

Beyond the Endless Frontier

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Introduction

Perhaps the unique characteristic of higher education in America is the strong bond between the university and society. Historically, our institutions have been shaped by, have drawn their agendas from, and have been responsible to the communities that founded them. Each generation has established a social contract between our leading universities and the society they serve.

The particular form of this contract for the latter half of the 20th Century was framed by the seminar report, *Science, the Endless Frontier*, drafted by Vannevar Bush following World War II. It established a strong partnership between the nation and its universities in which the federal government would support the conduct of basic and applied research on the campuses. This partnership resulted in one of the 20th Centurys more important societal institutions, the American research university.

It has made America the worlds leading source of fundamental scientific knowledge. It has produced the well-trained scientists and engineers capable of applying this new knowledge. The academic research enterprise has played a critical role in addressing many of the nations most important challenges, including national defense, health care, agriculture, and economic competitiveness.

The Good News...and the Bad News

Largely, as a result of this partnership, Americas research universities have become the strongest in the world at a time when the benefits from R&D investment have never been higher. A few years ago, a New York Times editorial referred to our nations research universities as the jewel in the crown of our national economy. It went on to assert that university research is the best investment taxpayers can ever make in Americas future.

Yet, many today fear the 1990s stand a good chance of being the worst decade for higher education since the 1930s. There is a frightening sense of crisis at many of our nations most distinguished campuses.

Our universities are at serious risk on a number of fronts. The signs of stress are everywhere:

1. The breakdown of mutual trust has led to increasingly adversarial relationships between universities and government, including Congress, the administration, and federal agencies, as manifested in recent skirmishes over matters such as indirect cost reimbursement, scientific misconduct, and pressures to restrict the flow of technical information.
2. The skepticism indeed, hostility exhibited by the media and government has badly eroded public trust and confidence in the university, as revealed by the recent deluge of attacks on the academy, e.g., those who suggest that most scholarly activity is either the sterile product of requirements imposed by Philistine administrators or a form of private pleasure that selfish professors enjoy at the expense of their students.
3. Forces upon and within the universities, such as the rapidly escalating costs of research, are pushing toward a rebalancing of missions, away from research and more toward teaching and public service.
4. The morale of academic researchers has deteriorated significantly over the past decade, in part due to the pressures and time-consuming nature of the need to obtain and manage sponsored research funding and the disintegration of a "scholarly community" within the university. In a recent series of campus workshops sponsored jointly by the Government-University-Industry Research Roundtable and the National Science Foundation, a young faculty member described the modern university as a holding company for research entrepreneurs.

What is going on here? To some degree, we may be seeing evidence of the increasing estrangement of the American public and their elected representatives from science itself. The gap grows even wider between the omnipresent influence of science on modern society and the scientific literacy of the body politic.

We also may be experiencing the same forces of populism that rise from time to time to challenge many other aspects of our society—a widespread distrust of expertise, excellence, and privilege. Unfortunately, many scientists, universities, and university administrators have made themselves easy targets by their arrogance and elitism.

But, something else may be happening. Let me comment on several aspects of the current stresses on the academic research enterprise that may prove of critical importance in the years ahead.

The Biggest Challenge of All: Change

Let me suggest that beyond populism and scientific illiteracy, there is yet another important theme that we must consider, and that is change itself. Today, we find ourselves in the midst of two simultaneous paradigm shifts:

- i) in the nature of the government-university research partnership, and
- ii) in the character of the university itself.

These shifts are being driven by the extraordinary nature and pace of change in the world today.

Let me consider each in turn.

Erosion of the Research Partnership

A Shift in National Priorities: From Guns to Butter...

For almost half a century, the driving force behind many of the major investments in our national infrastructure has been the concern for national security in the era of the Cold War. The evolution of the research university, the national laboratories, the interstate highway system, our telecommunications systems, airports, and the space program, all were stimulated by concerns about the arms race and competing with the Communist Bloc. So, too, much of the technology that we take for granted, from semiconductors to jet aircraft, from computers to composite materials, were all spin-offs of the defense industry.

Yet, in the wake of the extraordinary events of the last five years—the disintegration of the Soviet Union and Eastern Europe, the reunification of Germany, and the major steps toward peace in the Middle East—the driving force of national security has disappeared and, along with it, much of the motivation for major public

investment. Far from a "peace dividend" providing new resources in a post-Cold War world for investment in key areas such as education and research, instead, the nation is drifting in search of new driving imperatives. While there are numerous societal concerns such as economic competitiveness, national health care, crime, and K-12 education, none of these has yet assumed an urgency sufficient to set new priorities for public investments.

