Technology Policy and the American University

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Introduction

Since my colleague Roland Schmitt assures us that "Technology policy has now come out of the closet" and can be spoken about freely, I intend to do so this afternoon with the candor of a midwestern engineer. However, let me put my colleagues on the National Science Board at ease and note that this afternoon I will most assuredly NOT be wearing my hat as chair of the Board. But rather I will talk from my perspective as president of the University of Michigan, located square in the heart of the Rust Belt, where we have been experiencing first hand the trauma of a transition from an industrial, domestic economy to what Erich Bloch has called "a global economy in an age of knowledge."

Indeed, I speak to you today in the wake of the recent news that General Motors has just announced the elimination of another 9,000 jobs in our state--including the closing, right in the backyard of my University, of perhaps the greatest symbol of American industrial might: the Willow Run assembly plant that a half-century ago helped win World War II by producing Liberator bombers--yet today has lost the capacity to compete effectively in the production of Chevrolets. While people generally look at the midwest as a relic of America's industrial past, let me suggest that in many ways, it can also be viewed as America's future. For it is in the industrial midwest--in Michigan--that we are being force to learn through the school of hard knocks, to fight and scratch our way back from the economic brink to achieve prosperity in the brave, new world of the global marketplace.

Thus I believe I can speak with personal feeling and experience as one who is fighting on the front lines to restore our nation's industrial strength.

The Need for a National Technology Policy

And it is from this perspective that I have become absolutely convinced that without a more coordinated federal effort in the development and application of technology, one-by-one our nation's industries will suffer the same tragic fate that has faced industries in Michigan.

Fortunately, many others have reached the same conclusion. Indeed, the White House, through the strong efforts of Allan Bromley and his colleagues, has taken the first important steps toward developing a national technology policy

appropriate for the 1990s. Hence, I don't believe I have to dwell long on the many reasons for such actions, e.g.,

- the degree to which other nation's are passing us by in investments in civilian R&D...in both relative and perhaps even absolute terms, as suggested by the most recent NSF Science Indicators data ...the manner in which our scattered and uncoordinated national efforts are wasting important assets such as our research universities, national laboratories, and industrial laboratories,

- the need to develop critical generic technologies such as
  ...advanced materials
  ...biotechnology
  ...information technology
  ...and manufacturing and process technologies

- the ability to use such a policy to bring national attention to issues, to stimulate policy debate, and to help focus and prioritize decision making.

Of course, adopting such a policy for strategic national investments in technology is nothing new for America. We have done so before when faced with national challenges ...in the development of modern agriculture in the early 20th Century ...in national defense in the Cold War era ...in biomedical sciences and health care ...in our space program. Indeed, I suggest the real question is why it took us so long to wake up to the needs to embark on a similar course to address the dominant challenge before America in the 1990s: our economic competitiveness.

Hence, I will assume that the case for a national technology policy is obvious, and instead turn to the role that the American university can and should play in such an effort. In doing so, let me note that in contrast with other industrialized nations, the United States has relied heavily on its universities to conduct much of the basic and applied research necessary to respond to national needs. Hence, any effort to develop and implement an effective technology policy for America will rest, in part, on a sound foundation of research universities as vital partners in collaboration with government and the private sector.

The Role of the American University

But, of course, turning to the university to address issues of national need is nothing new for America. Indeed, perhaps the most unique theme of higher education in America is that of service. For the bonds between the university and society are particularly strong in this country. Historically our public institutions have been responsible to, shaped by, and drawn their agendas from the communities that founded them. In fact, this unique partnership goes back over two centuries, to the Northwest Ordinance which stated that "Religion, morality, and knowledge being necessary to good government and the happiness of mankind, schools and the means of education shall forever be encouraged." This laid the foundation for one of America's most wondrous social inventions, the great land grant universities.

Because they added a commitment to public service to the traditional academic mission of teaching and scholarship, these institutions created a continuing connection between theory and practice between public universities and the people they serve. The result was a powerfully creative engine for progress uniting students and faculty in a collective discovery and transfer of useful knowledge and technology. The American university through oncampus research and offcampus extension activities was key to first the agricultural development of America and then its transition to the industrial age. WWII provided the incentive for even greater cooperation as the universities became important partners in the war effort, achieving scientific breakthroughs such as nuclear fission and radar. In this period our university research became "mission oriented" and we learned valuable lessons in how to develop and transfer technology strategically how to work as full partners with government and industry.

