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THE WHITE HOUSE

WASHINGTON

October 6, 1992

MEMORANDUM FOR THE PRESIDENT'S COUNCIL OF ADVISORS ON
SCIENCE AND TECHNOLOGY

FROM:

D. ALLAN BROMLEY *Dulan*

SUBJECT:

Draft Report on Research Intensive Universities

Based on the discussions at the last PCAST meeting, a completely rewritten draft report for the project on the health of research intensive colleges and universities is attached for your review and comment. This draft report will be the main focus of the discussions planned for October 8-9, 1992.

* Let me emphasize that it is essential that you take the time to read this draft carefully and in its entirety, since we expect this to be close to the final version that will be presented to the President and distributed to the public. Simple statements that you don't like something in the report will not be sufficiently helpful. In order to meet our schedule, I will be asking you to propose alternate prose for any sections that are not satisfactory.

Please also note that this is a SENSITIVE, CLOSE HOLD document. I would ask that you bring your marked up copy to the meeting and that you do not distribute copies to anyone, including your staff.

Although there is no formal agenda for the meeting, Thursday morning we plan to meet with David Kearns and Walter Massey to discuss the related work of the FCCSET Ad Hoc Working Group on Research-Intensive Universities and the Federal Government. I expect we will then focus on the report recommendations on Thursday afternoon and discuss the entire contents of the report on Friday morning.

We will begin both Thursday and Friday by having coffee in my office (Room 358) at 8:30 a.m., and moving to Room Room 472 of the Old Executive Office Building at 9:00 a.m. I expect that we will adjourn at approximately 4:00 p.m. on Thursday and be finished by 12 noon on Friday. This gathering will include lunch in the Indian Treaty Room on Thursday as well as a cocktail reception and dinner in the White House Mess beginning at 5:30 p.m. Thursday evening.

If you have any questions prior to the meeting, feel free to contact my office. I look forward to seeing you on October 8 and 9.

Attachment

** Having just read this draft myself, I have some questions about tone and presentation and will discuss them with you*

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DRAFT:10/6/92

PREFACE

The President's Council of Advisors on Science and Technology (PCAST) provides private sector advice to the President on matters of critical national importance involving the vitality of our country's science and technology efforts. Because the activities of many of our educational institutions at all levels impinge on the health of the nation's science and technology, PCAST's mandate extends to certain issues involving colleges and universities.

Since its establishment on January 19, 1990, PCAST has advised the President on a number of education-related subjects. In addition, in its monthly deliberations, PCAST has also frequently concerned itself with the state of U.S. colleges and universities, in particular the "research-intensive universities" (RIUs). These institutions, of which there are somewhat fewer than two hundred, are not only important educational institutions at both the undergraduate and the graduate level, but they are at the same time the performers of half the nation's basic research. As such they are critical to the generation of new knowledge as well as to the supply of succeeding generations of scientific and engineering talent and other important components of our human capital base.

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Furthermore, since approximately two-thirds of university-based research is supported by the Federal government, the relationship of the RIUs with the Federal government is of critical importance. It is the Council's fundamental belief that the RIUs and their partnership with the Federal government have been and should continue to be a very valuable feature of our nation's system of scientific and technological research and advanced education for a long time to come.

PCAST's principal concern about the RIUs has focused on two trends that are receiving considerable national attention. One, is the severe economic stress --some would say crisis-- that many of these institutions are experiencing. Whether or not the future of some institutions is at stake, all are being forced to reassess and make changes in the complex array of activities in which they are engaged: teaching, research, and other services to their communities and the nation. The second is the increased evidence of a wavering of public confidence in these institutions which has manifested itself, for example, in recent spate of books, articles and reports that are critical of colleges and universities, and in various governmental actions ranging from issues of scientific fraud to financial audits and investigations to anti-trust cases against universities.

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It is in this context that, in the Spring of 1992, PCAST was charged with reviewing [ALT: undertook a review of] the health of RIUs and their relationship to the Federal government. The U.S. "system" of higher education is the largest and most diverse in the world, and many of the difficulties confronting the RIUs are applicable as well to institutions of higher education other than the RIUs. However, because of their unique coupling of the educational process with a very high level of research activity, the RIUs present a special set of problems that are the focus of this report.

The fact that RIUs are the primary subject of this report should not imply that PCAST has little concern for colleges and universities other than RIUs. Quite on the contrary, in PCAST's view, many different types of higher education institutions make vital contributions to the nation's science and technology enterprise. For example, our leading liberal arts colleges provide a disproportionate share of students who go on to doctorates in science and engineering or who become teachers of science and mathematics at the pre-college levels. Historically black colleges and other minority institutions help ensure that the nation's scientific talent is drawn from all sectors of society. Two-year institutions, the most rapidly growing sector in higher education, are gaining in importance as the point of entry for many students

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who ultimately continue on to four-year institutions and graduate schools. More fundamentally, two-year institutions are also serving critical national needs in training the technicians who support R&D in industrial, government and university laboratories and, more genrally, the skilled labor force required by an increasingly technically demanding job market.

In its deliberations, PCAST has benefitted enormously from the information and views gathered at a series of six public meetings [footnote the dates and places]. PCAST gratefully acknowledges the support of the six institutions that hosted the meetings and is highly appreciative of the contributions made by the participants and the institutions that they represented. PCAST also greatly appreciates the many letters received and the valuable observations and suggestion contained in them.

In the course of PCAST's work on this report, important other policy-related discussions by other organizations were initiated. First of all, in coordination with PCAST, the FCCSET [spell out] has been considering the relationship between the RIUs and the Federal government RIUs from an Executive Branch perspective and is expected to issue its report at approximately the same time as this one. It is expected to provide a complementary perspective focused on the same set of institutions. PCAST appreciates FCCSET's

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parallel effort and the data and information support provided by its Working Group on the RIUs. Other parallel activities in the government include the review by National Science Foundation's Special Commission on the Future of NSF; the development of the NIH Strategic Plan; and the recent report of the House Science, Space and Technology Committee's Task Force on the Health of Research and the hearings that will follow.

All of these efforts have a rather direct bearing on RIUs and their relationship to the Federal government. They are a reflection of a broad consensus that the nation's current science and technology system, forged at the end of World War II and evolving ever since, continues to need reassessment and selective adjustment to meet the challenges of the decades ahead. This time of transition has come about as a result of many factors, ranging from global political and economic changes to the consequences of the remarkable successes of science and technology which have opened opportunities at the frontiers of knowledge which now outstrip national and even global resources available to exploit them all.