Further, much of the existing intellectual infrastructure, developed to underpin national defense, is now at risk. The national laboratories are facing massive downsizing and necessarily searching for new missions. The burdens of the massive debts incurred in the buyout-merger mania of the late 1980s have forced corporate America to downsize research and development activities, including the shift of many of America's leading corporate research laboratories, such as the Bell Laboratories and the IBM Research Laboratories, from long-term research to short-term product development.

Equally serious are signs that the nation is no longer willing to invest in research performed by universities, at least at the same level, and with a similar willingness to support understanding-driven basic research. Congress has made it clear that they will insist that universities focus increasingly on applied research, more directly related to national priorities (although many industrial leaders have tried in vain to explain that without "basic" research, there is nothing to "apply"). The federal government has yet to develop a successor to the government-university research partnership which served so well during the Cold War years.

Of course, it is certainly appropriate to seek to support "strategic" research, that is, both basic and applied research that has a high probability of contributing to national goals. And, it is also the case that universities have responded to such national priorities in years past, ranging from national security to health care to agricultural or industrial development. Indeed, many of our land-grant public universities have such strategic research as an important part of their mission.

Hence, the concern is not the renewed federal interest in strategic research, but rather the way that the federal government is approaching this effort. The American research enterprise triad, research universities, national laboratories, and industrial research laboratories, is generally approached through the institutional structure of Congress, where most committees and, therefore, budget decisions, are organized around specific mission-oriented agencies (e.g., defense, energy, health, and environment). While it certainly makes sense to attempt to redirect the entire American research enterprise to focus on new strategic objectives, to do so within a single committee or budget category could lead to a damaging distortion of our research capacity.

A Change from Partnership to Procurement

As we have already noted, the basic structure of the academic research enterprise of the past half century was set out in Bush's study, *Science, the Endless Frontier*, almost fifty years ago. The central theme of the document was that the nation's health, economy, and military security required continual deployment of new scientific knowledge, and that the federal government was obligated to ensure basic scientific progress and the production of trained personnel in the national interest. It insisted that federal patronage was essential for the advancement of knowledge. It stressed a corollary principle that the government had to preserve "freedom of inquiry," to recognize that scientific progress results from the "free play of free intellects, working on subjects of their own choice, in the manner dictated by their curiosity for explanation of the unknown."

Since at least in the past the government recognized that it did not have the capacity to manage effectively either the research itself or the universities, the relationship was essentially a partnership, in which the government provided relatively unrestricted grants to support a part of the research on campus, with the hope that wonderful things would happen. And they did, as evidenced by the quality and impact of academic research.

Unfortunately, in recent years the basic principles of this extraordinarily productive research partnership have begun to unravel, so much so that today this relationship is rapidly changing from a partnership to a procurement process. The government is increasingly shifting from being a partner with the university a patron of basic research to becoming a procurer of research, just like other goods and services. In a similar fashion, the university is shifting to the status of a contractor, regarded no differently from other government contractors in the private sector. In a sense, today a grant has become viewed as a contract, subject to all of the regulation, oversight, and accountability of other federal contracts. This view has unleashed on the research university an army of government staff, accountants, and lawyers all claiming as their mission that of making certain that the university meets every detail of its agreements with the government.

To be sure, we must all be concerned about the proper expenditure of public funds. But, we also must be concerned about restoring the mutual trust and confidence of a partnership and move away from the adversarial contractor/procurer relationship that we find today.

Unfortunately, even the procurement model may be only a transitional stage, since in recent months there have been signs that the paradigm is continuing to shift still further to the same cost-controller more correctly, federal cost-shifting patterns characterizing health care. Can you imagine a system of DRG cost-reimbursement rules for basic research?

Surely, the most ominous warning signs for academic research are the erosion, even breakdown, in the extraordinarily productive fifty-year partnership uniting government and universities. Scientists and universities are questioning whether they can depend on the stable and solid relationship they had come to trust and that has paid such enormous dividends in initiative, innovation, and creativity. It is truly perverse that the partnership that has been in large measure responsible for our long-undisputed national prosperity and security should be threatened at very moment when it has become most critical for our future.

A Shift in Attitudes toward Teaching and Research

In recent years, there has been a decided shift in public attitudes toward the purpose of a university, away from research and toward undergraduate education. A several decade-long public consensus that universities were expected to create as well as transmit knowledge, a consensus that supported strong investment in the scientific, technological, and scholarly preeminence of this nation, has begun to erode. The concept of faculty as teacher-scholars has narrowed to the belief that most university faculty should be confined primarily to the role of teachers.