The importance of this role was recognized in the post-war years through the seminal report by Vannevar Bush, Science, the Endless Frontier, which in a sense paraphrased the Northwest Ordinance partnership by noting: "Since health, well-being, and security are proper concerns of government, scientific progress is, and must be, of vital interest to government." The resulting partnership between the federal government and the nation's universities has had extraordinary impact. It has made America the world leading source of fundamental scientific knowledge. It has also produced the well-trained scientists and engineers capable of applying this new knowledge. Further, this academic research enterprise has played a critical role in the conduct of more

applied, mission-focused research in a host of areas including health care, agriculture, national defense, and economic development.

Yet as important as these institutions are today in our everyday lives, it seems increasingly clear that in the future they will play an even more critical role as they become the key player in providing the knowledge resources--knowledge itself, and the educated citizens capable of applying it wisely--necessary for our prosperity, security, and social well-being. As Erich Bloch himself once put it in Congressional testimony: "The solution of virtually all the problems with which government is concerned: health, education, environment, energy, urban development, international relationships, space, economic competitiveness, and defense and national security, all depend on creating new knowledge---and hence upon the health of America's research universities".

But here we have both some good news and some bad news. First the good news...

The Good News

The good news here is that America's system of higher education is still widely acknowledged to be the strongest and most productive in the world. A few weeks ago a New York Times editorial called our nation's research universities 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 America's future". This was an especially welcome, if all too rare, acknowledgement since all too often the university today is under attack from all sides.

The Bad News

And that brings me to the bad news... If the good news is that our universities are the strongest in the world the bad news is that the 1990's stand a good chance of being the worst for higher education since the 1930's. There is a frightening sense of crisis at many of our nation's most distinguished campuses.

To discuss national technology policy realistically I believe it is imperative that we first understand that our universities--a vital partner in any national strategy to improve competitiveness and productivity--are at serious risk on a number of fronts. The signs of stress are everywhere:

1. The breakdown of mutual trust leading 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 degree to which the skepticism--indeed, hostility-- exhibited by the media and government bodies has badly eroded public trust and confidence in the university, as evidenced 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 which are pushing toward a rebalancing of missions, away from research and more toward teaching and public service, not the least of which are the rapidly escalating costs of conducting cutting-edge research.

4. The deteriorating morale of academic researchers driven by 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. Indeed, in a recent NSF workshop, 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 between the omnipresent influence of science on modern society and the scientific literacy of the body politic widens, the fear of science may be driving much of this hostility as a way to "control" it, to keep it in its place.

So too, we 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. And unfortunately, many scientists...and 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 strains on the academic research enterprise which may prove of critical importance to their participation in a national technology policy.

Strains on the Academic Research Enterprise

The Political-Economic Crisis

The most immediate stress is coming from the effects of a deep and profound political-economic crisis. For one thing, of course, universities are feeling the effects of the current recession both nationally and regionally. But current fiscal woes are not just temporary set-backs they go much deeper.

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 government struggle to meet short term demands at the expense of long term needs. The electorate has adopted a new credo: " Eat dessert first. Life is uncertain...and by the way, just sent the bill to the kids later--say in a decade or two". Education at all levels is feeling the effects of two decades of political failure to invest in our people and infrastructure--in our children's future.

The states are in trouble. For the first time in thirty years, state support for higher education is dropping. In fact, I suspect there are few areas of the country in which state support for public higher education will be even able to keep pace with inflation during the 1990s... despite the fact that enrollment pressures are now building rapidly as we bounce back from the post-war baby boom and bust cycles.

Cuts in federally supported financial aid has shattered. the dream of equal educational access for many students leaving higher education to scramble to try to make up the difference while they also are forced to increase tuition to make

up for massive losses in other revenue. So, too, the federal government has embarked upon a massive effort to shift more of the costs of federally sponsored research to the universities through limits on overhead reimbursement rates even though these rates are less than one-half to one-third those characterizing other federal contractors in the public and private sectors.

Hence, both public and private institutions are facing very serious financial difficulties today. While you read in the national press about the staggering budget deficits faced by relatively affluent institutions like Harvard, Yale, and the University of California, let me caution you that the situation is far more serious in those institutions who do not benefit from massive endowments or generous state support. Clearly, these financial pressures will impose very real limits on the universities' capacity to participate in a national technology policy without significant additional public and private support.