PCAST hopes that this report's findings and recommendations will facilitate both the public policy process and the private sector adjustments that together can ensure the continued success of the nation's science and technology for the long term.

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DRAFT: 10/6/92

SECTION I: THE RESEARCH INTENSIVE UNIVERSITY

The Research Intensive University and the Nation's Needs

The nation's public investments in higher education and in research and development programs are primarily motivated by the national desire of assuring equal opportunity for all citizens and sustaining the health, welfare, security, economic prosperity, and cultural vitality of our nation.

As the nation pursued these objectives --particularly in the period since World War II-- the Research Intensive University (RIU) became a critical component of the country's overall effort in higher education--particularly graduate and professional education--as well as the nation's on-going commitment to strengthen and constantly revitalize its research and development capacity. As part of its mandate to provide private sector advice to the President on matters of national importance involving science and

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technology, the President's Council of Advisors on Science and Technology (PCAST) has, therefore, a particular interest in America's research intensive universities and in the long-standing relationship between RIUs and the Federal government. It is within the context of PCAST's overall concern with vitality of the nation's research and development base together with our consideration of the central role of science and technology in the decades ahead, the pivotal role of the contemporary RIU in this arena, and the growing chorus of concerns regarding the future ability of the RIU to continue to meet its numerous responsibilities to society that PCAST has undertaken this study.

University-based research and advanced education serve both to press back intellectual frontiers and to generate the knowledge base and a significant component of the human capital required for the nation's continued economic well-being, national security, public health, and cultural vitality. It is for this reason that, since World War II, the federal government --along with state government-- has provided substantial support for particular aspects of our nation-wide "system" of research intensive universities. The success of that arrangement is attested to by the accomplishments of these institutions in education and scholarship, and their many fundamental contributions to the nation's welfare. [INSERT OR REFER TO SIDEBAR ON "THREE AREAS OF

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ACCOMPLISHMENT".]

Indeed, America's preeminence in science and technology rests, in no small part, on the accomplishments of an outstanding and evolving set of approximately two hundred universities which are referred to in this report as research-intensive universities (RIUs). In addition, we now bear witness to the desire to emulate the American RIUs by many countries around the world that seek to raise their level of scientific and technological capabilities.

The Research Intensive University: Teaching, Research and Service

What sets the RIUs apart from other American institutions of higher education who also play an important role in our national life is the dual function of the RIUs as producers of new knowledge and as providers of the most advanced research training to successive generations of students. Moreover, within the RIUs, education and scholarly research do not merely take place side by side. The two functions are in fact inextricably linked in what some have called a "joint production" process. That linkage is, perhaps, what gives research intensive universities their most unique character and is at the core of many of the issues addressed in this report. In addition, RIUs and their faculties dedicate substantial efforts in

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service and outreach to their respective localities and regions. Examples of this third major function include agricultural extension services, university hospitals and consulting for industry and government at various levels. While many important contributions to education and scholarship are made by a wide variety of institutions, the RIUs --with their multidimensional roles-- are of vital importance to the nation's overall efforts in education and research.

RIUs and Their International Setting

The character of research intensive universities cannot be fully appreciated without reference to their international character and setting. First, the scholarly community has long been truly international in character. In most areas, national borders have had remarkably little influence on the flow of new ideas, and international collaboration in research and education is commonplace. Moreover, the increasing need for so-called "megaprojects" (e.g. Super-collider, ITER, Space Station, Human Genome) is likely to intensify the need for international cooperation in science and advanced research training. In addition, the increasing economic and political importance of the international flow of technology has further tied these

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institutions not only to the international world of scholarship but to international economic and, therefore, political relations. Second, scholars trained abroad have greatly enriched U.S. faculties. Third, American institutions of higher education now host more than 400,000 foreign students, more than any other country in the world. This represents nearly one third of students worldwide who are studying abroad. Nearly half are studying at the graduate level where they comprise close to half of all graduate students in certain fields of science and engineering. This "open door" policy long followed by the United States has further served to internationalize our colleges and universities in at least two major ways. First, many of the foreign students have remained in the United States to enrich the ranks of university faculties and research communities. Secondly, many of those who have returned to their countries of origin have served as vital bridges between the United States and those countries.

Yet one other factor linking RIUs to their international setting is the history of the current partnership between the federal government and research intensive universities. That partnership has its foundation in experiences forged during World War II in response to the national war effort. In subsequent decades, international conditions -- particularly our national security needs resulting from the Cold War -- were a major factor in expanding and

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consolidating our "system" of research-intensive universities and their partnership with the federal government. There were, of course, other critically important factors, such as the expansion of broad based educational programs --often at the state level-- and major national commitments in the area of biomedical science. These and other factors generated substantial federal support for university based research and educational programs, including some outside the natural and engineering such as foreign language and area studies¹.

The abrupt end of the Cold War and rising concern in the health care sector have given rise to a new, but as yet imperfectly defined, set of national security and health care needs. If highly trained personnel or breakthroughs in science and technology are required to meet these needs, however, we can expect the RIUs to have a continuing role in helping the nation fulfill those objectives.

Moreover, contemporary developments on the international scene will continue to have major implications for science policy and for

¹ There were, of course, other critically important factors such as the expansion of broad-based educational programs --often at the state level-- and major national commitments in the area of biomedical science.

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RIUs. There is not only the dramatic political changes that have occurred in recent years, but the continued emergence of an international economic system characterized both by its intense competitiveness and by the growing interdependence of national economies. These developments, together with the growing economic importance of science and technology, have made the development of new knowledge and advanced training a critically important economic input. Knowledge-based industries can be expected to grow and to provide nations that have well developed R&D capabilities with the potential for a significant competitive edge in international markets. Although the United States has had a substantial lead in basic research and advanced research training during the decades since World War II, this lead may well be challenged as we enter the twenty-first century by both the European Community and/or Japan. As we consider science policy in the United States and its implications for the activities of the RIUs, we need to focus on our future challenges and not simply our past accomplishments.

The critical nature of knowledge-based economic activity places a heavy burden of responsibility on RIUs, other research performers, and on their sources of finance. The nation's output of new knowledge, in the form of basic research, and highly educated human capital become an increasingly critical ingredient in the international competitiveness of the United States.

