 percent of GDP goes into research and development. Last year, technology companies in Israel raised \$ 1.75 billion in venture capital investment, and there are currently about seventy Israeli companies listed on the NASDAQ. For a country of only 7.2 million people, these are big numbers.

And there is more. Many innovations that all of you know about have come from Israel. Maybe your laptop computer has the Centrino wireless platform; the chips and other components for that have been designed at Intel's Israel Development Center in Haifa. ICQ, the first instant messaging software for the Internet, came from an Israeli company called Mirabilis. This company was bought by AOL and the software is still used widely, maybe by your children. I could go on, but the point is, by many indicators, Israel is a very entrepreneurial society.

Israel's universities are one reason for this state of affairs. They are part of a system that includes government policy, industry, and society at large. Let's keep that whole system in mind as we pose a basic question: What do we mean by entrepreneurial universities?

There are at least three answers to the question.

- One way universities may be “entrepreneurial” is that they are innovative in terms of how they organize and run themselves as institutions. You can be very conservative in that respect, very attached to your roots; or you can spread your institutional wings and fly.
- A second way to be “entrepreneurial” is for universities to serve as engines of entrepreneurship in the broader economy—by generating ideas, by nurturing entrepreneurs, by working with industry.
- The third definition of “entrepreneurial” universities refers to their being agents of change in society at large. They can do this not only by producing startups and spinoffs, but in a wider way—or, here again, they can resist change, and be bastions of conservatism.

In short, when we talk about entrepreneurial universities, we may mean that they're being entrepreneurial in any one or more of these three modes. But here is a key point I'd like to make: It is very hard to be entrepreneurial in *just one* of these modes. For example, it is difficult to be an economic generator of spinoffs and new ideas while being very conservative on the institutional side, and vice versa. You need to address all of the aspects of being entrepreneurial.

I am urging this broad view because, in public discussions of the entrepreneurial university, there is too much emphasis on the TTOs (technology transfer offices). Universities create these offices, and then compare notes on how many spinoffs they've generated and how many royalties they've collected, and the object is to be able to say: “Mine is bigger than yours.” That's the sort of a beauty contest we

often see—and it only addresses one part of one aspect of the issue, which is not necessarily the most important part.

This leads me to a subject that often is overlooked. Universities essentially have two key missions: One is to create new knowledge, and the other is to preserve and transmit existing knowledge. Of course, the missions are interconnected, but they're not the same. And knowledge can be lost: It can be destroyed; it can be forgotten. If you want a superb science-fiction rendition of knowledge loss, recall Isaac Azimov's seminal "Foundation" series, which brings home with great poignancy what could be the dire consequences of such loss. The humanities are not going to generate many startups or IPOs, but knowledge in the humanities is being lost in every society as we speak and we have to address that. Even knowledge in the physical sciences can be lost, in spite of having progress at the same time. So, while we are busy creating new knowledge by pushing the frontiers and asking new research questions, at the same time we must have the mechanisms to preserve and cultivate knowledge that is already here. And for that, we need a diversity of institutions with different comparative advantages and facilities.

But before I go further, I want to sound a cautionary note on the topic of knowledge creation. In my view, there are probably too many institutions with too many people "pretending" to be engaged in knowledge creation or, rather, in writing an ever-growing number of papers. Publishing that many papers requires new outlets, so we create yet more journals until we don't have room in the library, but then enter the Internet, which supposedly has room for everything. Is all that, or even most of it, really adding to scientific knowledge in any meaningful way?

We are creating congestion in the pipelines of knowledge, and this has become a liability. It gets in the way of true scientific advance. We have to become more selective about true knowledge creation. In fact, we need to devise a system of incentives that will promote self-selection and specialization, so that those with a comparative advantage in knowledge creation will not be crowded out by those with a comparative advantage in knowledge preservation and transmission (including, but not limited to, teaching), and vice versa.

Otherwise, everybody in academia jumps into the game of publishing articles and congesting the system. It's not an easy game to get away from, because every university president, justly so, wants to be "on top"—which, at present, means being on top in a single dimension: research. Diversity is a nice slogan, but in a one-dimensional system, there is no diversity. Ranking is not diversity. Universities need to

operate in a multidimensional space. We need to define that space, and then fill the space by defining the incentives that will allow diversity to develop and flourish.

Israel's Universities (and what made them entrepreneurial)

Now let's look at the universities in Israel, which I think you will find entrepreneurial in various dimensions.

Start with the first sense we referred to above, namely being innovative as institutions. In Israel, we have six research universities plus one big research institution, the Weizman Institute of Science, which also trains PhDs. My university, Tel Aviv University, is the largest, with about 27,000 students. And, like the others, it has grown not just by adding students and faculty, but by expanding the mission and the scope of studies—often, into multidisciplinary, promising new areas. Israel also has more than fifty colleges that grant bachelor's degrees and, in some cases, master's. Many of these colleges have been founded in the past fifteen years, so we've literally had a wave of "academic startups" that still are evolving, and this, too, is institutional innovation.

As for being engines of innovation and entrepreneurship for the economy—there is plenty of evidence that our universities have done well. The Technion is legendary for producing scientific breakthroughs and startups; the Weizman Institute is second only to MIT in terms of revenues from patent licenses, and the Hebrew University is not far behind.

If you want to measure scientific output by papers published, Israel for years has been one of the three leading countries (along with Switzerland and Sweden) in terms of scientific publications per capita. We also are near the top on measures of human-capital input, such as the number of scientists and engineers per capita, and university degrees per capita. So there's excellent scientific performance and we're doing especially well in fields such as computer sciences, math, and chemistry.

The question we have to ask next is: What are the characteristics of Israel's universities that have enabled this success, in a country that has no lack of pressing concerns? A key factor has been a set of institutional mechanisms that were put in place early on—and I keep thinking that some of this was just luck. You know, sometimes you do something in public policy or institutional design that turns out to be right and then claim, "Oh, I thought about that." I'm not sure if that was the case here, but it's true that these mechanisms have worked well.

One such institution is what I'd call a buffer mechanism. Israel's universities are public in the sense that they're publicly funded—but there is a buffer between the government and the universities. There is a central funding and planning authority that receives the funds for higher education from the government in a lump sum, then distributes the funds on its own to the universities. This authority is controlled by the universities. It is supervised by the government, but not managed by it. Of course, there always are debates about how much the government can and should intervene, but this is one mechanism designed long ago that confers a great deal of autonomy to publicly funded universities.

Another key mechanism has been the universities' policies on intellectual property. For years, the universities in Israel have had huge numbers of patents, and virtually from the beginning—almost by default, as it were—they practiced a *de facto* policy of no-policy. Many of those patents were simply put into commercial use by the faculty scientists themselves, without negotiating with the universities. More recently, the universities have tried to impose a structure on the process, with the creation of TTOs and other measures. But the notion of allowing the scientists to benefit from the IP was there long before that, and it has created a system full of entrepreneurially minded faculty members. Perhaps universities in other countries can learn from our experience in this regard.

We conduct so much collaboration and exchange that you could almost say that Israel's universities function as an extension of the U.S. system.

The final important mechanism is a close linkage to the U.S. university system. We conduct so much collaboration and exchange that you could almost say that Israel's universities function as an extension of the U.S.

system. This, too, was neither an intentional development nor an expected one. Many of the founders of Israel's universities came from Europe and had a European orientation. The Technion, for instance, was established by professors from Germany. But somehow, the whole situation has evolved into one of close connection with universities in the United States. We work with them, we emulate their modus operandi, and we evaluate faculty by their standards: When any faculty member is promoted, we do that on the basis of her standing in the U.S.-based scientific community, not that of Israel. And, since American universities are the best in the world, this connection has been of great, lasting advantage.

Government policy in Israel in the realm of R&D also has helped to make the universities entrepreneurial, since it has encouraged collaboration between academic

and applied research. For example, in the early 1990s the government began a program called “MAGNET,” which supports consortia from industry and academia to perform pre-competitive research in some area of special interest and promise. The roster of MAGNET consortia keeps changing and there are currently about a dozen of them, in fields from cell therapy to next-generation wireless. They’ve become very important in terms of breeding collaboration, knowledge exchange, and the entrepreneurial spirit.

During this same period, we also started an incubator program for “zero-stage” startups, responding to the opportunity presented by the huge influx of immigrants from Russia following the collapse of the Soviet Union. Many of them were scientists with tremendous knowledge and ideas, but no experience with taking ideas to market. So the incubators, along with the other mechanisms and policies I’ve described, have helped to bring these people into an entrepreneurial environment.

To return once more to how the universities themselves have been entrepreneurial: They have reacted quickly to the emergence of high-tech industry in Israel. They have done this in many ways: by collaborating with companies in Israel, and with outside companies locating operations in Israel. By educating more graduates who go into the high-tech sector, and by allowing professors to go back and forth between the universities and industry—their policies are quite liberal in that respect. All of this produces an interchange that is very fruitful for all concerned.

Now, is everything fine with this entrepreneurial university system? By no means. I was a member of a government commission formed recently to examine the higher education system, the proximate reason being that we have been facing a serious budget crunch (prompted in part by the rapid growth in the number of students), but more importantly because of deeper structural problems that have been lurking the background. For one thing, the universities are not flexible enough in terms of salaries. The faculty unions negotiate nationwide agreements that set the pay scales, and we need to work on that aspect. Also, one of our advantages is that we played globally before globalization was in fashion, but globalization cuts both ways. A lot of our best students now become faculty in the United States, and we are losing in the game because we don’t have the flexibility to counteract the market forces.

As for student tuition, our tuition fees are now about \$2,500 per year. We want to raise them, and at the same time provide long-term loans that are easily repayable. We think this is necessary to fund higher education in the future and, personally, I think it’s also the best thing to do socially. About 50 percent of each cohort does *not* go into the higher education system—and yet, currently they are subsidizing

those who will probably go on to do better financially than they do, because of the expected value of a university degree. I think that's inequitable. And there are further issues such as the right division of labor between research universities and teaching colleges, the role of competitive funding versus funding according to number of students, etc.

The point is that, even if Israeli universities traditionally have been quite entrepreneurial, we cannot take anything for granted: In such a dynamic global environment, there is need for constant change, revision of received dogma, and rethinking of institutional design. Indeed, I believe this also is true for universities throughout the world.

The Capacity for Change

In thinking about change, it is important to keep in mind a notion put forth by Nathan Rosenberg, the prominent economic historian from Stanford. He suggests that good universities are those that managed to evolve into “endogenous” institutions. This essentially means that they rapidly adapt as the environment changes and, indeed, they become an integral part of the change. Here is a classic example:

One of the distinctive features of MIT and Stanford is that they have been extremely fast in bringing into the university new fields that developed elsewhere, such as solid-state physics in the early 1950s. Soon after the invention of the transistor, MIT and Stanford brought in experts to teach and jump-start the emerging field of solid-state physics—even if they didn't have traditionally sanctioned academic credentials. These institutions were flexible and foresighted enough to bring them as adjuncts, years before any other universities anywhere in the world even started to grasp the potential importance of this fledging scientific field, which would be destined to have such a dramatic impact for decades to come.

There were similar “early responders” in chemical engineering at the start of the twentieth century, and later on in aeronautics. Some universities moved into these fields when they were not yet recognized by the academic community as legitimate fields of study, not quite certified as the real stuff. And ten years down the road, that not-quite-real stuff turned into the main thing. So the ability to recognize what's going on out there, and to bring it in even if doesn't quite fit within the well-established rules of behavior of the university—that's a key trait.

Speaking of behavior, as I noted earlier, one role of entrepreneurial universities is to be agents of change in the society generally. And one way universities can do that

is through their often-overlooked function as socializing institutions. They take youngsters eighteen or nineteen years old, who, of course, come in with their own values and desires, but who are still quite malleable and susceptible to change during the years they spend at the university. How you treat them is extremely important—what sorts of incentives and challenges you present to them, what sorts of outcomes you lead them to expect down the road in life. If you pamper them, if you give them all A's, if you give the feeling that, no matter what, they're going to get the degree, so they ought to relax and enjoy the ride—well, it is rather unlikely that they will become entrepreneurs. Socialization is something we don't pay enough attention to. We are too instrumental in our perceptions. We think mainly about universities producing papers that will get citations, and that, in turn, will generate more funding, rather than looking into the wider economic and social context.

Another crucial issue that needs more attention from universities is how we can “build in” the ability to change our own behavior as institutions. One of the basic predicaments in the evolution of societies and economies is that, whereas technology typically changes very quickly, institutions tend to move slowly: They have institutional inertia. Thus, from time to time, any society can suffer from a disjunction between the nature of its institutions and what has evolved around them. The most successful societies are those with built-in capabilities for institutional change. Think about democracy: The reason democracy has spread is not because it's nice to people. That has never been a criterion for success in history. Democracy has prevailed because, essentially, it's a mechanism for endogenous change, for non-traumatic adaptation, for preventing inertia.