The Inability to Comprehend the Modern University

There is another dilemma here, one perhaps best illustrated by the old parable of the blind men feeling different parts of an elephant, and arguing over just what the beast looks like. The modern research university is complex and multidimensional. People perceive us 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 government 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).

Further, it is now asking to us to assume additional roles such as:

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

Unfortunately, most folks--and most agencies of the federal government--can picture the university "elephant" only in terms of the part they can feel, e.g., for research procurement, student financial aid, and political correctness. Few in Washington seem to see, understand, or appreciate the whole enchalada of the university. And no one seems to understand or care that shifting federal priorities, policies, or support aimed at one objective or area will inevitably have an impact on other roles of the university. For example, it is clear that excessive cost-sharing requirements or inadequate reimbursement of research overhead costs will inevitably cause fund shifting from other functions of the university such as education or public service.

Manpower Issues

Research is an intensely people-dependent activity. No matter how much funding we have, no matter how fine our facilities, no matter how effective our organizations, if we do not have great people going into these fields, we will not have great research.

For the past decade the National Science Board has been attempting to assess scientific and technical manpower needs of our nation. It is our belief that we will indeed face serious shortages at both the B.S. and Ph.D. levels. In fact, most universities can tell you that the manpower crisis is already upon us in many fields--although people in Washington continue to argue around the fringes, e.g., debating "shortfalls" versus "shortages," questioning the assumptions in various manpower projections, while the universities in corporate America suffer, and the clouds continue to build on the horizon.

Sure, we may get a temporary respite from the shift of scientists and engineers from the defense effort into civilian R&D or from scientists

immigrating from the collapsing Soviet states. But this will be short-lived. There are clear trends suggesting that over the longer term, we may face some serious problems:

i) the declining number of college-age citizens
ii) the declining fraction of students majoring in S&E
iii) no growth in number of citizens obtaining doctoral degrees in S&E
iv)the surge of faculty retirements anticipated in 1990s
v) a probable growth of industrial jobs requiring advanced degrees
vi) the appalling failure of K-12 science education.

Hence we should at least consider policy options that might serve as an insurance against possible scientific and technical manpower shortages.

Beyond the question of numbers is the question of quality. We have to face the fact that our best talent--our smartest students--are simply not attracted to research or academic careers these days. Instead, they are attracted to careers in law, business, politics--to wealth, power, and fame--and not to intellectual excitement. As I suggested earlier, it just isn't as much fun to be a faculty member these days, and our students sense this. Clearly the faculty of today feel stressed out, overloaded from the rigors of grantsmanship, paperwork, committee assignments, review panels, oversight strains--with precious little time left over for teaching and research, much less thinking.

We need to address these manpower challenges or we can forget about the rest of the agenda.

Paradigm Shifts

Let me suggest that beyond the financial pressures, and manpower concerns, and the difficulties in comprehending and balancing the many missions of the university, there is yet another important theme that we must consider, and that 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.

The Transition from Partnership to Procurement

The basic structure of the academic research enterprise of the past half century was set out in the seminal study chaired by Vannevar Bush shortly after the end of WWII, Science, the Endless Frontier. The central theme of the document was that the nation's health, economy, and military security constantly required the 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 upon the principle of federal patronage 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.

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. That is, 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; while the university is shifting to the status of a contractor, similar to that of other government contractors in the private sector. In a sense, today a grant has become increasingly viewed as a contract, subject to all of the regulation, oversight, and accountability of other federal contracts. This view has unleased 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. But even this may be a transitional stage, since in recent months there have been signs that the paradigm is continuing to shift still further to the same cost-control--or more correctly, federal cost-shifting--patterns characterizing health care. Gad, can you imagine a system of DRG cost-reimbursement rules for basic research?

Surely the most ominous warning signs for academic research is the erosion, even breakdown, in the extraordinarily productive fifty-year partnership uniting government and universities. Scientists and universities are wondering if 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. Truly perverse that the relationship that has been in large measure responsible for our long undisputed technological superiority should be threatened at very moment when it has become most critical for our future.