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Each of the major industrial countries mobilizes its national effort in R&D and advanced education in its own distinctive fashion. First, the overall magnitude or relative importance of research and development is different from country to country. Second, the overall objectives of the R&D effort differ from country to country. For example, the importance of defense-related research is much different (higher) in the United States than in Japan or Germany. Third, the relative importance of particular classes of research performers varies a great deal. In Japan, for instance, the proportion of research and development done in the private "for profit" sector is higher than in the United States. Moreover, the relationship among the various research performers may be quite distinctive country by country. For example, the extent of international involvement in joint efforts with "not-for-profit" research laboratories --perhaps university based-- not only differs by country but shifts over time. Fourth, the relative importance of basic or "discovery" research as opposed to applied research or development is yet another source of distinctiveness. Fifth, the source of finance for R&D activities and the various forces impacting the research and development agenda exhibit quite different profiles in each country. Finally, the method of developing human capital at the most advanced levels proceeds in quite different patterns in various industrial countries.

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These differences in objectives, size, institutional arrangements, priorities, finance, education and overall science policy make international comparisons exceedingly difficult and perhaps not very helpful. Despite these differences, it seems clear that most industrial nations today are highly sensitive to the importance of research and advanced education, and many are adopting programs to intensify and/or reshape their efforts. At the current time, however, no nation matches the United States in the extent of its reliance on research intensive universities both for pressing back the frontiers of knowledge through basic research and for producing the human capital base needed for developing and implementing ongoing advances in science and technology. Moreover, within the RIUs these objectives are joined together. While it is widely accepted that there are substantial benefits to the "joint production" process, if one decides to shift the level of support in either research or education alone, the adjustment process could be more difficult.

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The Research Intensive University and Its Clients

It is the Council's fundamental belief that the RIUs--change as they have and as they must over time--and their evolving partnership with the Federal government should continue to be a key feature of our nation's science and technology enterprise.

Indeed, American leadership in science and technology in the decades ahead cannot be maintained without the continuing involvement of a thriving array of research intensive universities. In turn, the health of those universities and the success of their research and educational missions on behalf of the nation depend fundamentally on the confidence and support of the American public and of their representatives at the federal, state and local levels. It is essential, therefore, that we continue to have a shared vision of the role and responsibilities of these distinctive American institutions as well as the appropriate role and obligations of their public and private supporters.

Critical to that confidence, support, and shared vision is an understanding of the complex, multifunctional nature of the RIU. Research intensive universities serve a multiplicity of "constituencies", each with its own view and expectations of what should be a university's primary functions and which functions should be most heavily subsidized. The major constituencies are,

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of course, students and their families, state and local governments, public and private research sponsors, scholars and faculty, alumni and trustees. More than ever, the expectations of these constituencies are high, diverse and not always consistent with one another.

Ultimately, it is important for everyone to understand that it is the special interrelationship of a broad array of an RIU's activities that make it what it is: an integrated entity in which many of the distinct components are mutually enriching. This is not to say that all activities of the RIU (current or proposed) are essential or even necessary to the institution's most important tasks. We presume that it will continue to be appropriate for each RIU to make thoughtful choices regarding its portfolio of activities. Our point rather is to highlight the important synergy that characterizes its two primary activities of education and scholarship and to note that it is the overall multifunctional character of an RIU, not simply its individual elements, that has made the RIU of such unique and critical value to the nation.

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The Future of the RIU

The Council is confident that, as the twenty-first century draws closer, America's system of research intensive universities can continue to serve uniquely well certain national research and educational needs.² However, the Council is also convinced that our RIUs are currently under serious stress--some would say in crisis--and that their relationship with the Federal government, which is essential to carrying out their dual research and educational functions, is far from being as positive and constructive as it should be. While a certain amount of tension between patron and performer is healthy and while appropriate public accountability is essential for both parties, a common level of trust and shared belief is also a critical ingredient in generating the best possible set of outcomes for the nation.

In 1986, PCAST's institutional predecessor, the White House Science Council issued a report entitled "A Renewed Partnership", which focused on the federal government-university relationship. Its

²This may not be true, of course, for every RIU. The system of RIUs is a constantly shifting set of institutions and we presume that such changes will continue. In the post-World War II decades, for example, there has been a dramatic expansion of the number of RIUs. Other changes--in both directions--could continue.

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most fundamental conclusion was that, without substantially increased support, universities could not "respond to society's expectations for them or discharge their national responsibilities in research and education." In the late 1980s there was cause for optimism as resources available for university-based research rose substantially. But the 1990s seem to present a very different picture. First, dramatic political and economic world changes in recent years have served to increase the nation's reliance on universities for new talent and new knowledge. Second, the resources now required to sustain the highest quality research and education programs are increasing rapidly--both because of research and education costs and the scope of the necessary research and education portfolios. However, virtually all principal sources of support for university-based programs--federal, state, industry, foundations, endowment and tuition--are simultaneously under severe constraints and appear to many to be reaching their upper limits. The PCAST felt that it was imperative to revisit the issues identified by the White House Science Council in 1986 in the context of a more complex and challenging set of conditions.

It is the sense of the Council that the current situation is more than a transitory or cyclical phenomenon. Rather, the symptoms all about us, such as a growing number of financial crises at

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individual institutions of higher education, a seemingly widening range of adversarial interactions between the federal government and universities, and a public mood reflected in recent writings critical of our higher education system seem to suggest that some secular trends may be at hand. The Council is concerned that, in order for RIUs to continue to fulfill their vital national role effectively, those institutions and their traditional constituencies either must rededicate themselves to the vision that created the current system or develop together a redefined vision appropriate to the perceived challenges of the next decades.

In the most general terms, the "system" appears to have become squeezed between rising demands and expectations and constrained resources. In a sense, it has become the victim of its own success. The widespread university-based scientific advances of recent decades have not only produced a large number of socially valuable discoveries, but have also generated a vast number of research opportunities worthy of pursuit, and have attracted a large number of new scientists and engineers into the system. This array of resources is poised for further discoveries and the development of another generation of scholars, scientists and engineers, but at just this moment our society faces a natural and very difficult question regarding the optimal size and

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configuration of the university-based system of education and scholarship. That is, given the competing requests for public and private funds, we must find a way to decide whether the system as a whole should be changed in size or reconfigured in ways that would improve its overall effectiveness. Clearly, some of the current tensions (e.g., shortage of support for certain programs) could be partially resolved by some combination of new policies and levels of support by the federal government and new initiatives by the RIUs to improve the effectiveness of their programs. The selection of the most appropriate strategies depends critically -- of course, on an assessment of the country's particular needs in the years ahead and how the RIU's assets relate to these objectives. Regardless of which strategies are identified, PCAST believes that the nation must devote its R&D resources to the projects and facilities most likely to meet national objectives in the most effective way. PCAST deplures, therefore, the growing trend of Congressional earmarking of R&D activities and facilities that divert resources from meeting the nation's strategic needs in the most effective manner.