One of the basic predicaments in the evolution of societies and economies is that, whereas technology typically changes very quickly, institutions tend to move slowly: They have institutional inertia.

And just as the capability for change is present in the political arena, it needs to be made present in the realms of science and higher education by creating mechanisms for continuous change. Others at this conference have described recent changes in the German university system, which has a highly distinguished track record, but that seemed to have been locked for too long into institutional inertia. But what I'm saying to all of you is: Don't look only at the changes you need to make today. Think about the changes that will need to come in the future, because no matter how well you design your institutions, what you decide today is not going to be good in ten or fifteen years. Therefore, the real question is, do we know how to *institutionalize* change?

The Challenges Ahead

I will close by pulling back to a global view. There are now four trends operating worldwide that are changing the fate of our societies. They place immense demands on our abilities to change and respond.

- One trend is the shift from West to East. When you look at the rates of growth in China, India, and other nations, it's clear that the center of gravity of the world economy is moving east, and nothing is going to stop it. So, for us at universities in the rest of the world, the question is, what do we do about this shift? How do we connect to it?
- The second trend is climate change. This is not the first time humanity has affected nature, but two things are different now. One is the scale and the other is the recognition that nature also is endogenous, meaning that we can affect it both ways—for better and for worse. And, again, what we are going to do about that as universities?
- The third trend is the rise in commodity prices, which is not just a short-term issue. When we have a world growing as a whole to an incredible extent, the pressure on resources is bound to lead to much higher commodity prices. The only answer is science and technology that can produce substitutes for the rising commodities. We want Malthus to keep turning over in his grave as we prove him wrong again and again. He has been wrong every time in the past, and he will be wrong this time as well—but we have to make it happen, and the universities have to play a big role.
- The last trend is aging, which also creates a completely different world for humanity. It raises a host of challenges that I won't expand on, except to say that universities will be involved.

Lastly, let me touch on the issue of managing change. Here at this conference we have many presidents of universities and other scientific institutions, and I keep wondering: What has prepared you for the job? When you manage a big corporation, you go through preparation in management—you go to business school, you rise in the ranks of managing, you have mentors along the way, and so forth. I'm not saying that this is the ideal. We have to recognize that, in academia, there's a problem with managing universities. Our academic leaders rise to the top by their scientific

a v i e w f r o m i s r a e l

achievements first and foremost, not necessarily by their managerial skills. Something has to be done to help cultivate those skills.

Somebody at this conference said that these are exciting times to be the president of a university. To me, these are exciting times, period. The trends I just described are trends that happen not with a frequency of years, and not of decades, but of centuries. To be alive at this time, to be able to try to influence where the world is going, is a great privilege of our generation and we should be using it wisely.



University Alert: The Information Railroad is Coming

by William Wulf
University Professor and the AT&T Professor of Computer Science
University of Virginia

William Wulf is a university professor and the AT&T Professor of Computer Science at the University of Virginia. From 1997–2007, he also was president of the National Academy of Engineering of the United States. Earlier in his career, he was a professor at Carnegie Mellon University, and the founder and CEO of a software firm, Tartan Laboratories. In 1968, Wulf earned the first PhD in computer science ever awarded at the University of Virginia. His research interests revolve around the hardware/software interface and, thus, span programming systems and computer architecture. For instance, he designed Bliss, a systems-implementation language, and was one of the architects of the DEC PDP-11 minicomputer.

To think about the future of universities, we need to think about information technology, and not only in terms of what it might help us to do. We need to think about how it might change what we do.

My purpose today is to stimulate that kind of thinking. What I will say here is drawn, in part, from a paper I wrote more than a decade ago, which was published in the Summer 1995 *Issues in Science and Technology*, and in part from a workshop I co-chaired with Jim Duderstadt at the National Academies in 2001.¹ Some of the content has had to be updated, but the basic theme is as relevant now as it was then: For universities, the rapid evolution of information technologies presents challenges and opportunities that are not widely or fully understood. I can best convey this with a parable.

1. The Panel on the Impact of Information Technology on the Future of the Research University, January 2001. National Research Council of the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, Washington, D.C. James Duderstadt is president emeritus and university professor of science and engineering at the University of Michigan.

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It's New Year's Day, 1895. My name is Hans. For seven generations, my family has made the finest buttons in the region, using the good local horn.

Today I learned that the railroad is coming to our village. My friend Olaf says that cheap factory buttons will come on the trains, but they will never compete with my craftsmanship.

I think he is right, and wrong. They will come, but they will compete with my buttons. I must make some choices. I can become a distributor for the new buttons, or I can invest in the machinery to make buttons and export them. Or, closest to my heart, I can refine my craft and sell exceptional buttons to the wealthy.

My family's business is dead. I cannot stop the train; I must change.²

Simply put, universities are in the information business, and the information railroad is coming!

With 20-20 hindsight, it's easy to accept the demise of a quaint industry—or, more accurately, the demise of a quaint method of manufacture, distribution, and sale. The button industry flourishes, of course. Even the craft of handmade buttons is doing well, if my local art fair is any indication. However, the nature of the industry changed dramatically as technology allowed the manufacture and distribution of vastly less expensive but highly serviceable buttons.

It's harder to look inward at the university, with its tradition and obvious social value, and introspect about whether it might change in dramatic ways. But, although its roots are millennia old, the university has changed before. In the seventeenth and eighteenth centuries, scholasticism slowly gave way to the scientific method as the way of knowing truth. In the early nineteenth century, universities embraced the notion of secular, “liberal” education. In the late nineteenth century they included scholarship and advanced degrees as integral parts of their mission. After World War II they accepted an implied responsibility for national security, economic prosperity, and public health in return for federally funded research. Although the effects of these changes

2. I owe the idea for this parable to remarks by Prof. Jeff Ullman of Stanford at a meeting of the heads of Computer Science and Engineering Departments, July 1994.

have been assimilated and now seem “natural,” at the time they involved profound reassessment of the mission and structure of the university as an institution.

Let me be clear. Higher education will flourish, just as does the button industry. If anything, the need for advanced education is increasing across multiple dimensions. More people need to be educated to be productive in an increasingly technological workplace. The period during which particular skills are relevant is shortening, so the need for lifelong learning is growing. The knowledge and skills necessary to work at the frontiers of knowledge are increasing as well, and so, with it, the need for advanced degrees.

So higher education is not in danger. But we would be wise to ask whether the particularly quaint ways that universities produce and deliver that education will survive. I think there will be major changes—not only in the execution of the mission of universities, but in our perception of the mission. Moreover, in the words of Marye Anne Fox at the above-mentioned Academies workshop: The change will be profound, rapid, and discontinuous.³ As someone else said at that workshop, information technology will transform not only the intellectual activities of universities, but the way they are organized, financed, and governed.

Thus, we must engage in an intellectually honest exercise of trying to understand the implications of technology for our institutions. Before proceeding, however, we need to dispense with two issues. First, is the button analogy valid? Second, is the technology for higher education really going to change all that much?

Certainly, some specifics of the button parable are inappropriate. Universities don’t make a product that could be mechanically mass-produced, for example, and what universities do is much more complex than what button-makers once did. But, while there are differences, it would be a mistake to dismiss the similarities. Both button making and higher education are very labor-intensive activities that depend on the skill of master artisans. Both have been regional, requiring collocation of the producer and customer. Both have long traditions. Both contributed to the prestige of their locale. Both evolved powerful guilds to protect the masters. And, now the university also is faced with a technological revolution.

Universities share at least some of the attributes of other vertically integrated industries, as well. We “manufacture” information (scholarship) and occasionally

3. Marye Anne Fox is the former chancellor of North Carolina State University and, since 2004, chancellor of the University of California, San Diego.

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“reprocess” it into knowledge or even wisdom; we warehouse it (in libraries); we distribute it (in articles and books), and we retail it (through classroom teaching). Information technology already has changed each of these, and the future changes will be much greater. Like industries that have been overtaken by technology, we need to understand its individual and collective impacts on our basic functions. It's not a comfortable thought, but we must at least consider that a change in technology—a change that will facilitate the flow of our essential products: information, knowledge, and even possibly wisdom—might provoke a change in the *nature* of the enterprise.

One of the hardest things for most people to grasp about information technology is the compound effect of its exponential rate of improvement. For the last four decades, the speed and storage capacity of computers has doubled every eighteen to twenty-four months; the cost, size, and power consumption have been reduced at about the same rate. The bandwidth of computer networks has increased even faster, and Internet traffic has grown by many measures, from the numbers of users to the magnitude and nature of what they send and do on the Internet. For the foreseeable future, all of these trends will continue; the basic technology to support them exists now.

The compound effect of this rate of improvement is hard to appreciate. Speaking of ENIAC, the first fully electronic digital computer, a 1949 article in *Popular Mechanics* magazine said:

"ENIAC contains about 18,000 vacuum tubes and weighs 30 tons, but in the future computers will contain only about 1,000 tubes and weigh only 1½ tons."

Today, to demonstrate the effect of the exponential improvement in computer hardware, I carry a computer in my briefcase that is one hundred times faster than the ENIAC. It's not my laptop or even a PDA. It's a holiday card that plays a tune when opened! It's intended to be used once, to make the recipient smile, and then be discarded. It costs less than a single vacuum tube and, of course, contains none.

The first finding of the Academies' workshop was that the extraordinary pace of information technology evolution not only is likely to continue for the next several decades, but could well accelerate. For most of the four decades that I have been in computing, someone would observe that there are physical limits: “This exponential pace of change can't go on forever.” That's obviously true, but the slowdown is not on the horizon, and it's not going to spare us from rethinking the university.

The wise thing to do in such cases is to imagine a range of scenarios that might result. None of them will be exactly right, but the discipline of thinking about them will improve our ability to respond to, and to shape, what does happen. The only really dangerous course is to assume that something won't change just because today's technology doesn't support that change. That's a guarantee to be unprepared.

A Spectrum of Possibilities

How might we use this equipment to change education and scholarship? That seems like a simple question, but as both an academic and a computer scientist, I don't know. Ironically, although we can sometimes predict the improvement in technology with precision, predicting the societal impact of that improvement has been difficult. Certainly, knowledge—its creation, storage, and communication—is part of the essence of a university. The ability to process information, the raw stuff of knowledge, thus sits at the heart of what the university is and does. A technology that alters that ability by orders of magnitude cannot avoid having an impact on at least how we fulfill our mission, and possibly on the mission itself.

As a start, we might look at several functions of our vertically integrated information business and note how they have been and might be changed.

Scholarship: The impact of information technology on scientific research is both apparent and pervasive. Scientists now routinely talk of computation as the “third modality” of scientific investigation, on a par with theory and experimentation.

The easy examples are those that simply automate what was done manually: the reduction of data, the control of instruments, etc. The profound applications, however, are those that lead to whole new areas of research and new methods of investigation—and thus to science that was not and could not be done before: the final proof of the four-color conjecture, analysis of molecules that have not been synthesized, measuring the properties of a single neuron by growing it on a silicon chip, watching a model of galaxies collide, and letting a scientist “feel” the forces as a drug docks in a protein. These applications have transformed the nature of scientific investigation; they led to asking questions that would not even have been asked before.

I don't think science, however, will be where we see the most dramatic impact. I say that despite a report from the National Research Council that I helped to co-author that paints an expansive image of the transformation of scientific research.⁴ Instead, I

4. National Collaboratories: *Applying Information Technology for Scientific Research*, National Academy Press, 1993.

believe that a more dramatic transformation is about to shake the foundations of scholarship in the liberal arts. Humanists, more than scientists, will lead the way to innovative applications of the technology in the university.

The comfortable stereotype of humanists as technophobic just doesn't apply anymore. The availability of both text and images in electronic form, coupled with the processing power of modern computers, allow the humanist to explore hypotheses and visualize relations that were previously lost in the mass of information sources. The presentation of humanists' scholarly results in electronic form is moving even faster. Precisely because of the complexities of the relationships they need to present, and the subtle webs of relation and inference they need to express, electronic hypertext books and journals are emerging. Indeed, they are emerging faster, with more vigor, and with more effect on their disciplines than are their counterparts in the sciences.

We all expect scientists and engineers to use computers in their research, but the notion that information technology could be central to humanistic scholarship is a bit more startling; at least it was to me. In large measure, it was talking about the application of computers to historiography and the theory of text that opened my eyes to the larger issues I am trying to raise here, and that also formed the basis for the Institute for Advanced Technology in the Humanities (IATH) at the University of Virginia.

IATH was founded in the early 1990s to explore how information technology could be used to support humanistic scholarship. As with the sciences, there are easy examples that automate what had been done manually—creating concordances, for example. We have just scratched the surface of the profound examples, but again we see the ability to ask and answer questions about the human record that would not have been asked before. We also see a shift in the sociology of scholarship, from strict individual scholars to teams, for example.

Textbooks: I don't know anyone who prefers to read from a computer screen, and besides, you don't want to take a computer to the beach—or so say the nostalgic. They are right, and yet so profoundly wrong.