For decades, the conventional wisdom has been that research and teaching were mutually reinforcing and should go together. Indeed, even as recently as last year, the National Science Board in a major policy statement recommended that

The integration of research and education is in the national interest and should be a national objective. To advance this goal, federal science and engineering policies should strengthen efforts to promote the integration of research and education at all levels and should support innovative experiments in this area. Confidence that academic research enriches the educational process at U.S. colleges and universities underpins public support for science and engineering. Federal science and engineering policies should promote public awareness of model higher education institutions and programs that have demonstrated leadership in strengthening the synergy between research and education.

Yet, even within the academy, doubts have been raised about the impact of the research university culture on education. Harold Shapiro, President of Princeton University, has noted the increasing disparity between what faculty like to teach and what students need to learn: There is a growing sense that the competitive demands of specialized scholarship and other developments have placed an irreparable rift between graduate and undergraduate education and may have impaired the capacity of research universities both to remain centers of modern scholarship and to fulfill their broader educational functions. The real problem is that teaching and research may be too closely related. At the root of our unmet challenge in undergraduate education is the failure to distinguish between the transmission of knowledge and the development of a capacity for inquiry, discovery, and continued learning. The predicament is that the faculty is transmitting what they know and love with little awareness of what the student needs to learn.

The disparity at the graduate level, between graduate education and the needs of our nation, may be even greater. In fact, Robert Atwell, past president of the American Council of Education, used his last letter to his membership to suggest that doctoral education, rather than the crown jewel of American higher education, may be at the root of many of our problems. He suggested that the mismatch between doctoral education and the higher education marketplace is great. Too many faculty in our research universities are out of touch with the mainstream of higher education not to mention societal changes and fiscal realities and so they go on trying to clone themselves in the persons of their graduate students, to assist in their research. As a result, many new PhDs who find jobs in nonresearch colleges become frustrated and often pressure these institutions toward becoming research universities which implies, of course, offering PhDs. Atwell contends that the research/graduate university paradigm has created a pecking order in American higher education that is out of touch with the need of the nation and the academic marketplace.

The Pressures for Change in Higher Education

The profound nature of the challenges and changes facing higher education in the 1990s seems comparable in significance to two other periods of great change in the nature of the university in America: the period in the late 19th Century when the comprehensive university first appeared, and the years following World War II when the research university evolved to serve the needs of postwar America. We now face challenges and opportunities similar to those two earlier periods of change. Among the many pressures driving change are the following:

The Political-Economic Crisis

All universities are suffering the consequences of the structural flaws of national and state economies, the growing imbalance between revenues and expenditures, that are undermining support for essential institutions as governments struggle to meet short-term demands at the expense of long-term needs. The new mantra of the day in Washington has become Balance the budget within seven years. While the particular Tao, the path to deliverance, is still uncertain...whether via the Contract with America or Reinventing Government...the endpoint is clear. Discretionary domestic spending, research and education programs, and federal support of the research university, are all at great risk. Some leaders have even suggested that the very viability of the research university paradigm may be at significant risk during the next several years.

The states are also in serious trouble. Cost shifting from the federal government through unfunded mandates such as Medicare, Medicaid, ADA, and OSHA has destabilized many state budgets. The commitment many states have made to funding K-12 education through earmarks off-the-top and massive investments in corrections have undermined their capacity to support higher education. In fact, in many states today, the appropriations for prisons have now surpassed the funding for higher education and shows no signs of slowing. A case in point: a decade ago, when I began my presidency, Michigan had 15 public universities and eight prisons. Today, we still have 15 universities, but 35 prisons. More to the point, this year our state will spend \$1.4 billion for the education of 250,000 students in its public universities and over \$1.4 billion for the incarceration of 40,000 inmates at an annual cost per inmate of \$35,000, somewhat more than the cost of a Harvard education! This situation is not unique to Michigan. California is in a similar bind, destined to worsen with mandatory sentencing Three strikes and you're out.

Moreover, in recent years, both state and federal leaders have taken actions which shift the costs of higher education increasingly from general tax revenues to tuition and fees from public support to students. In a sense, the public principle that education is a public good that benefits all of society and, hence, should be supported by society at large is shifting to the perspective of education as a private good that should be paid for by those benefiting most directly the students.