Whatever the ultimate answer to the difficult question of determining the most appropriate size of the nation's array of RIUs, it is clear that the current system is too large given the

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resources we are currently willing and/or able to devote to the tasks of the RIU. It is critical to the quality of the RIU's output and the social return from the public investment involved that the long term size and configuration of the system be consistent with its resource base and the nation's need for the highest quality outputs.

The Council believes that the best interest of the nation would be served by sizing and configuring our overall research and development efforts--including university-based programs--to sustain world class efforts (second to none) in all important areas of science and technology. We believe this is critical to the future vitality of our national life. For the moment, however, we must work within the constraints established by public and private policy and try to deploy available resources in manner that will ensure the world-class quality of those efforts that we do undertake. Whether this is accomplished by attracting more resources or redeploying the resources we currently have available is, of course, a key issue.

As we look to the long-term future, it is important to bear in mind the inter-relationship of our "system" of RIUs and the economy. On one hand, the optimal size and configuration of the system is

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directly dependent on the state of the U.S. economy. For example, given the expected costs of maintaining the quality of advanced education and research programs, unless the economy experiences both a sustained and unusually rapid rate of growth, none of the RIUs' revenue sources --tuition and fees, state appropriations, Federal support, corporate support of research, gifts and endowment income-- can be expected to grow fast enough to sustain the quality and scope of the RIUs' existing portfolio of commitments. On the other hand, the output of the RIUs --new knowledge and innovative science and engineering talent-- is one of the most critical factors in the growth of the economy over the long term. PCAST believes that the best national policy would be to allocate available resources to the RIUs in a manner that focuses on the quality rather than the quantity of inputs.

This report seeks to identify areas requiring particular attention and to make recommendations regarding the types of adjustments required. Many readers of this report are likely to have a role, be it within an RIU or outside, in resetting the balance of activities and resources. More likely than not, most will be dealing with discrete issues. PCAST urges them, as they deal with segmented issues, to bear in mind the health of the "system" as a whole and its critical importance to the nation.

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ACCOMPLISHMENTS FROM UNIVERSITY BASED-RESEARCH

INTRODUCTION

Over the course of the last half-century, university-based research funded primarily by the federal government has propelled this nation to the forefront of almost every domain of science and engineering. Unique in both scope and intensity, this special relationship between government and academe has--with ups and downs in enthusiasm--endured because it has served the interests of both parties and the nation. Year after year, as judged by the Congress and the President, the products of the partnership justify continued support well in excess of that provided by any other country. In America we have chosen to place a higher proportion of our basic research efforts at universities--particularly research intensive universities (RIUs)--than do other nations.

The dividends from this long running public investment in the RIUs are both varied and plentiful. Many discoveries and developments are tangible contributions toward major societal goals and thus reinforce the utilitarian expectations that invariably accompany the use of tax revenues. Other discoveries furnish new stimuli to

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the life of the mind and thereby prefigure the even more substantial practical payoffs that the future may bring.

The benefits to date span an extraordinary range: e.g., from strengthening national security to enhancing the food supply to improving health care; from elucidating the fundamental nature of matter and the origin of the universe to synthesizing novel materials to characterizing the environments of the nearby planets; from training new generations of students at the most advanced level to stimulating local industrial development to augmenting the competitiveness of US industries in the global economy. By almost any measure, embedding publicly financed basic research firmly within the milieu of RIUs has proved efficacious for the United States.

Three examples illustrate the extraordinary productivity of university-based research:

1. Computers and Communications

Computers and telecommunications rapidly are becoming ubiquitous in every facet of modern life as digital technology inexorably transforms our world of sovereign nations, independent organizations, and individual citizens into a global information society. University-based research in such basic areas of physics

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and information theory has fueled the advance of virtually every aspect of the relevant sciences and technologies over the last several decades--contributing invaluable new ideas, techniques, and highly trained personnel in such areas as semiconductor materials, automated manufacturing of miniaturized integrated circuits, machine architectures for parallel processing, operating software and programming systems and communications techniques. A great American industry has been founded on these accomplishments.

2. Biotechnology

Cellular and molecular biology have matured at an extraordinary pace since the 1960s, transforming in their wake an ever increasing number of disciplines in other parts of the life sciences as well as opening new vistas for American industry. University-based research has been--and continues to be--the principal impetus for this biological revolution, beginning with the most fundamental development in biology. Biotechnology now is one of the most rapidly growing industries around the world--its methods finding extensive use in such commercially significant areas as medical diagnosis and therapy, drug and vaccine manufacturing, production of food and fiber, environmental clean up, materials production and mining.

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3. Agriculture

University research, primarily in the land grant universities, has revolutionized agriculture through such seminal developments as new crop varieties; chemical fertilizers and herbicides; chemical and biological methods for pest control; crop and land management techniques; and mechanization. Moreover, the generation of this knowledge has proceeded--and continues to proceed--in lockstep with sustained close interactions between academic scientists and farmers. As a consequence, US farms yield the best and most abundant supply of food and fiber in the world, having tripled their production since 1940 while increasing the amount of cultivated land by only 3 percent. And the advent of plant biotechnology augurs for an even more productive future as transgenic plants become increasingly important sources of not only traditional agricultural products but also heretofore nonagricultural items such as fuel, industrial chemicals, and plastics.

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SECTION II

EMERGENCE OF THE MODERN RESEARCH-INTENSIVE UNIVERSITY:

TRENDS IN EDUCATION, RESEARCH, AND SERVICE

INTRODUCTION

By the end of the nineteenth century, traditions from such diverse sources as the Colonial college, the German university (emphasis on research and graduate training), the British University (emphasis on undergraduate education in a residential setting), and the American Land Grant university and engineering-oriented polytechnical school began to come together to form the modern profile of the American research university. The nature of the system continued to evolve slowly throughout the first four decades of the twentieth century and, by the eve of World War II, the research-intensive universities (RIUs) were established in an important and distinctive niche -- the simultaneous pursuit of teaching, scholarship, and service. Although other types of educational and research institutions make critical contributions to the nation's overall efforts in education and scholarship -- and to the RIUs --, only the RIUs unite their education, research, and service programs within a vision that takes full advantage of the

SECTION II: RIU TRENDS

synergy that can be achieved when the three endeavors are linked.