There are two fallacies here. The first is the assumption that electronic books will contain only text, and thus be essentially the same as paper books but presented differently. In reality, it will not be possible to reproduce an electronic book on paper. These books will not be simple linear presentations of static information. They will contain animation and sound. They will let you access the data behind a graph by clicking on it, allow you to try alternative analyses of that data, and perhaps lead to new norms for data sharing. They will contain multidimensional links so that you can

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navigate through the information in ways that suit your purpose rather than the author's. They won't contain references to sources, but the source material itself; the critique of a play will "contain" its script and performance. They will have tools that let you manipulate equations, trying them on your own data or modifying them to test scientific hypotheses. They will let you annotate and augment the document for use by later readers, so making it a living document.

The second fallacy is presuming that today's technology, or something similar, will be tomorrow's. We should not be thinking about reading these electronic books from today's screens. The advantages of the electronic book will be so strong that engineers will make the form factor of the medium human-friendly. Flexible "electronic paper" already exists, with a resolution as good as that of the printed page, and in the future it won't necessarily be packaged in the kinds of e-book devices now on the market, which have made great advances in their readability. Why would anyone lug around several heavy books when something the size, clarity and readability of a single one contains them all? I mean all—all the books in the Library of Congress. I *will* take that to the beach!

Libraries: For thousands of years, libraries' focus has been on the *containers* of information, books. The information itself was the domain of the library's users, not the library. Information technology turns that premise on its head and, with it, many of the deepest unstated assumptions about the function of a library.

Tracing back to Alexandria and before, the librarians' principal objective has been to build the collection—to amass a set of materials was their measure of worth. But, in the future, a library will not "collect." Electronic information can be communicated virtually instantly, so its source location is irrelevant. Instead of being a hoarder of containers, the library must become the facilitator of retrieval and dissemination.

If we project far enough into the future, it's not clear whether there is a distinction between the library and the book. The "technology" of the bibliographic citation pales by comparison to the hypertext link—to the ability to gain immediate access to the full referenced source, and thence to browse through the context of the reference. It will take a long time to build the web, and especially to incorporate the paper legacy, but the value of a seamless mesh will doom the discrete, isolated volume.

As the library and the book merge, it seems compelling to me that another merger will accompany it—a merger precipitated by devolving disciplinary boundaries. Knowledge isn't inherently compartmentalized; there is only one nature; there is only

one human record. The division of the sciences into physics, chemistry, etc., and their further subdivision into physical and organic chemistry, is a human imposition, as is the division into history, English, and anthropology. For very practical reasons, paper texts have mirrored this artificial division, but those “practical” reasons evaporate in the electronic world. Clearly, the “long pole in the tent” will be human rather than technical; disciplines are complex and idiosyncratic social structures that will not easily dissolve. However—and here I can only speak with limited authority even on technological disciplines—much of the most interesting work already is happening at the boundary of traditional disciplines. That’s not news; Einstein opined that most of the important science lay at the interstices of traditional disciplines. What is new is that we have technology that facilitates incremental accretion of knowledge at these interstices.

Finally, note that the book as we know it is passive; today’s books sit on shelves waiting for us to read and interpret them. While there is an intellectual thrill in discovery and interpretation, passivity of the text is not required for that. As Marvin Minsky, a professor at MIT, said, *“Can you imagine that they used to have libraries where the books didn’t talk to each other?”* One of the profound changes in store for libraries is that parts of their collection will be active, with software agents collecting, organizing, relating, and summarizing on behalf of their human authors. They will “spontaneously” become deeper, richer, and more useful.

Teaching: The notion of computer-aided instruction has been touted for thirty years. Frankly, it has had relatively little impact, especially at the university level. The reason is obvious: Chalk and overhead projectors have been perfectly adequate technology given the current nature of scholarship and texts.

If, however, the bulk of the professorate are using information technology in their scholarship, and the results of that scholarship can only be exhibited using the technology, the classroom will follow rapidly. How will it follow? Not, I think, by the automated-drill scenario we have come to associate with computer-aided instruction.

Beyond automated drill, the obvious application of technology is telepresence—the possibility of involving remotely sited individuals in a seminar, for example. Again, do not think in terms of today’s teleconferencing technology; as the fidelity of communication improves, telepresence will certainly happen. While now it’s a big deal to bring a leading authority to campus, and access to the person is often limited to research colleagues and graduate students, this will not be the case in the future. The technology will give an increased number of undergraduates access to these

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authorities. Relieved from the overhead of travel, who among us would not cherish a few hours each week with the bright young minds at a remote Harvard or Yale?

These are interesting but mundane applications—mundane in the sense that they do not change the educational process in a deep way. More fundamental is the opportunity to involve students in the process of scholarship, rather than merely in its results. We like to say that we teach students to think, not merely to learn rote facts, but in truth:

- We mostly limit students to thinking about what has been thought before. We can't ask them to explore new hypotheses, because of the practicalities of access to sources and the sheer grunt work of collecting and analyzing data. Information technology eliminates those “practicalities.”
- Students are forced through the linear sequence of the text, course and curriculum before we judge that they “know enough” (facts) to embark on a scholarly project (think).

A hint of the kind of change that lies ahead can be detected in the impact of *Thesaurus Linguae Graecae* on scholarship and education in the classics. This long-running project at the University of California, Irvine has compiled a database of nearly all extant Greek literature from Homer through the fall of Constantinople, plus a good bit written since then. Available on CD-ROM or online, this database has enabled undergraduate participation in research.

A more personal example for me is a project created by the Civil War historian Ed Ayers at IATH.⁵ Ed's project, *The Shadow of the Valley*, details the lives of some 10,000 individuals who lived at opposite ends of the Shenandoah Valley, in communities that were very similar except for being on opposite sides in the American Civil War. Richly hyperlinked, *The Shadow of the Valley* provides an invaluable resource for students and scholars alike, and it irrevocably changed Ed's courses on the Civil War. He could no longer tell a simple linear story because his students had too much access to the messiness of real history. Instead, Ed concentrated on historiography—the process of historical scholarship—using the War and *The Shadow of the Valley*.

One cannot leave the subject of teaching without mentioning the subject of “productivity”—a code word that reflects the public's frustration with the rising cost of

5. In 2007, Edward Ayers was named president of the University of Richmond.

higher education and the perceived emphasis on research over teaching. In the most simplistic interpretation, a call for increased productivity would mean that we want professors to channel their energies into teaching more material to more students, so that the process becomes more cost-efficient.

The irony, of course, is that one of the oldest measures of merit for any school—a low student/teacher ratio—is diametrically opposed to this sort of “productivity.” Information technology is not going to resolve this tension; for our *own* children we want relatively individual attention from the most qualified, intellectually alive professors possible. Information technology *can*, however, shift the focus of the discussion to the effectiveness and quality of the student/teacher interaction rather than just the number of contact hours.

Indeed, in modest ways it already has shifted that focus. By removing the barriers of space and schedule, for example, e-mail has given my students much greater access to me than ever before. Involving students in the process of scholarship and giving them greater access to international authorities are more profound shifts, but I suspect that these are still just pale precursors of what we can do. Part and parcel of rethinking the impact of technology on the university is addressing precisely this issue.

Rethinking on a Deeper Level: the Nature of the Enterprise

Whether or not you agree, I hope this discussion has at least suggested how activities in the academy might change. Even so, that does not imply that the nature of the university as a whole will change. Will it?

One approach to answering such a question is to examine unstated assumptions. That’s hard, but I would like to examine just one.

Historically, a university has been a *place*. The stone walls of St. Benedict’s Abbey at Monte Cassino were meant to provide defense against the physical and intellectual vandals of the dark ages. In American colonial times, Jefferson’s Academical Village provided access to scholarly materials as well as collegial interaction by collocation. In other places and times, scholars flocked to scientific instruments and library collections. And, where the scholars assembled, the students followed.

In his influential nineteenth-century essays on *The Idea of a University*, John Henry Cardinal Newman wrote:

“If I were asked to describe ... what a University was, I should draw my answer from its ancient designation of a *Stadium Generale* ... This description implies the assemblage of strangers from all parts in one spot.”⁶

The Cardinal then went on at some length to emphasize that books were an inadequate source of true education that must be buttressed with discourse—which obviously was only feasible if the discussants were collocated. Thus, the notion of being “in one spot” was, to him, essential to the very definition of the university; as he wrote, “Else, how can there be any school at all?”

But, with the possible exception of teaching, to which I’ll return in a moment, I believe that information technology obviates the need for the university to be a place.

Once again, please remember that, although we are presuming technology better and cheaper than today’s, this is not hypothetical. The trends are clear; the capabilities for at least the next decade are predictable and, in many cases, the technology is already in the laboratory. Only how we will use the technology is in question.

With powerful, ubiquitous computing and networking, I believe that each of the university’s functions can be distributed in space, and possibly in time.⁷ Remote scholarship and authoring are the direct analogs of telecommuting in the business world, and every bit as appealing. Academics tend to identify more closely with their disciplinary and intellectual colleagues than with their universities. Freed from the need to be physically present in classroom, laboratory, or library, grouping by intellectual affinity may be more appealing. But even then, physical grouping may be unnecessary and even undesirable as such things as location preference are taken into account.

There are some disciplines that need shared physical facilities, say a telescope, and that thus seem to suggest the need of a “place.” But large scientific instruments such as telescopes and accelerators already are run by consortia and shared by the faculty from many universities, and many of these facilities do not require the physical presence of the investigator, who could be online and have access via the network. Thus, the university as “place” already is irrelevant to at least some scientific scholarship.

6. From the *Rise and Progress of Universities*, Chapter II.

7. See, for example, the Sloan-sponsored work on Asynchronous Learning Networks.

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As with instruments in the sciences, direct access to archival materials is necessary for some humanistic scholarship—but hardly all, and certainly not all of the time. Ponder the excitement, for example, caused by the release of images of the Dead Sea Scrolls, even though the scrolls themselves are not accessible to most scholars. If anything, the ubiquitous information infrastructure will provide greater access to archival materials to a much larger set of scholars, of a quality that’s “good enough” for most purposes.⁸

As for teaching, we don’t really know whether it can be distributed or not. I do know that even asking the question is considered heretical by some good teachers—teachers who contend that physical eyeball-to-eyeball contact is necessary. Others, including me, contend that, although they need feedback to teach well, there is a threshold of fidelity beyond which one does not need to go; student and teacher probably don’t need to smell each other, for example. Thus, there is some finite amount of information required to produce an adequate representation of the parties. If true, when that threshold of fidelity is reached electronically, high-quality teaching *will* be distributed. The fallacy in Cardinal Newman’s reasoning was only that he could not imagine quality discourse at a distance—but that is precisely what the technology enables.

Could institutions such as universities, that have existed for millennia and are icons of our social fabric, disappear in a few decades because of technology? If you doubt it, check on the status of the family farm. Will the “university as place” in particular disappear? I expect not; the reduced importance of place does not imply *no* place. However, just as farming has been transformed, so will the university. The everyday life of both faculty and students will be very different.

Questions, Questions

I have more questions than answers as to the new shape of the new university. Having now laid the groundwork, let me pose a few of these questions:

- I believe that higher education not only will survive, it will flourish. But are the choices for universities, like the choices for Hans, to become either mass-market manufacturers or distributors on the one hand, or niche

8. One of the interesting sociological changes we have observed at IATH is that humanistic scholarship has become a year-round activity. Whereas scholars could previously only access materials during a summer trip to the place where the materials were housed, they can now access them during the rest of the year online.

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tutors to the privileged on the other? Alternatively, is there some other model more appropriate to academe?

- Does it really make sense for every university to support the full complement of disciplines, or should universities specialize and share courses in cyberspace? This might be a natural consequence of aggregation by disciplinary affinity, for example.
- The decision by MIT to make its courseware freely available has stimulated other universities to similar benevolence. It is too soon to assay the impact of these decisions, but could the ability of smaller and non-U.S. schools to deliver high-quality instruction in deeply technical areas be greatly enhanced?
- Might professors affiliate with several institutions, or become freelance tutors to telepresent to students? Indeed, might we go “back to the future” of tele-itinerant scholar/tutors?
- Might some employers (and hence students) prefer a transcript that lists with whom certain courses have been taken rather than where? In the tele-itinerant scenario, one could imagine a bright student not only self-designing a program of study but also choosing an “all-star” faculty for it, by applying to study with the leading experts in key subjects regardless of their locations or affiliations. Wouldn’t that student then appear to be better qualified than someone whose learning was confined to a single university, even a very good one?
- What about alumni and sports? Surely the allegiance of alumni to their *alma mater* has a great deal to do with place, and in the United States is cemented on football weekends. And, since alumni support has become essential to universities, isn’t that very human need sufficient to perpetuate the university as place? Perhaps. But alumni programs and large sports programs are themselves evolving in relation to place—universities have alumni chapters around the world and in online virtual worlds; their sports teams recruit and are marketed widely—and a better question may be: How might these programs go on evolving?
- Will universities merge into larger units as the corporate world has done, or will the opposite happen? I could argue either side of this question. On the one hand, if a university isn’t (just) a place, its major remaining

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function is certification—it certifies the competence of the faculty, the programs, and the graduates. We don't need thousands of organizations to do that. On the other hand, I can envision many small colleges being empowered to provide a broad curriculum via telelocation while retaining the intimacy so valued in our small liberal arts institutions. I don't know anyone who really *wants* the impersonal ambiance of a mega-university. The current size of these universities seems optimized for the physical infrastructure, not for education or scholarship.