In my view, these structural budget problems will make it very difficult for most states to provide better than inflationary increases in appropriations for higher education in the decade ahead and, for many, even this scenario will be overly optimistic. Although some have suggested that the states might be willing to pick up some of the shortfall resulting from declining federal support for university-based R&D, I believe it is quite unrealistic to believe that most states will have either the capacity or will to do so.

The One-Percent Problem

There is an additional challenge faced by the best of America's universities. Harold Shapiro identifies what he calls the "one-percent problem" facing those institutions that compete to be the very best in teaching and scholarship. The decade of the 1980s experienced a trend in which the costs of achieving excellence in higher education rose roughly one percent per year more rapidly than the available resource base. Most studies project that this trend is likely to continue throughout the 1990s, driven in part by the expanding knowledge base and by the cost structures of quality research and teaching. While a given institution may be able to accommodate such an imbalance between costs and revenues over a short period, it is clear that over the long term, the "one-percent problem" will require a significant restructuring of the mission and activities of the university.

Cost Shifting

There is another dilemma here, one perhaps best illustrated by the old parable of the blind men each feeling different parts of an elephant and arguing over just what the whole beast looks like. The modern research university is complex and multidimensional. People perceive it in vastly different ways, depending on their vantage point, their needs, and their expectations. Students and parents want high-quality, but low-cost, education. Business and industry seek high-quality products: graduates, research, and services.

Patients of our hospitals seek high-quality and compassionate care. Federal, state, and local governments have complex and varied demands that both sustain and constrain us. And the public itself sometimes seems to have a love-hate relationship with higher education. They take pride in our quality, revel in our athletic accomplishments, but they also harbor deep suspicions about our costs, our integrity, and even our intellectual aspirations and commitments.

Beyond the classic triad of teaching, research, and service, society has assigned to the university over the past several decades an array of other roles:

- improving health care - national security - social mobility - parenting - big-time show biz (intercollegiate athletics).

Today, society is asking to us to assume additional roles such as:

- revitalizing K-12 education - improving race relations in America - rebuilding our cities - securing economic competitiveness.

Looking at the university from an economist's perspective, one would see as inputs: our people (students, faculty, and staff), our funding (tuition paid by students and families, gifts, and income on endowments), and taxpayer dollars from state and federal governments. Our outputs are the value added through the education of our students, the knowledge produced on our campuses, and through direct services to our society, such as through agricultural extension services or teaching hospitals.

The problem is simple: each stakeholder wants to minimize the input it provides and maximize the output it obtains from universities, but none of the funding contributors is looking at the university as a whole, with diverse missions. More specifically, each party seems to want much more out than it is willing to put in, thereby leveraging other contributors.

Unfortunately, most people and most components of state and federal government can picture the university "elephant" only in terms of the part they can feel, e.g., research procurement, student financial aid, and political correctness. Few seem to see, understand, or appreciate the entirety of the university. This is particularly true in Washington, where each element of the federal government attempts to optimize the procurement of the particular products or services they seek from our research universities. There seems to be little recognition that shifting federal priorities, policies, or support aimed at one objective, will inevitably have an impact on other roles of our institutions.

Let me illustrate this with two recent examples: Federal efforts to impose artificial limits on the reimbursement of indirect costs on research grants, and the alarming trend to increasing cost-sharing requirements.

Recent efforts to reduce the costs of federally-sponsored research by imposing limits on the rates in indirect cost reimbursement is an example of this type of cost-shifting. While complex to calculate, indirect costs are nevertheless real costs associated with the conduct of federally-sponsored research, and must be paid by someone. Indeed, many of these costs are driven directly by the federal government through layer after layer of regulation, accounting, audits, and policy shifts.

To put it in the bluntest of terms, most institutions have only one recourse to respond to federal efforts to pay less than the full costs of the university research they procure: student tuition and fees. That is, if the federal government decides it wants to reduce federal research expenditures by several hundred million dollars by capping indirect costs, in reality it is asking students and parents to pick up this much of the tab for federal research projects, since this is the only alternative funding source most universities have.

The same can be said for cost-sharing requirements on federal grants. While there is a certain simplistic rationale behind such requirements after all, cost-sharing can be viewed as a kind of earnest money proving the sincerity of the institution seeking the grant they can have serious negative implications, since they usually result in the diversion of discretionary funds away from educational programs and into federally-sponsored projects.