Over the decades since World War II, the RIUs have deepened and shaped and reshaped this distinguishing characteristic in response to the ever-changing constellation of opportunities, challenges, demands, and expectations. The adaptability of these institutions has been one of their greatest strengths.

Although the decades since World War II were characterized by rapid growth and reconfiguration of the RIU's programs, these changes did not occur uniformly over time. The result -- for the nation and the RIUs -- was a set of extraordinary new educational and research capabilities, a new generation of scientists and engineers, and discoveries that yielded many economic and social dividends. At the same time, however, the RIUs came to face new kinds and levels of vulnerability.

The tripartite mission of teaching, scholarship, and service not only makes the RIUs uniquely important; it also lies at the root of much of their vulnerability. The successful pursuit of their multiple functions requires a heterogeneous array of clients and supporters. Historically the primary support of educational programs has come from students and their families (tuition), state governments (subsidizing the activities of public universities),

and income from private and/or public endowment funds. The support for scholarship, however, depends critically on the federal government which has, of course, a somewhat different set of objectives. Funding sources therefore are numerous; they appropriately pursue somewhat different agendas; they rarely coordinate their actions with respect to any given institution; and individually their financial support for the RIUs is subject to unexpected fluctuations. Moreover, each of the RIUs principal patrons seeks the greatest possible leverage from its own financial commitments. Thus, the federal government seeks greater cost sharing in the support of scholarship and greater influence on the RIUs scholarly and educational agenda. Other patrons, including students and their families, seek to have other sources of funds further subsidize the outputs they prefer. The distinctive portfolio of the RIUs carries, therefore, a number of challenges. The balance of efforts between the mutually interdependent programs for teaching and research requires constant adjustment to changing circumstances and evolving objectives. As noted above, however, this task is complicated by the fact that financial support for the RIUs is received from different patrons with different objectives. While the mutual interdependence of the RIU's programs in education and research carries many advantages, it also carries some special vulnerabilities. In particular, rapid changes (in either direction) in the financial support of a particular patron with

particular objectives will make appropriate adjustments in a joint product quite difficult. For example, any substantial change in federal support for research programs may require an adjustment in both research and education programs. This "tie" is seldom recognized by the various patrons of the RIU.

At best, even though each client of an RIU naturally focuses on the activity of most interest to it, all clients recognize the synergy that derives from the simultaneous pursuit of the multiple functions, seek the benefits created by that synergy, and contribute knowingly and willingly to the web of cross-subsidizations on which the multifaceted efforts rest. At worst, an RIU's clients either do not fully appreciate or do not see special value in the scope and character of its mutually reinforcing activities. These clients therefore may work aggressively to leverage their funding at the expense of other sponsors -- a practice that can produce serious strains and instabilities and eventually place the entire institution in jeopardy.

The viewpoints that guide individual clients and supporters in their transactions with the RIUs are so diverse as to defy ready summary. Even within a given constituency, uniformity of attitude is more the exception than the rule. The following paragraphs

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therefore are far from exhaustive. Instead, they are but a broad-brush characterization of the principal perspectives with which the RIUs must continue to relate effectively if they are to thrive.

The Federal Government

Both the Executive Branch and the Congress recognize the significance of the RIUs within the US educational system and, through a variety of programs operated by the Department of Education and other agencies, regularly seek to aid those who working toward baccalaureate and advanced degrees. It is widely recognized that the quality of tomorrow's workforce is being determined to a great extent in our schools today and that the US system of higher education is an asset not to be squandered or allowed to deteriorate. Strong differences emerge quickly, however, over proposals to ensure its vitality.

With respect to research, the dominant theme within the Executive Branch frequently is utilitarian -- i.e., the expectation that support of university-based research will yield practical solutions to contemporary problems. Those who hold the extreme form of this viewpoint most commonly are found in the missions agencies. These officials value science and technology only insofar as these endeavors fulfill short-term program goals; and they value the RIUs

only insofar as these institutions generate practically applicable knowledge faster and more economically than do other research-oriented institutions such as government laboratories, not-for-profit research institutes, and industrial laboratories.

Other, broader-based views exist, of course, in the mission agencies and elsewhere; and, more often than not, they have considerable influence in shaping policies toward science and universities overall. As the National Science Foundation and other research-oriented agencies formulate their program priorities and strategic plans, they generally are mindful that investigator-initiated basic research is the key to long-term success and that university-based scientists and their institutions need not only strong, sustained support but also considerable discretion in the management of awarded funds if that promise is to be realized. In short, they understand that excessive utilitarianism eventually works to undermine utility and rob the future of the scientific raw material (basic research results) it needs to meet social and economic goals. Nevertheless, the Executive Branch lacks a standing mechanism to monitor the course and well-being of the US system of RIUs in all its myriad functions.

Attitudes within the Congress toward universities usually track strongly with those found within the Executive Branch.

Congressional decision-making is highly decentralized, with many different committees controlling authorizations or appropriations for particular agency programs. The inevitable result is asynchronous, fine-grained, program-specific oversight. Any given committee is more likely to ask whether the programs within its purview are getting the most for their money than to ask whether the federal government is investing sufficient resources in the RIU system to enable these institutions to meet their civic responsibilities to both current and future generations.

Issues of the latter genre receive attention from time to time from certain oversight committees. The outcomes invariably are salutary. But each study or hearing is more likely to be selective than comprehensive in its coverage; and the successive episodes of attention therefore exhibit little substantive continuity. Like the Executive Branch, the Congress has no standing mechanism to monitor the health of the US university system.

State Governments

State governments traditionally have viewed the public RIUs as the pinnacles of their state higher educational systems. State appropriations have been instrumental in propelling many public and

private universities to the forefront of teaching and scholarship on the national level while simultaneously accommodating the rapidly swelling ranks of undergraduate and graduate students that has marked the post-World-War II decades. As a result they are viewed by state governments as important vehicles for providing opportunity to state residents, enriching cultural and economic life, and providing special expertise to other institutions.