- For-profit universities have flourished recently, and several have high “customer satisfaction” ratings because they are convenient for working students, but also because they have developed curricula and pedagogy that take advantage of the most modern understanding of how people learn. Might we see outsourcing of large introductory courses, which most research-oriented faculty don't like to teach anyway? If so, what happens to the cross-subsidy from these courses that supports small upper-level undergraduate and graduate courses?
- Might technology revive the talented amateur's participation in the scientific community? Except for a few disciplines like astronomy, the talented amateur largely has disappeared from scholarly discourse in science and engineering. Surely such individuals still exist, but they are isolated from the community of scholars. How can/should the university re-engage them?
- What about the various businesses that have affiliated with universities—the university press being an especially poignant example? My guess is that each of these will be forced to rethink its principal mission, and many will be irrelevant.
- Will more (most?) universities serve a global clientele, and how does that square with the publicly supported university in the United States and elsewhere? In particular, will private universities have greater flexibility to adapt to globalization, thus dooming the public universities?
- Does the function of socializing young adults, which perhaps remains a reason for “place,” need to be coupled with the educational function, or could it be done better in some other form?

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Some will interpret these questions as threatening; I don't. That there will be change seems inevitable. But, change always implies opportunity and, in this case, the opportunity is to improve all facets of what we do in the academy. The challenge is to anticipate and exploit the changes.

Procrastination and inaction are the most dangerous courses for colleges and universities in this time of technological evolution. Dispassionate contemplation of the what-ifs and careful examination of our often-unstated assumptions are the best preparation for preserving—and, better yet, expanding—the critical roles that universities play in our society. Universities are in the information business, and the information railroad is coming.



The Role of the Global University In Accelerating Discovery-to-Product in BioPharmaceuticals: Some 'Black Swan' Scenarios

by Frank Douglas
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Frank Douglas advises the Kauffman Foundation as a senior fellow. He is a partner of Pure Tech Ventures, and the founder and first executive director of the MIT Center for Biomedical Innovation. At MIT, he was the Professor of the Practice in the Sloan School of Management and also held appointments in biology, biological engineering, and the Harvard-MIT Division of Health Sciences and Technology. Formerly, Dr. Douglas was executive vice president and chief scientific officer of Aventis. He received the 2007 Black History Makers Award and twice was named Global Pharmaceutical R&D Director of the Year. He holds a PhD in physical chemistry and an MD from Cornell University. As an MD, he was an intern and resident in internal medicine at the Johns Hopkins Medical Institution and a fellow in neuroendocrinology at the National Institutes of Health.

All speakers bring their own backgrounds to their topics, and I am no exception. I have spent my entire career in biopharmaceutical research; as an academic, as a practicing medical doctor, as the chief scientific officer at a major pharmaceutical company, and as a funder of biotech startup ventures. In short, I've had the opportunity of working across the whole ecosystem of biopharmaceuticals.

I will draw on this background in my remarks today on the variety of roles that global universities could play in re-shaping and ideally improving the biopharmaceutical ecosystem to make it work better. I realize this may strike some as a narrow industry-specific subject. But the development of new pharmaceuticals is essential to curing or controlling many diseases, and university-based research historically has been critical to this process. As universities increasingly "go global," as President Alan Merten has

discussed with us today, it is important to address what impact this trend will have on the biopharmaceutical ecosystem.

The Global University

I begin with a threshold question: What is a “global” university, exactly? Rather than try to define it by describing a set of features, I’ll offer a functional definition—an ideal mission statement to adopt, if you will:

A global university enables people to anticipate, and to generate solutions for, global problems and opportunities.

The “people” in this statement include the students, faculty, and third parties with whom the university interacts. And the rest of the mission statement is, in a sense, really just a matter of applying scientific method globally, to problems of global import. The Internet and all the other technologies and methodologies at our command have given us the ability to gather tremendous amounts of data on almost any topic—from all over the world. When you’re able to gather a lot of data, you can form hypotheses. As you form hypotheses you get into the business of anticipating. The challenge is capturing knowledge that you can use to see what lies ahead and to make things happen. This entails designing experiments to test the hypotheses, and, as you learn from the experiments, you begin to see the problems, solutions, and opportunities ever more clearly. A global university engages in this paradigm of generation and testing of hypotheses to better understand and address problems of global human significance.

A global university enables people to anticipate, and to generate solutions for, global problems and opportunities.

Now let’s expand on this definition by introducing the concept of “place.” Earlier, President Michael Crow stressed the importance of leveraging “place” for a university. And closely related to that idea is the one that Manuel Trajtenberg raised—that the university has to be an endogenous institution, an integral part of its community and environment. These are tricky notions to act upon, because our sense of place and community has been changing. We keep hearing that we live in a global village, which means we should see the whole world as our community. Does this, then, mean that a global university should be everywhere, with campuses all over the world? Or conversely, does it mean that physical location doesn’t matter at all, as long as you are linked up virtually with the rest of the world? My answer is: neither. I’d like to propose an entirely different way of defining the role of place for a global university:

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Wherever it is located physically—in one location, or in several—a global university serves as a *meeting point* for the global village.

A “meeting point” has several meanings. First, it’s a place where people can meet in the sense of getting to know one another, as in: “I’m glad to meet you; this could be a productive relationship.” Or, much like a designated meeting point in an airport, it’s a place you can come to in order to find a particular person or kind of person, such as an expert for a specific project. A meeting point also is a place to exchange and discuss information, as you do when you “have a meeting.” And, of course, it’s a place where people congregate for ongoing work of much longer duration as well, just as they do in an office or factory.

At a global university, people from all over the global village meet in all of these senses, both physically *and* virtually. And, ideally, the university also takes advantage of its physical location. It does this by becoming a meeting point for certain kinds of work that can be enhanced by being done in that location—for instance, because there are other institutions or industries nearby that do those kinds of work.

One university that has established itself very firmly as a global meeting point is MIT, where I’ve been on the faculty. MIT has large numbers of foreign-born students and faculty on campus, so members of the global village are meeting there physically. It also has international partnerships, like the Cambridge-MIT Institute, in which people are always going back and forth physically as well as communicating virtually. And, to bring us back to my original definition of a global university, one of those partnerships is the Alliance for Global Sustainability. MIT, along with universities in Europe and Japan, created this Alliance in 1997—before sustainability was widely recognized as the global hot-button issue that it has become today. So, that’s an example of a university using its meeting-point status, harnessing the power of the global village, to “anticipate, and generate solutions for, global problems and opportunities.”

Now let’s look to the future. Let’s start thinking imaginatively, and see how we might use these concepts to address other global issues—perhaps in ways that haven’t been tried yet, to achieve results that haven’t been achieved thus far. And to do this I will introduce one more concept, because we’re going to be looking at “black swan scenarios.”

The Black Swan

Nassim Nicholas Taleb, a distinguished Lebanese finance expert living in the United States, has written a popular, highly-acclaimed book called *The Black Swan: The Impact of the Highly Improbable*. The title refers to the fact that long ago in Europe, people assumed that all swans were white. The term “black swan” was a metaphor for something that didn’t exist or couldn’t happen, but, in fact, actually did occur (as some Europeans journeying to Australia discovered when they did see black swans). Today, in the sense that Taleb and others use it, a black swan event is understood to be a high-impact event that was unexpected or at best seemed highly improbable. One example Taleb gives is the terrorist attacks of 9/11, and another is the emergence of the Internet as we now know it.

I suspect that each of you can name other “Black Swan” events. Indeed, I think we now live in a world where the highly improbable is becoming not so improbable. All around the world, in many different fields of endeavor, there are so many people, technologies, and systems in the mix that the possibilities keep multiplying, and more and more the main limitation is what we can imagine doing.

Please keep all this in mind when you look at the “black swan scenarios” I will discuss next. They are scenarios that may seem unlikely to occur, or difficult to create, but they are not just fanciful ideas that I’m floating into the blue sky. They are scenarios that *could* be created, if the appropriate people set out to do it.

The Issue Area: Discovering Drugs and Moving Them to Market

For an example of a global issue area in which we can find both problems and opportunities, I’ve chosen one that affects us all. It is the process of dealing with human diseases and disorders by discovering new drugs and bringing them to market. Although we’ve made great progress in this area—and although the work involved is very complicated and difficult—many people think that we could, and should, be doing much better.

The entire process from discovery to market is a long one; it can take anywhere from ten years to decades. It can be very expensive and, despite our efforts, there are a number of major diseases and disorders we’ve had little success in controlling. Thus, what many people see is a situation in which treatments are slow to arrive, are unaffordable or very hard to afford when they finally get there, and never do arrive—or are only of limited help, at best—for some of the most urgent cases.

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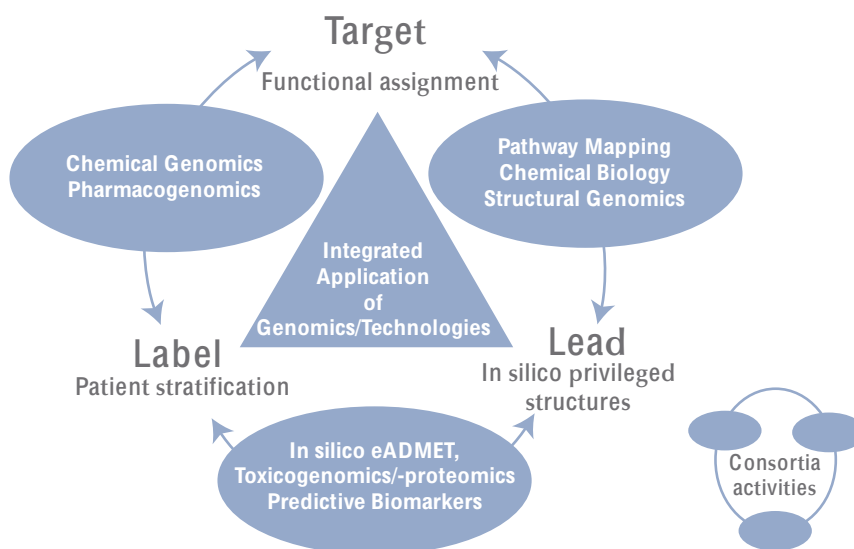
Nothing is more important to anyone than life and health. If ever there were an area in which it behooves us to have the best processes for new-product development that we possibly can, it's the area of developing products to preserve life and improve health. So, instead of hoping for a white knight to come to the rescue, let's look for black swans.

The Nature of the Problem

Chart 1 shows key factors that come into play in drug discovery, and in any attempt to develop new paradigms for the process. The chart uses a good bit of scientific jargon because it's meant to communicate with experts in biochemistry. For those of you who are not insiders, I'll explain a number of the major items briefly.

1. Next Paradigm in Drug Discovery Depends on ...

Impact of Genomics on Drug Discovery



The chart starts with a disease you would like to treat or prevent. The “target” is something in the body, such as a receptor or a gene, you believe might help. A receptor is a protein molecule, in the membrane of a cell, that might allow certain other

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kinds of molecules from outside the cell to attach themselves to it, thereby changing what goes on in the cell. If the receptor will bind to unfriendly molecules, then it might be part of the disease process; if it will bind to therapeutic molecules, then it might be part of the solution. There are many, many different receptors in different kinds of cells throughout the body, just as there are many different genes—and thus, many possible targets that one could aim for in trying to treat a given disease.

The “lead” is a compound or antibody that you think will have the desired effect, if you can deliver it to the target. Here again, there are many possible leads, as well as many possible pathways by which to deliver them—and I’m already oversimplifying what is a complex discussion. You can use “*in silico*” computer simulations to explore the possible effects of a potential lead molecule. Eventually, you hope these will lead to *in vitro* and *in vivo* experiments that give you proof of concept, so you can proceed to the different phases of clinical trials. The goal is to get a drug approved and onto the market, with a “label” that specifies how it’s to be used and the effects that one should expect. And even the “label” stage is not the end of the process, because now you must do follow-up studies of the drug’s long-term performance and effects in the marketplace. These can sometimes suggest new targets, and the cycle continues.