Politics

Most of America's colleges and universities have more than once suffered the consequences of ill-thought-out efforts by politicians to influence everything from what subjects can be taught, who is fit to teach, and

who should be allowed to study. Too often, such interference is a short-sighted effort to exploit public fears and passions of the moment for immediate political gain. The long-term costs to citizens is high because politically motivated intrusions into academic policy lead, in the long run, to educational mediocrity.

Once again, harmful political forces are gathering strength to intervene in university affairs. This time they originate in California, where the Governor and his appointed regents, have ordered the University of California to dismantle its time-tested and effective affirmative action policies by next year. A ballot initiative, eliminating government affirmative action programs entirely, is slated for a vote in November. Inspired by California's example, more than a dozen states are now reported by the Washington Post to be considering similar legislative initiatives to end affirmative action in admissions, hiring, and financial aid decisions.

This intensifying political pressure on our nation's great public universities is a threat to their unique historic role of providing a world-class educational opportunity to all students who have the will and ability to succeed. And, if politics today influence university admissions policies, what will be targeted next? Curriculum? Faculty hiring? Research?

Further, the special interest politics characterizing our times, with their slash and burn tactics, sometimes focus on higher education. In the past, these institutions, so critical to our future, were buffered from such attack politics both by their governing boards and the media. Today, however, these groups now serve to focus and magnify political attacks on our campuses rather than shielding us from them...

Sunshine Laws

Public universities face one particular political challenge spared private institutions, sunshine laws. Most states have passed laws requiring that the meetings of public bodies, such as governing boards, be open to the press and members of the public. Further, many also have freedom of information laws that require public disclosure of any documents or data not protected by personal privacy laws. The media are using these laws not simply to pry into the operations of public institutions, but to actually manipulate and control them.

Populism

Higher education is also no stranger to the forces of populism that rise from time to time to challenge many other aspects of our society's widespread distrust of expertise, excellence, and privilege. Indeed, many universities, faculty, and university administrators have made themselves easy targets by their arrogance and elitism. But, today we see a particularly virulent form of populism, almost a post-modern, deconstructionist variety, that aims at not simply challenging but actually destroying our social institutions and commitments. This slash and burn approach offers little in the way of alternatives. It also has a decidedly anti-intellectual character.

The Deteriorating Power of the University Presidency

This fall, the Association of Governing Boards released the report of their National Commission on the Academic Presidency which concluded that the greatest danger to higher education is that colleges and universities were neither as nimble nor as adaptable as the times required. The reason was simple. The academic presidency has become weak. (Anemic was the term they used.) They found that the authority of university presidents had been undercut by all of their partner-trustees, faculty, and political leaders and, at times, by the presidents' own lack of assertiveness and willingness to take risks for change.

The Changing Paradigm of the Research University

There is an even more profound transformation occurring: that involving the paradigm of the research university itself. As one of civilization's most enduring institutions, the university has been extraordinary in its capacity to change and adapt to serve society. Far from being immutable, the university has changed over time and continues to do so today. A simple glance at the remarkable diversity of institutions comprising higher education in America demonstrates this evolution of the species.

One frequently hears the primary missions of the university referred to in terms of teaching, research, and service. But these roles can also be regarded as simply the 20th Century manifestations of the more fundamental roles of creating, preserving, integrating, transmitting, and applying knowledge. From this more abstract viewpoint, it is clear that while these fundamental roles of the university do not change over

time, the particular realization of these roles do change and change quite dramatically, in fact. Consider, for example, the role of teaching, that is, transmitting knowledge. While we generally think of this role in terms of a professor teaching a class of students, who, in turn, respond by reading assigned texts, writing papers, solving problems or performing experiments, and taking examinations, we should also recognize that classroom instruction is a relatively recent form of pedagogy. Throughout the last millennium, the more common form of learning was through apprenticeship. Both the neophyte scholar and craftsman learned by working as apprentices to a master. While this type of one-on-one learning still occurs today in skilled professions such as medicine and in advanced education programs such as the PhD dissertation, it is simply too labor-intensive for the mass educational needs of modern society.

The classroom itself may soon be replaced by more appropriate and efficient learning experiences. Indeed, such a paradigm shift may be forced upon the faculty by the students themselves. Today's students are members of the digital generation. They have spent their early lives surrounded by robust, visual, electronic media: Sesame Street, MTV, home computers, video games, cyberspace networks, and virtual reality. They approach learning as a plug-and-play experience, unaccustomed and unwilling to learn sequentially to read the manual and rather inclined to plunge in and learn through participation and experimentation. While this type of learning is far different from the sequential, pyramid approach of the traditional university curriculum, it may be far more effective for this generation, particularly when provided through a media-rich environment.