In recent years, attention has once again focused on the role that state universities might play--in the information or knowledge age--in promoting regional economic development. There are, for example, increased numbers of "joint ventures" between RIUs and other organizations designed to sponsor research and technology transfer in critical areas. Moreover, many of these universities now contain such initiatives as an affiliated research park, often supported by state and local funds, wherein start-up, high technology companies can collaborate with faculty members or use the university's facilities and services.

Only time will tell whether these newer activities will prove compatible with the traditional goals of teaching and independent scholarship. PCAST believes that careful experimentation in this area may prove beneficial to the universities and the nation. But it is essential to be sure that these arrangements do not undermine

the central function of the RIUs in education and scholarship. To the extent that governors, state legislators, and the voting public in general recognize that the RIUs have both major strengths and significant limitations in this arena and that the highest priority must be given to ensuring the continuing vitality of the RIUs primary education and scholarly programs, these universities--already uniquely important--have the potential to become significant assets in this new arena.

Students and parents

As one might expect, students and their parents collectively hold a broad spectrum of opinions regarding the RIUs. In many ways, this diversity of viewpoints reflects the full diversity of hopes and aspirations within a large and diverse student body. Also contributing to this heterogeneity of perspective is the considerable variability in the characteristics of the RIUs themselves.

At the undergraduate level, American higher education offers a wide variety of high quality alternatives, including but not limited to the RIUs. Whether undergraduate students find the RIUs attractive insofar as their personal educational goals are concerned is a

matter of individual preference, geography, and financial considerations. Some undergraduates are drawn to one or another RIU by its reputation, the credentials of its faculty, or the richness of its programs and facilities. Others may find those same features intimidating and incompatible with the high degree of personal attention and small group experiences they seek from their undergraduate education. In any case, the RIU is widely perceived as one of a number of key partners that provide the basic strength of undergraduate education in the US.

Overall, students and parents typically hold the RIUs in high regard, for they recognize the nature of the special opportunities they offer for students and that the faculty of these universities define the leading edge of advanced study in essentially every domain of learning. Moreover, surveys of alumni reveal that students of RIUs report a great level of satisfaction regarding their undergraduate experience. Those students who wish to pursue a graduate or advanced professional degree come to realize quickly that the RIUs offer the best array of options for meeting their needs. Most students and parents are at least generally aware that the contributions of the RIUs in both education and scholarship enrich not only the university of their origin but also higher education in general.

Industry

Industry too places high value on the educational contributions of US universities. Industrial leaders look to them more than anything else for the stream of well-trained individuals from which to recruit the talent they need to meet their commercial goals.

With respect to research, technologically oriented commercial organizations unequivocally endorse the role of the federal government as a sponsor of basic research. Industry relies heavily upon both the new knowledge and newly trained scientists and engineers that emerge steadily under this arrangement. These go far beyond anything industry could do alone.

Executives of large and small companies, respectively, differ somewhat as to how far beyond the domain of basic science the government funding should go. Some within large companies, e.g., those in the pharmaceutical industry, typically assert that support of basic science is a sufficient role for government because industry is far more effective in conducting targeted research and in making the transition to applications. They point out, for example, that these companies have sufficient wherewithal in terms of corporate research programs and direct ties to universities to effect whatever technology transfer serves their business goals.

On the other hand, spokespersons for small, high-technology companies note regularly that certain generic technologies need to be taken systematically beyond the basic science stage and that only government-sponsored university-based programs can do this in such a way as to benefit all sectors of science and industry. Most small companies simply cannot muster the capital or human resources to make more than a few carefully defined forays into these areas. A national effort involving RIUs, small companies, and large firms receives endorsement in many quarters. This includes direct funding of commercial organizations, such as through the Small Business Innovation Research Program, as well as other funding arrangements that encourage partnerships between universities and industry.

Certain areas of technology such as materials and manufacturing are foci of special interest. Some observers question the adequacy of the traditional approach to technology transfer - i.e., from basic science, typically in a university setting, to commercial development within industrial laboratories. For these and other domains of emerging importance to international industrial competitiveness, the scholarly agenda of university-based programs may not be adequately sensitive to the market signals and other information that guide commercial strategies. In these instances, industry must find some way to develop much more effective links

than now exist between projected end-users of technology and basic scientists. To the extent that some of these basic scientists are in RIUs and the government elects to facilitate the requisite collaborations, this will add yet another dimension to their ever-evolving relationship.

EDUCATION

The Surging Enrollment in Higher Education

Undergraduate enrollment. The decline in college and university enrollments that inevitably accompanied World War II quickly reversed during the post-War years as former members of the military, many aided by the GI Bill, entered or reentered higher education. However, by the mid-1950s, when most of the cohort of returning veterans had passed through the system, the level of enrollment once again became primarily a function of the number of traditional "college age" persons in the population -- i.e., the 18-21 year-olds.

This pattern held until the mid-1960s, after which time enrollment in undergraduate programs began growing much more rapidly than the traditional "college age" population and then continued growing despite the decline in that age group as the "baby boom" cohorts successively achieved adulthood. Since the mid-1960s, the number of

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students enrolled in US institutions of higher education has grown by a factor of 4 -- i.e., from about 3.5 million in 196_ to about 14 million (?) in 199_. This was the result of increasing participation of many different age groups, especially students over 25 years of age.

A substantial contributor to the overall upward trend in undergraduate enrollment was the increasing participation of women throughout the 18-44 age band but primarily in the group under 25 years of age. Women now make up slightly more than half of the undergraduate population.

Members of underrepresented racial and ethnic minority groups also have accounted for a somewhat larger share of college enrollments in recent years. Figure __ displays the trend for the 18-24 year-olds. The direction is encouraging, but the modest magnitude indicates that much more needs to be done to enable and encourage more minority individuals to enter higher education. Both social justice and the national interest mandate that high priority be accorded efforts to increase the numbers of underrepresented minorities enrolled in colleges and universities, especially those who are intent upon pursuing careers in the sciences or engineering.