The ovals in Chart 1 indicate parts of the process where there are a lot of data to be generated, collected, and analyzed; and where better analytic and predictive methods might lead to better, faster results overall. These are prime areas in which global research universities can, and do, step in to help. In any given case, some of the key unknowns to be explored as we move around the cycle include:

- Which targets will give the optimal benefit/risk ratios?
- Which strategy, small-molecule or biological, should be pursued?
- Which patients will best respond to which therapies?
- Which patients will be susceptible to which side effects from which therapies?
- Which low-frequency side effects are “early warning signs” of much wider, or more severe, side effects that might become manifest later?

And there’s more. The triangle in the center of Chart 1 represents two emerging fields in which we’re learning and developing new things that could be integrated throughout the process. One is genomics—the study of the human genome—and another is a range of new technologies that are not strictly biomedical or

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biochemical, but could have useful applications. They would include new information technologies, new materials, and a host of others.

There's plenty of room for improvement in the triangle, too, not only in terms of specific inventions and discoveries, but in terms of improving the scientific process. This was demonstrated after the Human Genome Project began, when a private firm, Celera Genomics, stepped in with its own approach and wound up accelerating the mapping of the genome. So the overall message is as follows: This process of developing drugs is complex and arduous. But it also presents many opportunities for making gains.

Finally, in the island in the lower right corner of the chart, I've put "consortia activities" to show that universities, firms, and governments are already collaborating in many ways on various parts of the drug-development process. Let's now consider some macro-ways in which this whole structure of scientific investigation might be reorganized to yield more results more quickly—and how global universities might fit into each of them.

Some Black Swan Scenarios







Earlier in this conference, Bill Wulf made the excellent point that a good way to plan for the future is to paint multiple scenarios, because while none of them will come true entirely, some parts of them might—and the discipline of thinking about them helps you to prepare for any or all of them.

That's what I now invite you to do, as leaders of global universities and university systems. I will present four different scenarios for the future of drug discovery and development. They are scenarios that could result from various forces; none would be driven entirely by universities. But for each one, I invite you to ask how global universities might fit into the picture. How would some of these events impact what you're currently doing? Are there things you'd like to see happen that you could make happen?

The first scenario is one I call the "**Internal**" **Black Swan Scenario** because it consists of changes that could come from within the biopharmaceutical industry. Some people may be skeptical that large pharmaceutical companies can ever really change the way they operate. But we've certainly seen other large firms and industries change themselves, so let's take a look at Chart 2:

Suppose, first of all, that large pharmaceutical firms decided to no longer rely so much on their big in-house research departments. Instead, they would focus more on forming “Strategic Discovery Clusters”—alliances with university labs, research institutes, and biotech companies, with each cluster devoted to research around a particular mechanism or disease. Among other things, we would then see the emergence of a new type of key person in the industry: the “Alliance Managers” who direct the clusters.

2. Large Pharma Will Focus on:

-  Strategic Discovery Clusters
-  New Role for the Alliance Manager
-  Commercial / R&D spend: 2:1 → 1:1
-  Approvals after Ph 2b
-  A Changed IP Space
-  “Safe Haven” and Pre-competitive Space

Suppose, too, that the companies began to shift their spending, so that instead of spending twice as much on the commercial phase as they do on the R&D phase—which is typical today—they began moving toward a one-to-one ratio. That would make a lot more money available for the early stages of research. One way this could be accomplished is by pushing for market approval of at least some new drugs after Phase 2B clinical trials, instead of during or after Phase 3 clinical trials. Thus, more money could be spent in trying to find the right subset of patients for which the drug would be efficacious, as well as determining the types of patients who might have unexpected side effects to the drug, before entering into Phase 2B. In addition, once the drug is in the market, there is a broader population on which to test its effects. The “Safe Haven” line at the bottom of Chart 2 refers to the kind of pre-competitive space we created when I was at MIT, the MIT Center for Biomedical Innovation. This is a place where scientists from academia, industry, and government can work together on problems related to productivity in innovation. What if the pharmaceutical industry showed a desire to be involved in more ventures of this type—and what if the industry also joined the push to change how intellectual property is handled? I think the potential impact on innovation of joint efforts of this type would be enormous.






Altogether, the “Internal” Black Swan Scenario adds up to a sweeping package of changes that may seem unlikely to occur, and even less likely to be driven by the industry itself. But I would point out to you that every aspect of this scenario is already being tried, or at least contemplated, in some form somewhere. It’s really not a blue-sky fantasy at all. It is a set of changes that any opportunistic company might think

about. So the question I pose to you is: How would an opportunistic global university respond to help make this scenario a reality?

Next is what I call the **“External” Black Swan Scenario**, as it would be driven mainly by forces external to the biopharmaceutical industry. The key elements of this scenario are shown in Chart 3. They are possible responses, by governments and others, to perceived problems and concerns in health care today.

Here, let’s begin by supposing that governments and other research sponsors decide to focus their funding in just a few areas where the chances of progress seem most likely, or where constituencies are pressing the hardest for results. We would also see governments and/or private insurers mandating the use of generics to cut costs. Regulators wouldn’t approve a new drug, or allow an existing non-generic to stay on the market, unless the company had markers identifying which patients were unlikely to be helped by it and which would have side effects.

3. ‘EXTERNAL’ BLACK SWAN SCENARIO: CHANGES IMPOSED ON THE INDUSTRY

-  Funding for research on few conditions: e.g., Alzheimer’s, some cancers, orphan diseases
-  Mandatory use of generics by drug class
-  Identification of responders to efficacy and side effects required for approval and marketing of all non-generics
-  Preventive health measures are preferentially reimbursed
-  Price controls!!!

Suppose further that funding tilts more and more to preventive measures—so that instead of funding more research on diabetes, for instance, the government reimburses my doctor for getting me to lose weight, so my blood pressure goes down and I’m less likely to become diabetic. And finally, what if prices implode across the pharmaceutical industry? Again, I invite you to consider: How would events like these impact the role of universities in drug discovery and development, and how could the universities respond?

In the third Black Swan Scenario, I am envisioning how some combination of the previous two scenarios—plus other developments—could lead to a globally **“Restructured” Biopharmaceuticals Industry**.

As shown in Chart 4, you would first see in this scenario the industry simultaneously consolidating and fragmenting, much as a number of other industries have done in this age of globalization. We would be left with a few big pharmaceutical companies that serve mainly as “integrators” of the work of many small, specialized players. Venture capital plays an increasing role in this scenario and “virtual everything”—virtual management, virtual collaboration—becomes the order of the day. The notion of “outsourcing” in the old sense fades away because it is no longer just a matter of companies shifting production or other activities to cut costs. Everyone is now **sourcing** everything globally, to wherever it can be done best for any number of strategic reasons.

In this scenario, global universities surely would collaborate in new ways with industry and government. Some questions to ask are: What are the possible forms of collaboration? What would the most visionary universities be doing?

A ‘Black Swan Pilot Project’ for Cancer

The final scenario that I will offer is different from the rest. This is a vision of a pilot project that could be actively, consciously created by universities working in partnership with others. I will describe this scenario in a bit more detail, because not only do I think it could happen, I think it must happen—hopefully, sooner rather than later.

The pilot project would be focused on cancer, a disease—or more accurately, a set of diseases—that we’ve had only limited success in treating. All cancers have a common characteristic, which is that cells grow uncontrollably, sometimes spreading from their site of origin. This common characteristic might lead one to think that all cancers, or at least a wide range of cancers, would be susceptible to a common treatment regimen—if only we could discover it. But so far, such a breakthrough has eluded us. Despite decades of effort—and despite having an arsenal of interventions that range from drugs and surgeries to radiation therapy and other therapies—we can

4. BLACK SWAN SCENARIO FOR A ‘RESTRUCTURED’ PHARMA INDUSTRY

-  3-4 top-tier Large Pharma as integrators
-  Many small specialty players
-  Venture Capital Firms as research translators
-  Virtuality becomes a Reality
-  Strategic Global Sourcing
-  Academia/Government/ Industry collaborations

only claim fairly good success in treating some cancers, and little to none in treating many others.


Experts are starting to recognize that we need to do more than just go on funding new research projects within the existing frameworks. We need new frameworks, new approaches to conducting the work. That is what my proposed pilot project would provide. It also would be a means of integrating and enhancing new approaches already being tried, so we could mount a cohesive, multifaceted effort to conquer what is obviously a multifaceted set of diseases. Some key elements of the pilot are shown in Chart 5.

The first step is to declare, and commit to, a global “Cancer Project.” The project should have a firm goal and a time frame, such as developing very effective treatments for cancer (or for certain cancers) within X years. In that sense, it would be similar to some previous large-scale scientific efforts in the United States, such as the Manhattan Project and the program to send men to the moon, which both had very ambitious goals and demanding schedules.

To marshal the global commitment required for a Cancer Project, there will have to be a launch consortium that includes major governments, as well as partners from academia and industry. Global universities could network to provide the impetus for this first, formative step.

Next, the project will need global “meeting points” to serve as nexuses of activity. Earlier I described how a global university itself plays a meeting-point role, but since the Cancer Project will have a large agenda, I’m going to suggest one meeting point much larger than any single university: the entire state of Massachusetts, within the United States. Work on the project will, of course, go on across the country and worldwide, but Massachusetts has all the key attributes needed for focusing the attack on cancer. It has multiple major research universities—MIT, Harvard, the University of

5. BLACK SWAN PILOT PROJECT

-  A global Cancer Project, akin to the Manhattan Project or man-to-the-moon project in the United States
-  Massachusetts as a global “meeting point”
-  Mechanistic pre-clinical and clinical studies
-  Methods and tools for predictive power
-  Monitoring and measurement techniques
-  Managed Academia/Government/ Industry collaborations

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Massachusetts, and others. There also are independent research centers, like the Dana-Farber Cancer Institute, and big hospitals, like Massachusetts General. Every global pharmaceutical company has a presence in Massachusetts. There are hundreds of biotech companies, and a large and knowledgeable investment community. Better yet, all these players are already highly networked, both within the state and worldwide. Finally, Massachusetts has a diverse patient population: Within one fairly compact state, people of many ethnic and racial backgrounds reside, carrying a range of genetic traits and living in environments from a major urban area to rural areas.

In short, if you can bring this whole state on board with the Cancer Project, you will have an ideal platform for developing new approaches—not only in research, but in every aspect of the work. You'll have a strong base for developing pre-clinical and clinical studies, along with new tools and techniques for prediction and measurement. Academic-government-industry consortia can take a systematic, integrated approach to exploring many kinds of therapeutic tools, from new drugs to engineered devices, and can integrate those with new approaches to personalized care.

The project would generate a wealth of data from which to start making new correlations. It would provide a highly entrepreneurial regional economy for trying out new approaches to commercialization and commercial partnership in the anti-cancer arena. Every company that has a new therapy, and every research group with a new idea, would want to be part of this Cancer Project in some way. As never before, we would truly harness global competition, cooperation, and connectivity in the quest to cure cancer. And global universities would be integral to the quest at every step. In fact, as endogenous institutions, they would be constantly re-defining their own roles and taking on new roles as the project evolves and expands.

A Template for the Future

The kind of project I've just described also can serve as a template for similar efforts in other global issue areas. Such a template consists of global universities using their expertise, and their networks of connections, to help craft new approaches to global problem-solving that are neither bureaucratically planned and managed nor simply left to *laissez-faire*. You create a framework from which good things can emerge, and you recruit some of the best people and entities from the global village to engage in the work. The key ingredients are:

- A big idea—one that addresses a significant, unmet global need, and is big enough to fire the imagination of those you would like to engage.

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- A case for action—a general plan that could work, and that offers distinct advantages over any alternatives currently being tried. If what you're proposing is a black swan scenario, a reach beyond what's currently even imagined, so much the better. That will help to capture the interest of highly entrepreneurial types who have the third necessary ingredient:
- A bias for action.

In German, they have three words, *wollen*, *können*, *machen*—to want, to be able, and to do. You have to want to do it; you have to be able to do it; and you have to make it happen. For global universities that aspire to create the future, I haven't heard a simpler prescription. And for the big idea that I am partial to, a global Cancer Project, I like what Nike says: Just do it.



Should Universities Be Agents of Economic Development?

by Robert E. Litan and Lesa Mitchell¹

It is appropriate that we are ending the conference by addressing the question of whether universities should be agents of economic development—because in doing so, we really are addressing one of the central roles of the university.

If by “university,” one means an institution devoted both to the production of new knowledge and its dissemination through the teaching of students, then either implicitly or explicitly, the *effect* of such an organization, regardless of its intention or purpose, will be to foster economic “development” and thus growth.² Economists have well established that new knowledge, when successfully commercialized, is the leading cause of growth in economies at or near the “technological frontier” (or beyond the point where technology can be borrowed or bought from elsewhere and combined with investment in new capital goods). Furthermore, a more educated workforce is both more likely to become more productive over time and also to adapt more easily to change (and thus less likely to resist it, through trade protection or overly onerous regulation that makes the labor market less flexible). Both outcomes clearly contribute to economy-wide growth.