Hence, it could well be that faculty members of the 21st Century university will be asked to set aside their roles as teachers and instead become designers of learning experiences, processes, and environments. Further, tomorrow's faculty may have to discard the present style of solitary learning experiences, in which students tend to learn primarily on their own through reading, writing, and problem solving. Instead, they may be asked to develop collective learning experiences in which students work together and learn together with the faculty member becoming more of a consultant or a coach than a teacher.

One can easily identify other similarly profound changes occurring in the other roles of the university. The process of creating new knowledge of research and scholarship is also evolving rapidly away from the solitary scholar to teams of scholars, perhaps spread over a number of disciplines. Indeed, is the concept of the disciplinary specialist really necessary or even relevant in a future in which the most interesting and significant problems will require big think rather than small think? Who needs such specialists when intelligent software agents will soon be available to roam far and wide through robust networks containing the knowledge of the world, instantly and effortlessly extracting whatever a person wishes to know?

So, too, there is increasing pressure to draw research topics more directly from worldly experience rather than predominantly from the curiosity of scholars. Even the nature of knowledge creation is shifting somewhat away from the analysis of what has been to the creation of what has never been drawing more on the experience of the artist than upon analytical skills of the scientist.

The preservation of knowledge is one of the most rapidly changing functions of the university. The computer or more precisely, the digital convergence of various media from print-to-graphics-to-sound-to-sensory experiences through virtual reality has already moved beyond the printing press in its impact on knowledge. Throughout the centuries, the intellectual focal point of the university has been its library, its collection of written works preserving the knowledge of civilization. Yet, today, such knowledge exists in many forms as text, graphics, sound, algorithms, and virtual reality simulations and it exists almost literally in the ether, distributed in digital representations over worldwide networks, accessible by anyone, and certainly not the prerogative of the privileged few in academe.

Finally, it is also clear that societal needs will continue to dictate great changes in the applications of knowledge it expects from universities. Over the past several decades, universities have been asked to play the lead in applying knowledge across a wide array of activities, from providing health care, to protecting the environment, from rebuilding our cities to entertaining the public at large (although it is sometimes hard to understand how intercollegiate athletics represents knowledge application).

This abstract definition of the roles of the university have existed throughout the long history of the university and will certainly continue to exist as long as these remarkable social institutions survive. But, the particular realization of the fundamental roles of knowledge creation, preservation, integration, transmission, and application will continue to change in profound ways, as they have so often in the past. And, hence, the challenge of change, of transformation, is, in part, a necessity simply to sustain our traditional roles in society.

There is an increasing sense among leaders of American higher education, and on the part of our various constituencies, that the 1990s will represent a period of significant change on the part of our universities if we are to respond to the challenges, opportunities, and responsibilities before us. A key element will be

efforts to provide universities with the capacity to transform themselves into entirely new paradigms that are better able to serve a rapidly changing society and a profoundly changed world.

The 21st Century University

Of course, these paradigm shifts are being driven by the extraordinary pace of change in our society. We are living in the most extraordinary of times: the collapse of Communism, the end of the Cold War, the impact of technologies ranging from computers and telecommunication to biotechnology, a redefinition of the world economic order, and, of course, the human population pushing against the very limits of the planet. Many believe that we are going through a period of change in our civilization just as momentous as that which occurred in earlier times such as the Renaissance or the Industrial Revolution except that while these earlier transformations took centuries to occur, the transformations characterizing our times will occur in a decade or less! I used to portray the 1990s as the countdown toward a new millennium, as we find ourselves swept toward a new century by these incredible forces of change. The events of the past several years suggest that the 21st Century is already upon us a decade early!

This time of great change, of shifting paradigms, provides the context in which we must consider the changing nature of the academic research enterprise itself. We must take great care not simply to extrapolate the past and, instead, examine the full range of possibilities of the future.

Here, we face a particular dilemma. Both the pace and nature of the changes occurring in our world today have become so rapid and so significant that our present social structures in government, education, and the private sector are having increasing difficulty in even sensing the changes, although they certainly feel their consequences. They are simply incapable of understanding the profound changes characterizing our world, much less responding and adapting in an effective way.

Let me go further. It may well be that our present institutions, such as universities and government agencies, which have been the traditional structures for intellectual pursuits such as research, could be as obsolete and irrelevant to our future as is the American corporation of the 1950s. We need to explore new social structures capable of sensing and understanding change, as well as capable of engaging in the strategic processes necessary to adapt or control change.