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Implications for science and engineering. The trend of undergraduate enrollments, which is characterized increasingly by older and returning students, part-time students, women, and members of underrepresented minority groups, has not aided enrollment in science and engineering. This presents both a challenge and an opportunity. If the nation is to have the requisite number and quality of scientists and engineers for the needs of the coming decades, it must solve two distinct but related problems. On the one hand, it must strengthen precollege preparation in mathematics and science and encourage those high-school graduates who are oriented toward the sciences or engineering to embark promptly on full-time pursuit of their baccalaureate degrees. On the other hand, the nation also must do more to encourage more women and underrepresented minorities to prepare for a career as a scientist or engineer as well as help older and part-time students retool in mathematics and science.

Graduate-school enrollments.¹ Enrollment in graduate schools also has increased markedly since the mid-1960s. The number of graduate students tripled between 1963 and 1976 (from 0.5 to 1.5 million)

¹ This section focuses on graduate education at the masters and doctoral levels exclusive of professional degrees such as the Doctor of Medicine, Bachelor of Law, and Masters of Business Administration. RIUs of course play a prominent role in professional education. RIU-associated medical colleges have the additional significance of training most of the clinical scientists who are critical to the national effort in biomedical research.

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and has exhibited only modest fluctuations around the latter level since. Despite the plateauing of graduate enrollment overall, the number in science and engineering disciplines has continued to grow (Figure __). All of the net growth was accounted for by the increased enrollment in the natural sciences and engineering. Much of this was facilitated, of course, by the availability of funds for research and advanced training in these fields.

An increasing proportion are women: 32 percent in 1990 -- up from 16 percent in 1975. Although women consistently have comprised a greater percentage of enrollees in the social and behavioral sciences than in the natural sciences and engineering, in 1990 the absolute number in the natural sciences and engineering disciplines exceeded that of the social and behavioral sciences by a factor of 1.5.

The encouraging growth in the numbers and proportion of women in graduate education, especially in the science and engineering disciplines, has not been matched by equivalent achievement in the enrollment of members of underrepresented racial and ethnic minority groups. This underscores the need for intensive, broad-gauged efforts to attract and enable more minorities to pursue advanced degrees in all fields.

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The Institutional Response to the Enrollment Surge

The US system of higher education could not possibly have met the enrollment increases without significant structural change; and that change was well underway by the mid-1960s. Although virtually all types of institutions expanded the size of their undergraduate student bodies to a considerable extent, the 2-year community colleges and the 4-year public colleges and universities were the ones that accommodated the largest share of the expanded enrollment (Figure __).

The number of faculty members in institutions of higher education increased along with the expansion in enrollment and number of schools. Most of the increment occurred in the 4-year colleges, followed by the 2-year colleges and then the doctorate-granting schools.

One of the most rapidly growing subsets of professional employees within institutions of higher education are those who are engaged in research, including both faculty and nonfaculty positions. This is a manifestation of the additive influence of the simultaneous growth in research and teaching. At the same time, however, many research-oriented senior faculty were allowed to reduce their teaching commitments as the demands of their investigative

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activities grew, leading to the current wide-spread discontent among students and their parents as well as state legislators and others who play close attention to the state of US higher education.

Funding for higher education.

tuition

gifts

government-backed student loans

fellowships and scholarships

tuition remission for graduate research assistants

RESEARCH

The Government/University Partnership in Basic Research

The partnership in context. The extraordinary contributions that government-funded university-based scientists made to the Allied cause during World War II was instrumental in convincing federal policy makers to continue and expand this joint research effort in the post-war era. The Office of Naval Research and the US Public Health Service set the tone for the emerging partnership between government and academe -- making basic science, investigator-

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initiated proposals, and peer review the essential strategic ingredients for the effort to harness science and technology in the service of a broad set of national interests.

Total US spending for research and development (R&D) has grown significantly in the post-World-War-II era. By 1991, expenditures by all US sources, public and private, had surpassed \$151 billion - an amount greater than the R&D spending of Japan, Germany, France, and the United Kingdom combined. Although the US lead is less when the comparison is based on nondefense R&D only, the US still by far is the world's principal investor in the generation of new knowledge.²

Industry and the federal government consistently have accounted for the lion's share of US R&D funding: 51 and 44 percent, respectively, in 1991, with the final 5 percent provided by state and local governments, institutions of higher education, foundations, and other not-for-profit organizations. If one focuses on the national efforts in research alone -- as opposed to R and D --, the federal government rather than industry is the single largest source of finance; and the other nonfederal, nonindustrial sponsors together account for about a 10-percent

² Japan and Germany rank ahead of the US in terms of the percent of gross national product devoted to non-defense R&D.

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share of the funds provided.

Among the performers of research, industry consistently has ranked first in volume of activity since World War II; but universities and colleges have come to play a critically important role, especially in basic research. The importance of the federal government in funding university-based research programs is greatest in the area of basic research. As reflected in Figure __, the federal government funds about 61 percent of basic research whereas universities perform 47 percent of the projects.

Significance of the partnership. The federal government and the universities therefore have an extraordinary mutual dependence with respect to basic research. To be sure, other performers of basic science are a critical complement to the work done in academic settings; and universities make invaluable contributions to applied research as well as to development projects. Nevertheless, in addition to excellence in education -- graduate and undergraduate --, seminal basic science is what the US has come to rely on most from its universities.

Federal funding for basic research in the universities in and of itself does not - and cannot - guarantee the success of subsequent attempts to use its discoveries. The challenges to successful

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application of new knowledge and its continuous refinement are often even more formidable than fundamental discovery itself. Moreover, the critical efforts to adopt and usefully implement the new knowledge base being developed in the area of basic research usually call for equally highly talented expertise and specialized resources as do fundamental scientific inquiries.

But an inescapable reality remains: new developments in basic research are a critical enabling component -- one that creates opportunities for generating productive new applications. Further, given the organization of university-based basic research activities, appropriate personnel are being trained as part of the overall effort -- not only personnel who can help the industrial and governmental sectors make informed decisions as to which of the new discoveries have a reasonable chance of paying off and with what intensity they realistically might be pursued but also personnel who form an essential human capital base for the implementation of new technologies. Reaffirmation of the government/university covenant to foster basic research and advanced research training is a necessary step toward ensuring continued scientific and technological progress for the US.

Trends in Federal Funding for University Research

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Distribution of funds. Federal support for academic R&D, primarily basic research, expanded considerably but irregularly over the last half-century. Three periods of rapid growth (1956-68, 1974-81, and 1983-91) in the level of support were separated by intervening periods characterized by plateaus and even modest declines. By 1991, federal spending for academic R&D had passed the \$10-billion-per-year level, with more than \$9 billion of this supporting research projects at the 170 RIUs. This "90-percent share", however, is the result of a slow decline since the early 1960s, when these institutions received well over 95 percent.