The Changing Paradigm of the Research University

But there is an even more profound transformation occurring: that involving the paradigm of the research university itself. The triad mission of the university as we know it today --teaching, research, and service--was shaped by the needs of an America of the past. Today our nation and our world are changing at an ever-accelerating pace. Hence, is seems appropriate to question whether our present concept of the research university, developed largely to serve a homogeneous, domestic, industrial society of the twentieth century, must also evolve rapidly if we are to serve the highly pluralistic, knowledge-intensive world nation that will be the United States of the twenty-first century.

Given the pace and magnitude of change today, perhaps the decade ahead is a time for "reinventing" the American university. But will a gradual evolution of our traditional paradigm be sufficient? Or will the challenges ahead force a more dramatic, indeed revolutionary, shift in the paradigm of the contemporary research university? I'm not sure how rapid these changes will occur, but I can tell you that much of the energy on our campuses today is really part of a process to discover the nature of the University of the 21st Century, an institution that will almost certainly be as different from

what we know today as the modern research university is from that of the 19th Century.

A World Transformed

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, mankind pushing against the very limits of the planet. Indeed, many believe that we are going through a period of change in our civilization just as profound 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. But the events of the past year suggest that the 21st Century is already upon us--a decade early!

But are we ready for it? Are we prepared to face a world whose economy, culture, polity, is driven by the explosion of knowledge itself?

Is It Time to Break the Mold?

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

But 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 profound that our present social structures--in government, education, the private sector--are having increasing difficulty in even sensing the changes (although they certainly feel their consequences), much less understanding them sufficiently to allow institutions to respond and adapt.

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

An Example

Let me give you an example of what I mean. Since the business of the academic research enterprise is knowledge, let me suggest that the impact of the extraordinary advances in information technology could have--likely will have--profound implications. Technologies such as computers, networks, HDTV, ubiquitous computing, knowbots, and other technologies may well invalidate most of the current assumptions in thinking about the future nature of the research enterprise.

Will the "university of 21st Century" be localized in space and time, or will it be a "meta-structure" involving people throughout their lives, wherever they may be on this planet--or beyond?

Is the concept of the 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," where intelligent software agents can roam far and wide through robust networks containing the knowledge of the world and instantly and effortlessly extract whatever a person wishes to know?

Will lifestyles in the academy (and elsewhere) become increasingly nomadic, with people living and traveling where they wish, taking their work and their social relationships with them?

In the spirit of these questions, perhaps we should pay far more attention to evolving new structures such as "collaboratories" rather than old-fashioned structures such as research universities, federal research laboratories, research projects, centers, and institutes. There is a possible implication here. If information technology will indeed allow--perhaps even require--new paradigms for research organizations, should we not place a far higher priority

on linking together our scientists and engineers, not to mention linking them with the rest of the world? This would seem to be a modest investment compared to other megaprojects such as the SSC and the Human Genome Project. Further, without investigating the impact of such technology-based infrastructure first, we may find ourselves making massive investments in research structures of the past.

Some Final Caveats

Before concluding, let me offer a few more general caveats as we move forward with the debate on a national technology policy. For example, a policy should not take on or promise too much. It should start small and demonstrate effectiveness rather than risking a boomerang effect if can't deliver.

I also worry about the consequences if we justify a national technology policy purely in terms of national competitiveness. If we try to motivate by appeals to protectionist sentiments, scapegoating, and self interest we will be making a profound mistake. Not only are these antithetical to the values and methods of science and academia but they also create backlash since they are not worthy of our best values and will not inspire us to achieve common purpose and goals.

Instead, let us set our sights higher. A national technology policy should inspire our people to share a positive vision of our future through advancing knowledge and using its products to serve mankind. Any technology policy should, like the Vannevar Bush report, take a long term strategic view and it should recognize the central role of our universities. It should strive to be responsive to bottom up demand from industry and society more broadly rather than focus on top down policy making.

Concluding Remarks

The world and the structure of academic research have changed a greatly since Vannevar Bush wrote his report. But 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 that nurturing and maintaining the human strengths of a great technological nation and sowing the seeds of innovation 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, 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 rearticulate and revitalize the remarkably successful partnership that has existed between our government, our society, and our research universities over the past four decades.

Yes, the world--and the structure of R&D--have changed a great deal since Bush wrote his report, but the major principles he advanced in it merit reaffirmation. The long-term national interest still calls for investment in human and intellectual capital that are essential, ultimately, to national power and prosperity in the modern world.