A case in point: for the past half-century, the Bush paradigm of federal patronage of investigator-driven research has determined the nature of the research university. Only 125 of the 3,600 institutions of higher education are research universities, but these are just the institutions at most risk as the federal science and technology budget shrinks in the years ahead. Don Langenberg, Chancellor of the University of Maryland, goes even further: It is probably about as safe to assume that the dominant higher education institutions of the 21st Century will stem from this small but powerful group of present-day institutions as it would have been to assume that today's dominant life form on Earth would stem from *Tyrannosaurus Rex*.

Back to the Future

The anticipated decline in federal support of university-based R&D in the years ahead will inevitably cause a variety of responses on the part of both public and private research universities. Many university faculty will shift from the public to the private sector for support to accommodate the erosion in federal support. Beyond seeking corporate support for R&D, they will need to market educational services more aggressively and put in place more realistic price structures (e.g., tuition and fees) that accurately reflect costs.

But, there are more profound shifts that will likely occur in the character of institutions. Clearly, to thrive in the more competitive marketplaces of the 21st Century, universities must shift from the faculty-centered cultures of research universities to the student-centered enterprises of land-grant institutions...that is, in the language of the business world, from provider-centered to customer-market.

But, there is an even more subtle shift that I believe may occur. There could be a shift in public attitudes toward universities that will place less stress on values such as excellence and elitism and more emphasis on the provision of cost-competitive, high-quality services from prestige-driven to market-driven philosophies.

Let me elaborate a bit on this third issue. For the past half-century, the Bush paradigm characterizing the government-university research partnership has been one built upon the concept of relatively unconstrained patronage. That is, the government would provide faculty with the resources to do the research they felt was important in the hopes that, at some future point, this research would benefit

society. Since the quality of the faculty, the programs, and the institution was felt to be the best determinant of long-term impact, academic excellence and prestige were valued.

Yet, today, society seems reluctant to make such long-term investments. Rather, it seems interested in seeking short-term services from universities, of high quality, to be sure, but with cost as a consideration. In a sense, it seeks low-cost, quality services rather than prestige. The public is asking increasingly, If a Ford will do, then why buy a Cadillac?

Perhaps, rather than moving ahead to a new paradigm, we are, in reality, returning to the paradigm that dominated the early half of the 20th Century...the land-grant university model. In fact, perhaps what is needed is to create a contemporary land-grant university paradigm.

As Frank Rhodes, President-emeritus of Cornell University, and other leaders of public universities have stressed, the land-grant paradigm of the 19th and 20th Centuries was focused on developing the vast natural resources of our nation. The agricultural and engineering experiment stations and the cooperative extension programs were enormously successful. Today, however, we have come to realize that our most important national asset for the future will be our people. Hence, a contemporary land-grant university might be focused on human resource development along with the infrastructure necessary to sustain a knowledge-driven society.

The Transformation of the Research University

The nature of the contemporary university and the forces that drive its evolution are complex and frequently misunderstood. The public still thinks of us in very traditional ways, with images of students sitting in a large classroom listening to a faculty member lecture on subjects such as literature or history. Our faculty have more of an Oxbridge image, thinking of themselves as dons and of their students as serious scholars. The federal government thinks of us as just another R&D contractor or health provider, a supplicant for the public purse. Yet, the reality is far different and far more complex.

The reality is something quite different, as a brief analysis of our mission will indicate. While we generally all start from the classic triad of teaching, research, and service, the various forms these general missions branch into stretch on and on.

Let me suggest a different image of the modern research university: that of a very complex, international conglomerate of highly diverse businesses. Consider, for example, an organizational diagram of "the U of M, Inc.":

The U of M Inc., with an annual budget of over \$2.5 billion per year, would rank roughly 300th on the Fortune 500 list. We have several campuses where we educate about 50,000 students at any one time, about an \$800 million dollar a year operation. We're a very major federal R&D laboratory, over \$440 million dollars a year worth of grants and contracts. We run a massive health care company. Our medical center treated over 800,000 patients last year. We have a managed care operation with 100,000 managed lives. Last year we formed a nonprofit corporation, the Michigan Health Corporation, which will allow us to make equity investments in joint ventures to build a statewide integrated health care system, building to roughly 1,500,000 subscribers, which is the size of a population we believe necessary to keep our tertiary hospitals afloat (which, unfortunately, we own). We're already too big to buy insurance, so we have our own captive insurance company. We've become actively involved in providing a wide array of knowledge services, from degree programs offered in Hong Kong, Seoul, and Paris, to cyberspace-based products, such as managing part of the Internet. And, of course, we're involved in entertainment the Michigan Wolverines. That \$250 million you see under the Michigan Wolverines is not our athletic budget, but when you represent licensing and everything else we do, that's about the magnitude of it.