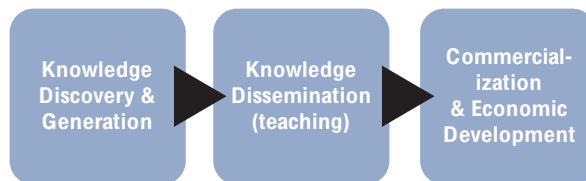
This much should be non-controversial, and, indeed, essentially a statement of fact. The hopefully more interesting question we wish to focus on here is whether

1. The authors are, respectively, Vice President for Research and Policy, and Vice President for Advancing Innovation at the Kauffman Foundation.

2. This definition excludes for-profit universities and teaching institutions that are devoted exclusively to teaching, and not to research; and also research institutes, which are devoted to production of new knowledge and not its dissemination. Only the “university” does both, and it occupies our attention here.

universities should deliberately do more to encourage the development of products or companies, whether on a global, national, or local scale. In the process depicted in Chart 1, the question is thus whether the university should assist in some fashion in the commercialization of new knowledge and/or local economic development. In a word, should the university become “entrepreneurial,” in the commercial sense of the term?

1. The University Knowledge Process



The answer, we suggest, is not “should” but “how.” In our view, universities—that is, institutions of higher education engaged both in research and teaching—increasingly have no choice *whether* to be entrepreneurial, although like for-profit firms, they do have a choice about *how* they go about doing so.

The reason universities have no choice about whether to pursue some type of economic development is simple: *because competition requires entrepreneurial behavior*. To be sure, there will always be some institutions of higher learning that try to avoid this competition by staying within a narrow niche—such as teaching particular subjects and students, in limited geographic areas, without being engaged in research and thus the production of new knowledge—just as smaller retailers choose to avoid competing with larger retail chains by specializing in the sale of and service for a limited range of products. But for universities that seek the prestige and recognition to be major players in both knowledge generation and teaching, competition cannot be avoided.

Competition among universities and colleges used to be a defining feature only of higher education in the United States. In other countries, central governments have played the dominant role in funding and directing universities, in some cases (France and Germany, for example) actually employing the faculty. Where governments are so heavily involved in funding universities, they also naturally tend to limit competition among them, presumably to avoid duplication or playing favorites.

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Although federal, state, and sometimes local governments in the United States contribute to funding of both public and private universities, there is no central government plan for university research and education as there is in other countries. To the contrary, in the United States, universities compete with each other on many levels: for faculty, students, administrative personnel, and research funding, and in a variety of inter-collegiate activities (of which sports is the most visible and expensive example). *The Economist*, in a well-noted survey of higher education in 2005, pointed to the central role of competition and the absence of government planning as two prominent reasons for America's success in higher education.³

But America is no longer alone in having a competitive higher education market. Increasingly, as *The Economist* survey pointed out and as events since then have only reinforced, higher education is now increasingly global in scope. Whether or not schools compete with each other within a country, many now compete on the global stage on all the same dimensions, except for sports, as has been true within the United States: for faculty, students, administrators, and research funding (if not from governments, then from private companies and foundations).

This global competition manifests itself in various ways. Some universities prefer to stay at home and try to lure talent to them. Others are going global, typically through partnerships with local universities on the ground, but in some cases through wholly owned and operated campuses abroad. We just heard from Alan Merten, who is leading George Mason in this latter direction.

In competitive markets, firms are compelled to match the leaders and, ideally, to surpass them. In the higher-education market, one of the dimensions in which United States and, most notably, Singaporean universities are now increasingly competing is for “star scientists,” or those relatively rare individuals who combine cutting-edge research skills with a bent toward commercializing what they discover, either by licensing their discoveries to existing commercial entities or by launching (on their own or, more typically, with entrepreneurs) new companies. To a significant extent, this competition in the United States has been spawned in the wake of the Bayh-Dole Act of 1980, which enabled universities to retain intellectual property rights in the discoveries of their faculty who were funded by federal research grants. To help motivate these faculty members to make such commercially useful discoveries, universities now typically give them a share in the proceeds from the “IP” that is so commercialized.

3. “Secrets of Success,” *The Economist*, September 10, 2005 (Survey).

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To be fair, American universities and their faculty have long had a commercial bent, pre-dating Bayh-Dole. The same *Economist* survey to which we have just referred cited the “useful” feature of university research and teaching in the United States as the third reason for its historical preeminence in higher education. The survey quoted the famous American historian, Henry Steele Commager, as saying that, even in the nineteenth century, for the average American, “education was his religion,” provided that it “be practical and pay dividends.”⁴

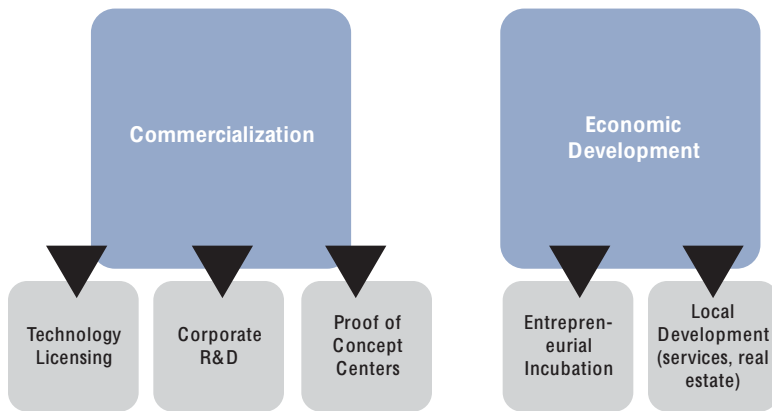
Universities in the United States have reflected this ethos, but their quest for both practicality and dividends has intensified considerably in the wake of Bayh-Dole and the substantial increase over the past several decades in U.S. government funding for university-based research, especially in the life sciences, which often can lead to commercially successful products (especially pharmaceuticals and medical devices). Many U.S. universities now have “technology licensing offices” or “technology transfer offices” (TLOs or TTOs), whose sole job is to identify commercial applications for discoveries made by university faculty and to realize revenue for the university in the process. Indeed, as we have elsewhere discussed and will return to shortly, we believe that many U.S. universities have put too much pressure on their TLOs to generate short-term profits, which ironically may be encouraging these offices to neglect many ostensibly “second tier” discoveries that also have commercial value, thus reducing the long-term benefits of technology commercialization.⁵ The prominent focus at all universities today is based upon a single patent-license pathway to commercialization, while providing relatively little or minimal strategy and resources required to support other means of promoting commercialization and entrepreneurship.

Chart 2 illustrates the types of other commercialization activities that universities pursue, at least in the United States. Universities seek corporate funding to defray the costs of their existing personnel and facilities, attract new star faculty (by funding new positions and spreading the word that their university is a “hot place” for rising and established star researchers to be), and provide the opportunity for faculty and graduate students to work on commercially relevant research. (While federal agencies historically have funded only basic research, some agencies, including the National Science Foundation, are funding more applied research, with potentially nearer-term prospects for commercialization). “Proof-of-concept” centers are more

4. *Ibid.*, at 6.

5. Robert E. Litan, Lesa Mitchell, and E.J. Reedy, “The University As Innovator: Bumps In The Road,” *Issues in Science and Technology*, Summer 2007.

2. Commercialization and Economic Development Options



recent ways for universities and their faculty to test the commercial feasibility of new knowledge, and thus act as precursors to commercial licensing or to the formation of new companies.

University commercialization, to the extent it is “successful,” clearly provides monetary benefits to the university and relevant faculty (and, often, typically the departments in which the responsible faculty are situated). But we believe an equally, if not more important, objective, or at least impact, of commercialization is the direct effect it has on faculty recruitment, and because star faculty tend to attract star students (especially graduate students), indirectly on the recruitment of star students.

Although we have seen no formal studies of this proposition, we know anecdotally that universities compete for star faculty not only on the basis of the salaries they can offer these individuals, but on other dimensions: the amount of research support (which typically translates into how many graduate students these stars can supervise and effectively employ) and the monetary arrangements from commercialization activities (typically the percentage of total royalties the university collects or the royalties faculty must pay the university if they launch their own companies). To our knowledge, the monetary arrangements relating to commercialization tend to be uniform across all faculty members within a university, and do not vary for individual “stars,” although this could change in the future as U.S.

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universities intensify their competition for these stars. Even if it does not change, it is possible that heightened competition for star faculty may lead, over time, to more uniformity *across universities* in their mechanisms to support commercialization and their royalty-sharing arrangements, because, as it is now, we understand (again, we are not aware of a study that documents this) that there currently is considerable variation across universities in these arrangements. Shortly, we will suggest that universities are beginning to compete on yet another dimension—through innovations in the ways that university-related technologies are commercialized—and that this could have significant positive benefits for both them and for society (nationally and globally).

In addition, because there is a strong correlation between the presence of star scientists at universities and entrepreneurial startups and other local commercial activity,⁶ local university trustees may press university administrators to recruit star faculty with both strong research and commercialization track records (in addition to faculty in non-scientific fields, who, though they may afford no commercial opportunities for the university, still can enhance a university's prestige among faculty at other universities and among students).

Universities outside the United States that wish to attract star faculty with successful commercialization records who already have or are seeking positions at U.S. universities must be able to offer at least roughly similar terms as those faculty members can receive from U.S. institutions.

The same competitive forces that are driving U.S. universities to compete for star faculty are increasingly evident on the global stage. In particular, universities outside the United States that wish to attract star faculty with successful commercialization records who already have or are seeking positions at U.S. universities must be able to offer at least roughly similar terms as those faculty members can receive from U.S. institutions. Already, other

countries have laid the groundwork for this competition by enacting their own versions of Bayh-Dole. Universities in China and India are actively competing for corporate R&D funding, which can be and is used to attract faculty from elsewhere or to prevent star faculty from leaving. Singapore, in its well-known bio-technology initiative, and, increasingly, universities in the oil-rich Middle Eastern countries (new ones and those partnering with foreign institutions), are using their ample government funds for the

6. Lynne Zucker and Michael Darby, in David Audretsch, Robert E. Litan, and Robert Strom, ed., *Openness and Entrepreneurship*, "Star Scientists, Innovation, and Regional and National Immigration" (Edward Elgar, 2008, forthcoming).

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same purpose. Even European universities, historically reluctant to engage in any aspect of commercialization, may soon be compelled by the increased global competition for faculty, students, and research funding to join the commercialization race in some manner (and indeed, the British universities already have).

Chart 2 illustrates a second way in which universities also are engaged in commercialization activities, through what we have labeled “economic development.” Our discussion of these activities will be focused only on U.S. universities—those we know best—though we are anxious to learn from this audience of similar ventures at universities in other countries.

In contrast to technology licensing, corporate-funded research and proof-of-concept centers, whose economic benefits may accrue widely to a broad population outside the university,⁷ the “economic development activities” depicted in Chart 2 are meant primarily to benefit the local communities in which universities are located. Furthermore, these development activities may or may not commercialize new knowledge.

For example, different kinds of “entrepreneurial incubation” programs are spreading at U.S. universities. Typically, these programs provide mentors—often entrepreneurs as well as (or in place of) university faculty—and networks, including access to angel and venture capital investors, to assist university students or faculty, or even local entrepreneurs who may have only a loose connection to the university, in the formation and growth of new companies. To the extent these programs succeed, they are likely first to benefit the community in which the university is located and, secondarily, a broader population.

Various forces drive these entrepreneurial incubation efforts. In some cases, the initiative derives entirely from an entrepreneurial founder, such as the late George Kozmetsky at the University of Texas’ well-known “IC-squared” program; Alec Dingee at MIT’s “venture mentor” initiative; or Desh Deshpande, the funder and the idea leader behind MIT’s Deshpande Center. Indeed, as we discuss again shortly, no entrepreneurial incubation effort can be successful without an entrepreneurial founder or leader.

But other, more competitive reasons may be at work as well. The founders and the universities that host these initiatives may want to impress local leaders, state

7. Local communities may and very likely do benefit from university commercialization, but local economic development is not the central object of the various commercialization activities.

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legislators (in the case of public universities), and alumni with “how relevant” their activities are to local area development, in order to attract greater funding to the university. The universities also may anticipate future contributions from successful entrepreneurs who benefit from these programs. With more funding, the university is in a stronger financial position to attract star faculty and students, or undertake other initiatives aimed at improving the university’s prestige.

A different competitive dynamic is at work when universities use their endowments, faculty resources, and alumni networks to promote local economic development in various ways: by operating elementary or secondary schools, offering health care to neighboring populations, and by various real estate development projects. In the United States, such activities appear to be most common for universities located in distressed urban areas, with the typical urban problems: high crime, poor K-12 education, and declining real estate values. In part, universities engage in such activities, which are unlikely to entail the commercialization of new knowledge, as a way of providing on-the-job experience for students and faculty. But universities located in distressed areas also may need to invest in surrounding areas in order to enhance their attractiveness to faculty and students who have options to attend or work at higher educational institutions located in more desirable locations.