In many ways, the university today has become the most complex institution in modern society far more complex, for example, than corporations or governments. We are comprised of many activities, some nonprofit, some publicly regulated, and some operating in intensely competitive marketplaces. We teach students; we conduct research for various clients; we provide health care; we engage in economic development; we stimulate social change; and we provide mass entertainment (athletics). In systems terminology, the modern university is a loosely-coupled, adaptive system, with a growing complexity as its various components respond to changes in its environment.

That is, the modern university has become a highly adaptable knowledge conglomerate because of the interests and efforts of our faculty. We have provided our faculty the freedom, the encouragement, and the incentives to move toward their personal goals in highly flexible ways. In a very real sense, the university of today is a holding company of faculty entrepreneurs, who drive the evolution of the university to fulfill their

individual goals. We have developed a transactional culture in which everything is up for negotiation.

But, while the entrepreneurial university has been remarkably adaptive and resilient throughout the 20th Century, it also faces serious challenges. Many contend that we have diluted our core business of learning, particularly undergraduate education, with a host of entrepreneurial activities. We have become so complex that few, whether on or beyond our campuses, understand what we have become. We have great difficulty in allowing obsolete activities to disappear. Today, we face serious constraints on resources that no longer allow us to be all things to all people. We also have become sufficiently encumbered with processes, policies, procedures, and past practices that our best and most creative people no longer determine the direction of our institution.

To respond to future challenges and opportunities, the modern university must engage in a more strategic process of change. While the natural evolution of a learning organization may still be the best model of change, it must be augmented by constraints to preserve our fundamental values and mission. We must find ways to allow our most creative people to drive the future of our institutions.

Our challenge is to tap this great source of creativity and energy associated with entrepreneurial activity, but in a way that preserves our fundamental mission and values. We need to encourage our tradition of natural evolution, but do so with greater strategic intent. Instead of continuing to evolve as an unconstrained transactional entrepreneurial culture, we need to guide this process in such a way as to preserve our core missions, characteristics, and values.

Concluding Remarks

The American university has always responded quite effectively to the perceived needs or opportunities of American society. In the 19th Century they developed professional schools, then rapidly transformed themselves to stress applied fields, such as engineering, agriculture, and medicine, favored by the federal land-grant acts. In the post-World War II years, they responded again to develop an extraordinary capability in basic research and advanced training in response to the federal initiatives embodied in Science, The Endless Frontier.

Again, this is not at all surprising, considering the individualistic, entrepreneurial nature of the faculty, and the loosely coupled, dynamic organizational structure of universities. We can argue that these institutions take on far too many missions as a result, but we cannot deny that they do respond to the opportunities and challenges presented by society. Today, universities are evolving rapidly, responding once again to their faculties perception of the marketplace. And the faculty are hearing loud and clear the message that America no longer values the importance of basic research and questions even the relevance of the research university.

While they may not like it, the faculty is remarkably sensitive to the criticisms voiced by critics of the academy...about too much emphasis on research over teaching...about too many PhDs and not enough jobs...about whether we should shift toward more applied activities. And they are responding, quite rapidly, to adapt to this brave, new world. Just survey any group of junior faculty.

The world and the structure of academic research have changed greatly since Vannevar Bush wrote his report. However, the major principles he advanced merit reaffirmation. Now, more than ever before, the national interest calls for an investment in human and intellectual capital. As Bush so clearly stated it, the government-university partnership is not simply about the procurement of research results. It is also about nurturing and maintaining the human strengths of a great technological nation and sowing the seeds that will ultimately bear fruit in new products and processes to fuel our economy and improve our quality of life.

The American public, its government, and its universities should not surrender the long-term advantage of this research partnership because of a short-term loss of direction or confidence. At a time when many of society's other institutions do not seem to be working well, the research university is a true success story. We simply must get that message across to the American public. We must re-articulate and revitalize the remarkably successful partnership that has existed between our government, our society, and our research universities over the past four decades.

And, we must sound the wake-up call to America sufficiently loud and clear that our faculty can hear the reverberations, before the American research university has evolved into some new paradigm, perhaps responding to other societal needs, but no longer with the capacity to respond to our intellectual needs.