In sum, competition among universities within countries and, increasingly, between universities in different countries, is driving many of them to be engaged in one or more “economic development” activities that extend beyond the traditional university functions of generating and disseminating new knowledge. Clearly, the greater the ambitions of the university, its trustees, faculty, and funders (often governments), then the greater will be the competitive imperative. But, having said that, universities, like firms in competitive markets, have a *choice* as to *how* they want to compete.

In terms of Chart 2, for example, universities may seek to commercialize (to earn revenue, attract/retain faculty and students) by licensing faculty-discovered technologies and/or by engaging in research funded by corporations and/or by sponsoring proof-of-concept centers. With respect to more local economic development, universities may engage in one or more entrepreneurial incubation efforts, assist in providing mentoring services, and/or pursue real estate development. We suspect that few universities will engage in *all* of these activities, but that, like most firms, will seek to specialize in one or a few of them.

What determines where universities will “pick their spots” to compete? Here again, universities are unlikely to differ from for-profit firms. Management strategists advise firms to concentrate on their “core competences,” and not to stray too far into unknown or untested markets or activities. The same advice seems apt for universities, as well.

Management strategists advise firms to concentrate on their “core competences,” and not to stray too far into unknown or untested markets or activities.

Thus, a more active technology licensing program—subject to the qualifications we will outline shortly—makes sense only for universities with lots of technology “on the shelf,” as it were, waiting to be licensed or commercialized, or with faculty having strong commercialization records. Likewise, efforts to persuade corporations to provide research funding or to support proof of concept centers only make sense if universities have the distinguished faculty, and therefore students, that can attract such funding and successfully carry out the research for which it may be provided.

Indeed, when it comes to competitive strategy, “core competence” is all about people, or talent. If a university has the talent for any of the various commercialization or economic development strategies we have identified, then that will largely define its competitive strategy.

What about acquiring talent if it is not already there? This question may be especially important to universities outside the United States that have not yet had the experience with any one or all of the commercialization and/or economic development strategies just outlined.

Clearly, “buying talent” is easier to do where the university already has some competitive strength and desires to add to it. Star scientists from other universities are less likely to move if they will be alone, or have to start a program from scratch, than if some future (or current) colleagues are already present. In addition, the further afield a university stretches, the greater are the risks in blending in the new “acquisitions” with the prevailing culture (unless, of course, university leaders deliberately seek to change that culture through an acquisition strategy).

Another challenge that universities face is managing whatever entrepreneurial endeavors it chooses to undertake. Take, for example, efforts at entrepreneurial incubation. From where we sit, most of the successful ventures of this type seem to be driven from “the bottom up,” by one or more entrepreneurial leaders who may or may

not have tenured faculty appointments, but who generally do have some affiliation with the university.⁸ Yet, precisely because these leaders may not be tenured and because, by nature, entrepreneurial incubation typically involves individuals from varied backgrounds, such efforts do not easily fit within a single university department. The challenge for university administrators nonetheless is to nurture these efforts without offending particular faculty or departments, and ideally to enlist the support and encouragement of as many qualified university faculty and employees as possible.

Another challenge where we expect continued innovation and competition in the future is the management of technology licensing. As we mentioned earlier, the passage of Bayh-Dole in the United States led to the formation of TLOs or TTOs to centralize and bring economies of scale to the university's technology licensing activities. Ideally, TLO officials identify technologies suitable for commercialization, potential parties interested in licensing them or launching entrepreneurial ventures surrounding them, and then negotiating licensing or other relevant agreements required to commercialize them. There are a number of highly successful TLO offices that have the requisite personnel and resources to carry out these functions efficiently and effectively.

However, too often in our view, university administrators and trustees have given TLO impossibly difficult missions—to generate substantial profits for the university *and soon*—with insufficient numbers of people with the right combination of skills required to perform at peak levels. These kinds of mandates can drive TLOs to have a “home run mentality”—to search for and then spend much, if not most, of their efforts on commercializing the few technologies that seem to promise the highest payoffs, or the “home runs.” Not only can this strategy shortchange many other university-developed technologies that have strong commercial potential, but it does not even guarantee the “home runs” themselves, since TLO personnel may not be in the best position to judge, or have the industry network to help them judge, whether a particular discovery will or will not lead to a home run. In addition, the bureaucratic procedures that are common to TLOs (and to universities themselves) can slow commercialization, frustrating entrepreneurial faculty and delaying the benefits of their discoveries for the consumers for whom they are intended.

Accordingly, we have urged university leaders to experiment with other commercialization models: allowing other commercialization “agents” to compete with the university TLO, forming multi-university TLOs to generate economies of scale and to

8. Indeed, it would be surprising to find tenured individuals—who gain that status through research rather than hands-on entrepreneurial experiences—to lead or have an interest in devoting significant time to entrepreneurial incubation.

take advantage of industry-specific expertise at other institutions, or even giving university faculty the intellectual property to their discoveries and relying on their post-success donations to the university as the (more than) equivalent of up-front compensation for the IP rights and the ability to commercialize without the involvement of the TLO.⁹

There are signs that U.S. universities and even state officials are beginning to recognize the virtue of this kind of experimentation. We have heard at this conference the decision by Michael Crowe, the president of Arizona State, to permit the university's departments to experiment with different technology commercialization models. The University of Washington is trying a similar approach with its engineering school.

In Texas, Governor Perry has proposed that all public universities make the commercialization of research one of the several factors considered when granting tenure to professors. Significantly, Texas is measuring commercialization not by licensing revenue but instead by counting the volume of innovations moved to the marketplace. State officials also have requested that the words “technology commercialization” and “economic development” be added to university and college mission statements. In 2006, Texas A&M University became what is believed to be the first public university in the United States to formally incorporate commercialization into its criteria for granting tenure to professors. That change appears to have led to a marked increase in patent applications filed by tenure-track faculty at the university (although time will tell whether the Texas A&M policy may unintentionally lead to excessive patenting by the university, which could slow overall commercialization).

Meanwhile, at Kauffman, we have received inquiries from other universities, or those affiliated with them, about how to go about pursuing one or more of the alternatives to the current technology commercialization model we have just identified.

If these experiments prove successful—and we believe they will be—they should begin to change the way technology licensing has been traditionally practiced, and more importantly, identify the additional pathways that must be utilized to support commercialization and entrepreneurship. Star faculty understandably will be attracted to those schools that offer them greater freedom—and potentially greater rewards—in commercialization than other schools that do not. Eventually, what may start as “experiments” in commercialization at a few schools should spread to many others.

9. Litan, Mitchell, and Reedy (2007). At Kauffman, we have launched an Internet platform, www.ibridgenetwork.org, which offers participating universities the ability to showcase their technologies for potential matches with entrepreneurs and capital sources that may be interested in commercializing them.

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If new approaches to technology commercialization begin to diffuse more widely throughout the university world—most likely beginning at first in the United States but ultimately finding their way to leading schools in other countries—society (national and global) should benefit in at least two ways.

First, the new models should be “win-wins”—in that society gets more innovation, more rapidly, while universities also should realize higher returns (counting licensing revenue, donations, and any other revenues that may be derived from commercialization activities).

Second, American higher education, in particular, may benefit in another way, as well. It recently has been noted that endowments among universities are increasingly concentrated in the Ivy League and other “rich universities.” Table 1 illustrates this point, providing the top twenty-five-ranked universities by size of endowment. Some may argue that this growing concentration of wealth and, thus, faculty talent, is a good thing, because it permits the richer universities to take advantage of economies of scale in physical research facilities and to realize the “agglomeration benefits” of having many talented researchers in such close physical proximity.

The U.S. experience runs counter to this, however. Without disputing the presence of these agglomeration benefits, there are offsetting benefits to a society of diversity—having talented researchers, all competing with one another, at many different locations (both within and outside the United States). Different locations and cultures give rise to differences in perspectives, which are important for promoting innovation, especially “radical” or “disruptive” innovation. Where resources and talents are too concentrated, inquiry can be subject to too much “group think.” Fortunately, the United States is large enough and rich enough to host many centers of excellence that can counteract group think.

In fact, if one looks at the universities that have been the most successful thus far in technology commercialization, the list looks very different than the one shown in Table 1. Table 2 provides the top twenty-five U.S. universities ranked by total licensing revenue during 2006, with their ranking on the endowment top twenty-five listed in parentheses by each school. We admit that licensing revenue is an imperfect measure of commercialization, or, more precisely, the total *social benefits* of university commercialization. Nonetheless, it does provide a rough guide to how active and successful universities are in commercialization activities. And, as Table 2 illustrates, few

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of the most richly endowed schools listed in Table 1 are present in the list of the most successful universities in technology commercialization, and vice versa (and for those listed in both tables, the rankings tend to differ between the two lists).

We point all of this out to suggest that not only is technology commercialization an important force that counteracts the ability of the most richly endowed institutions to attract and retain the “best” faculty, but if the schools that experiment most aggressively with alternative approaches to commercialization come from outside the “rich list” of endowed schools, as we suspect will be the case, then the counter-force provided by commercialization should exercise a more equalizing impact in the future than it already has. We believe this is good for higher education and good for U.S. society.

In sum, universities in the United States and elsewhere around the world clearly are in the “economic development” business, and are likely to be more so in the future. This trend should benefit the broader societies that support and draw sustenance from universities. And we owe it all to a more competitive environment, one that globalization is making possible.

The challenge for universities now is to figure out where they want to play in the economic development arena. They are likely to be most successful, in our view, if they play to their strengths, and if they permit and ideally encourage the “bottom up” entrepreneurial endeavors that may come to them from their faculty, students, alumni, and other supporters.

**Table 1: Top Twenty-five Universities
by Size of Endowment, 2006**

	Institution	2006 Endowment Funds
1	Harvard University	\$28,915,706,000
2	Yale University	\$18,030,600,000
3	Stanford University	\$14,084,676,000
4	University of Texas System	\$13,234,848,000
5	Princeton University	\$13,044,900,000
6	Massachusetts Institute of Technology	\$8,368,066,000
7	Columbia University	\$5,937,814,000
8	University of California System	\$5,733,621,000
9	University of Michigan	\$5,652,262,000
10	The Texas A&M University System and Foundations	\$5,642,978,000
11	University of Pennsylvania	\$5,313,268,000
12	Northwestern University	\$5,140,668,000
13	Emory University	\$4,870,019,000
14	University of Chicago	\$4,867,003,000
15	Washington University – St. Louis	\$4,684,737,000
16	Duke University	\$4,497,718,000
17	University of Notre Dame	\$4,436,624,000
18	Cornell University	\$4,321,199,000
19	Rice University	\$3,986,664,000
20	University of Virginia	\$3,618,172,000
21	Dartmouth College	\$3,092,100,000
22	University of Southern California	\$3,065,935,000
23	Vanderbilt University	\$2,946,392,000
24	Johns Hopkins University	\$2,350,749,000
25	University of Minnesota and Related Foundations	\$2,224,308,000

Source: National Association of College and University Business Officers, 2006 NACUBO Endowment Study (2007).

**Table 2: Top Twenty-five Universities
by Licensing Revenues, 2006**

	Institution	2006 License Revenues
1	University of California System (8)	\$193,499,879
2	New York University	\$157,412,824
3	Stanford University (3)	\$61,310,739
4	Wake Forest University	\$60,588,512
5	University of Minnesota (25)	\$56,193,050
6	Massachusetts Institute of Technology (6)	\$43,500,000
7	University of Florida	\$42,900,000
8	University of Wisconsin – Madison	\$42,363,611
9	University of Rochester	\$38,016,557
10	University of Washington	\$36,199,485
11	Northwestern University (12)	\$29,990,550
12	University of Massachusetts	\$27,183,583
13	Harvard University (1)	\$20,849,993
14	University of Michigan (9)	\$20,438,727
15	Emory University (13)	\$17,790,432
16	University of Iowa	\$16,912,938
17	University of Georgia	\$16,805,484
18	University of Utah	\$16,295,064
19	Johns Hopkins University (24)	\$13,938,457
20	California Institute of Technology	\$13,234,236
21	University of Texas Southwestern Medical Center	\$12,277,436
22	Washington University – St. Louis (15)	\$11,582,912
23	Rensselaer Polytechnic Institute	\$10,837,438
24	Case Western Reserve University	\$10,794,377
25	University of Illinois – Urbana-Champaign	\$10,222,735

Source: Association of University Technology Managers.

Summary of Discussion

Once each session's presentations were finished, speakers and audience alike engaged in a lively discussion of the issues raised.

In the first session, three presidents of European universities outlined the challenges in navigating their institutions through changing times. A consistent theme emerged: These European administrators envy, and seek to replicate, the relative freedom from government regulation and intervention enjoyed by their American counterparts.

The subsequent discussion focused largely on the differences between the American and European systems of tertiary education, and on ways that Europe's universities are changing to become more like America's.

First and foremost, private universities are far more common in the United States than in Europe, where most universities remain fundamentally state entities. And, even the public universities in the United States receive some or most of their funding from non-government sources, making the distinction less black and white. That gives American universities extraordinary freedom and flexibility—traits that the European educators openly professed to admire.

The European participants did, however, stress that their universities are striving to diversify their funding sources. The days of 100 percent government funding are already over, but the level of private support still has not grown to anything near American levels. U.S. universities enjoy many legal and tax advantages that make fundraising much easier for them. And the endowment—a staple of American universities, public and private—is only just beginning to be used as a serious tool in Europe. Overall, the European participants agreed that a movement away from state support and toward more private sources of funding will be healthy for European universities.

A second theme that emerged is the extent to which, in a sense, the American and European education systems are mirror images of each other. That the American system of tertiary education is far superior to Europe's, nearly all the discussants—American and European alike—agreed. On the other hand, all also agreed that Europe's primary and secondary schools generally do a better job than their American equivalents.

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Alan Merten, the president of George Mason University, iterated some of the reasons for the disconnect on the American side. First, there is competition—for students, for faculty, for resources—at the university level. The public school systems operate more or less as monopolies within their defined geographical areas. Second, universities can offer merit pay for faculty, something that nearly all teachers’ union contracts forbid at the primary and secondary levels. Third, and similarly, universities can pay their faculty differently according to specialty. This, again, is not allowed by most public school labor agreements—a factor which makes it difficult (for instance) to attract and retain qualified science teachers, who can be lured away by the higher salaries more prevalent in other fields that need their expertise. Finally, universities—public as well as private—enjoy substantial autonomy. Public elementary and high schools (some three-quarters of U.S. schools), on the other hand, are mostly dominated by state-level education laws and bureaucracies that limit management’s flexibility.

European universities by and large lack these advantages. The discussion then turned to the extent to which that is changing. Axel Freimuth of the University of Cologne noted that German universities are working to create a new salary structure for faculty; the current system is still far too restrictive. Wolfgang Herrmann of the

All the European educators agreed that Europe must do a better job of inspiring students to enter these fields, both to ensure the continued transmission of important knowledge, and to promote entrepreneurial activity in vital technical fields.

Technical University of Munich interjected that the system is nonetheless getting better, and cited some success in attracting private sector subject matter experts (for instance, in engineering and science) to teach at European universities. Another related push, though much smaller in scope, is to encourage faculty to try their hand in business, and bring that experience back into the classroom.

Still, there is a dearth of qualified math, science, and engineering faculty and graduates. All the European educators agreed that Europe must do a better job of inspiring students to enter these fields, both to ensure the continued transmission of important knowledge, and to promote entrepreneurial activity in vital technical fields.

A final difference between the two systems is the prevalence in America of community colleges and other non-university forms of tertiary education. Essentially, these systems allow the United States to educate more students, in ways more geared to their interests and abilities. Europe’s system is more “university or nothing,” thrusting some

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students into environments for which they are unprepared and unsuited, while leaving others out altogether.

The day's second discussion followed talks by Jan Willem Oosterwijk of Erasmus University Rotterdam and Manuel Trajtenberg of the University of Tel-Aviv. These thoughtful presentations focused on the specific ways that universities can foster entrepreneurship in the societies around them, and on their own campuses.

These efforts are difficult. For instance, there is significant internal political opposition to making the university take a more direct role in outside entrepreneurship. Faculty members in particular tend to view any such effort as inevitably leading to the subordination of the university's mission to business interests. University leaders strongly reject that charge, but admit that effectively rebutting it can be hard.

Another important obstacle is the aging nature of European societies. As European countries age, political pressure to spend more on pensions and retirement increases, and the appetite for allocating resources to education decreases.

This creates something of a vicious cycle. As Trajtenberg noted, aging societies above all need high growth to fund their social services programs for seniors. But in the modern world, high growth is fundamentally driven by innovation, which in turn is driven by education. So some significant resources—public and private—need to be committed to this sphere to help ensure the economic growth necessary to sustaining an aging population.

One way that American universities are becoming more entrepreneurial is by becoming more global. They are establishing campuses abroad and partnering up with foreign institutions for research and teaching purposes. European universities, on the other hand, lag behind in these efforts. The Europeans in the discussion acknowledged the gap, but argued that Europe understands the importance, and is working to catch up. In a sense, the Europeans have no choice. For a long time, they have watched as many of their best students and faculty end up overseas—particularly in the United States. With American universities now actively establishing beachheads in Europe and around the world, this “poaching” of talent will only accelerate, and Europe needs to compete.

While discussions of talent often focus on science and engineering, several participants noted that innovation is about much more. There are supply chain innovations, efficiency innovations, and innovations stemming from products and services that are not technical in nature. In fact, Bob Litan pointed out that 80 percent of the fastest-growing companies in the United States are not technology companies.

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The HOPE program, described in detail in Oosterwijk's presentation, was the one major effort by a university to foster entrepreneurship to be discussed at length. As such, it served as a sort of "case study." Oosterwijk presented a very simple measure of success for the program: real entrepreneurial activity by students who have completed the course. "To create entrepreneurial motivation is the #1 purpose of the HOPE program—to teach that it is fun to be entrepreneurial, and also to teach students to deal with failure," Oosterwijk said.

In the end, however, all agreed that entrepreneurship resists any formulaic answers. Certain ideas can help—for instance, the establishment of a "Phoenix Award" for an entrepreneur who failed once, tried again, and succeeded. Role models also can make a difference, but that can be a double-edged sword. For instance, some of the best known and most successful entrepreneurs in recent years (e.g., Bill Gates) were college drop-outs. But dropping out of school—while it may be the right decision for a few—is not something anyone should want to promote.

Ultimately, entrepreneurship results from a mixture of innate personal characteristics (that not everyone shares) and a culture that can encourage those characteristics where they exist.

Ultimately, entrepreneurship results from a mixture of innate personal characteristics (that not everyone shares) and a culture that can encourage those characteristics where they exist. Universities should focus less on teaching entrepreneurship—something that is hard to do in the best circumstances—and more on changing the balance of rewards and incentives within business and society to make them friendlier to entrepreneurship.

Michael Crow, the president of Arizona State University (ASU), gave the final talk of the first day. The discussion that followed focused mostly on the ways in which Crow is shaking up his school.

First of all, Crow reiterated a key theme from earlier in the day: "Public" universities are no longer really completely public, at least not in the sense that such universities receive all or even most of their resources from government. Of ASU's \$2 billion budget, only 20 percent comes from the state; the rest is raised from private sources. In fact, as Crow was at pains to stress, the distinction between public and private universities is close to meaningless today. The qualities of a university's ideas, faculty, and programs are what matter. In the end, all schools are chasing the same dollars.

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However, the public/private distinction is not entirely meaningless. Even that relatively small share of funding comes with strings. Rather than lament that, however, or seek to change it, Crow has chosen to embrace the strings. Unlike the University of Arizona, which is competitive, ASU has, by state law, an open admissions policy. For many top faculty this is a disadvantage, but for others it is a selling point. Some teachers get excited by the prospect of teaching students with a range of abilities, and ASU actively recruits those teachers.

The question most on the audience's mind was simple. At most universities, the faculty really runs the place while the president raises money. But Crow really does run ASU. How does he do it?

Crow forthrightly said that he chose to pick an intellectual fight. On the merits, he was certain that his reform agenda had value. As long as he kept the argument intellectual and civil, if and to the extent that opponents became emotional, they lost. He also found that direct appeals to self interest worked wonders: When he took over ASU, faculty salaries were tenth among schools in the Pacific-10 conference; now they are fourth.

Another secret to his success is to encourage innovation from the bottom up and allow it to happen. Crow is famous for the ways he has shaken up the management and structure of ASU. Less famous, but no less important, are all the proposals that have emerged, not from the president's office, but, as it were, in the field—initiatives that Crow then has championed and implemented.

To Crow, changing ASU to be more entrepreneurial in the way it operates is an imperative. It is still a young university—and moreover, it is the only one in a vast and growing metropolitan area. Not to change with the changing circumstances all around the school would be suicidal.

The focus of the second day's first session was on technology and how it is changing the university's mission and functions.

To some extent, this can be seen in the way that the old concept of the university as a place—defined by Cardinal Newman in the classic book *The Idea of a University*—is being redefined. The Internet supposedly meant the death of distance, but, in fact, we have found that, as ever, humans like human contact. A purely virtual university system will probably never become reality. Second, as Newman observed more than 150 years ago, there are advantages to working and living in clusters—advantages that accrue to this day.

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That's not to say that technology is having no impact. On the contrary, distance learning is more possible and more prevalent than ever. Some of the world's best teachers record their lectures on a variety of multimedia platforms, and some even simulcast them live. Technology improves so rapidly that no one really knows what the teleconferencing of tomorrow will look like. It's possible that the most renowned lecturers in the country—indeed in the world—could become, through technology, the teachers of students everywhere.

Interestingly, in other ways it is the non-technical disciplines that have so far proven themselves more adept at adapting to new technologies than technical fields like engineering and the sciences. Presenter Bill Wulf noted that in the hard sciences and engineering, scholarship is still dominated by the same paper journals and longstanding professional associations that have defined the fields for decades. In the humanities, on the other hand, the proliferation of niche specialties has led to the creation of new associations and more cost-effective “e-journals.”

The discussion closed with a note of disagreement. Prior presentations and discussions had mostly taken for granted that a funding mix that is largely private is good for the university. Wulf and others questioned whether this was truly the best formula for the university. To some extent, they argued, public spending on education is a measure of a society's commitment to education as a public good. All agreed, however, that, so long as the current mix stands, all universities—European ones in particular—are going to have to get better at raising private money.

The day's second session focused on the extent to which universities are becoming more global in reach and scope. Partly because the two presentations—one by George Mason University President Alan Merten, the other by biomedical researcher Frank Douglas—were so different, the discussion that followed was freewheeling and a bit disjointed.

Dr. Douglas' presentation outlined an ambitious plan to get every relevant institution—from universities to research labs to hospitals to big pharmaceutical companies to small biotech startups—in one state (Massachusetts) to work together on a cancer cure. In the discussion, he asserted that a unifying cause is often the best driver of new discoveries. For instance, the Manhattan Project and the Apollo program each had but one goal. But, in leveraging so many people and institutions to work toward that goal, they not only achieved what they set out to do, they made many path-breaking discoveries in many fields along the way. The problem with current cancer research efforts is, in part, that they are too scattered, disjointed, and unfocused.

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President Merten was questioned widely on the implications of “globalizing” the university—both his own specific school and the university in general. For instance, George Mason University has opened a campus in the United Arab Emirates (UAE). Different cultural norms can make such joint projects delicate. However, problems have not yet arisen because the UAE campus is located in a free trade zone where many of the rules and laws that govern the rest of society do not apply. However, cultural considerations like these could come more to the fore in other countries.

In the course of the discussion, it also emerged that universities on each side of the divide seek different things from global partnerships. Overseas schools primarily want to partner with American universities to benefit from their teaching expertise. American universities, on the other hand, are more interested in furthering their research mission, in benefiting from being exposed to different cultures and perspectives, and in establishing “people-to-people” contacts. The latter especially is a hugely useful tool for deepening understanding across some otherwise treacherous political and social divides. American universities also believe that they could be useful sources of dispassionate analysis on their host country’s policies. But, so far, host governments have not embraced this idea.

The final session focused on the extent to which universities should actively try to foster economic development. Despite universities’ historic unease with this role, presenters Bob Litan and Lesa Mitchell unambiguously argued that universities should overcome that unease and embrace the roll.

Hardly anyone disagreed. The resulting discussion focused on “how:” How can the goal be best achieved, all the while overcoming resistance from university personnel, particularly the faculty?

A number of ideas were proposed. One of the more promising was to “golden handcuff” research faculty by giving them operational control of research money, as well as the prospect of reward if the fruits of their research are successfully commercialized.

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Another suggestion—already in place at several universities—is for schools to lease excess space to private companies that work in fields related to the university’s research mission. The synergies created can often help both the companies and the faculty further their missions.

Concerns that the imperatives of business could take over and distort a university’s mission are not misplaced. But safeguards could mitigate the potential for abuse.

For instance, to the extent that university research projects end up commercialized, it’s important that universities not fold the revenues into their operating budgets. That would just create pressure and incentives to increase those revenue streams—incentives that could steer the university’s focus away from its core mission. It’s better to fold revenues from such projects into the endowment.

Another important measure would be to use some of those revenues to fund research and teaching in areas with little or no prospect for commercialization. This would meet most faculties’ core concern: that commercial projects could bleed resources away from unprofitable but culturally and intellectually vital fields of knowledge.

In the end, however, private money is always going to be more productive than public or non-profit sector money in producing and commercializing innovation. Universities’ core function is and should remain the production of new knowledge, and the preservation and dissemination of existing knowledge. By fulfilling that core function, the university can help the private sector generate entrepreneurship. But it always should yield first position in the race to the private sector.

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