The importance of basic research within the overall federal support for university-based research has varied considerably over time. From 57 percent in 1969, the basic-research share declined unevenly until 1978 and then resumed growth, reaching 62 percent in 1991. In general, changes in the proportion of federal support for basic research were offset by changes in the applied-research share, since the share of federal support allocated to university-based development projects has exhibited little change over the last four decades. Overall, university-based activities in R&D -- financed from all internal and external sources -- are divided as follows: basic research, just under 65 percent; applied research, about 25 percent; and development projects, the final 10 percent.

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More than 20 different agencies of the federal government provide support for academic R&D; and their individually unique program goals dictate their respective funding levels and associated spending priorities. The funding histories of the various federal agencies have had a decisive influence on trends in federal funding for various fields of science. Thus, the trends in the agencies' relative shares of academic R&D dollars during the years since World War II are strikingly different. Figure __ focuses on the last two decades.

The shifting budgets of the various federal "research agencies" have not, in general, had a significant destabilizing effect on university-based programs, since the major funding agencies generally have taken a broad view as to what fields of science and technology are relevant to their missions. Further, universities' internal organizational structures are sufficiently diverse and flexible to accommodate some of the differential and ever-changing program emphases of the agencies. Nevertheless, the overall size and thrust of federal support for university-based research has certainly changed the profile of the research and education programs of these institutions.

The declining federal share. As shown in Figure __, the federal

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government has - over the last two decades - remained the principal funder of university-based research. However, the federal share, which was essentially stable during the 1970s (near 67 percent), has been declining almost steadily since 1980, falling to 59 percent in 1990. The share for state and local government also shrank slowly throughout the 1980s. As a result, the share of university-based research financed from nongovernmental sources has risen from 21 to 33 percent over the last two decades.³

Offsetting the contracting proportions provided by governments, therefore, were the expanding proportions attributed to universities' own funds and industrial sponsors. The share of funding from all other sources (e.g., foundations) changed little from one year to the next, fluctuating around 7.5 percent.

Some notable differences exist between the public and private RIUs in the profile of their research support (Figure __). The private RIUs are more dependent on federal support -- 72 percent vis-a-vis 52 percent --, whereas the public RIUs are somewhat more dependent on their "own" funds⁴. Private RIUs support almost 10 percent of their research programs from their own funds (up from 6 percent in

³ For our purposes, nongovernmental support includes the discretionary funds of public universities. The source of these funds could, indirectly, be state appropriations.

⁴ See footnote 2.

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1973); while the analogous share for public RIUs is about 24 percent (up from 14 percent in 1973). Thus, in 1990, governments (federal, state, and local) funded about two-thirds of the R&D at the public RIUs and about three-quarters at the private RIUs. Finally, the private RIUs derive slightly larger percentages of their support from industry and other miscellaneous sources.

Modalities of support. Most federal support for academic R&D throughout the post-World-War-II era has been oriented to individual investigators, thereby at once reinforcing and capitalizing on the tradition of universities as communities of independent scholars. Such emphasis is evident in the overall funding actions of the six largest civilian agencies during the 1980s. As indicated in Figure __, during the 1980s awards for individual-investigator projects, expressed in 1989 constant dollars, consistently were the largest category - growing from just under \$3 billion in 1980 to \$3.7 billion in 1989.

However, funding for research teams rather than individuals grew even faster during the 1980s (from \$1.4 to \$2.2 billion), as did the funding for major facilities (from \$0.2 to \$0.4 billion). As a result, the share of funding allocated to individual investigators dropped from 56 to 51 percent, whereas the shares for research teams and major facilities grew from 27 to 31 percent and

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4 to 6 percent, respectively. Awards for research centers declined slightly -- from 14 to 13 percent (Figure __).

To many people, this shifting pattern seems consistent with the increasing complexity of modern science and technology - especially those involving multidisciplinary, collaborative efforts; but this remains a controversial issue. Universities face a substantial challenge in accommodating these interdepartmental and multidepartmental endeavors while determining the appropriate scope and depth of subject matter for the curriculum and maintaining the requisite standards for sustaining the quality of its education and research programs.

Little of the current funding for major facilities is allocated for the construction of new research buildings. Indirect-cost reimbursements (see below) are the principal source of federal support for university infrastructure. With the exception of earmarks in appropriations statutes (generally affecting about __ percent of the budget for the Department of Energy and substantially less for other agencies) and some modest initiatives through NSF and NIH, the federal government has not provided capital grants for research-facilities construction at universities since the 1960s. In 1990, federal agencies provided about \$200 million in capital funds for universities and colleges -- less than

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10 percent of such funding from all sources. The RIUs received more than 85 percent of these capital funds (Figure __).

Indirect costs. During the years since World War II, the indirect-cost payments that are part of federal awards for academic research have become increasingly important. These payments relate to important and productive expenditures that are shared by many research and teaching programs but cannot be allocated readily on a project-by-project basis. Indirect-cost reimbursements, therefore, offset essential costs of research. These payments form a critical part of universities' efforts to fund liabilities that have arisen as a result of agreement to undertake federally supported research programs.

Within recent years, the fraction of federal academic research funds allocated to indirect costs has been almost stable for NIH and NSF, the only agencies that keep award-by-award records of such expenditures. NIH payments for indirect costs have varied between 30 and 32 percent of total awards; the comparable range for NSF is 24 to 26 percent. The gap stems largely from differences in clientele; about 50 percent of NIH awards go to medical colleges, where research programs generally involve higher overhead expenditures. As with all costs of federally sponsored research, the federal government and the academic community have a stake in

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ensuring that these payments are governed by sound policies and consistent practices and that these, in turn, are rooted in accurate, up-to-date information.

SERVICE AND OUTREACH

US colleges and universities have a history of important contributions to their communities in areas beyond the traditional and primary domains of teaching and scholarship. The agricultural extension stations associated with many Land Grant universities are a critical ingredient in rural development and the enormous progress made in American agriculture. Schools of forestry pioneer in land use and conservation. University hospitals anchor regional health-care systems. Intercollegiate athletic events provide popular entertainment, reinforce regional pride, and, for some institutions, generate considerable gross revenue.

Faculty and staff advise or otherwise participate in local governments, school systems, businesses, and civic organizations. For example, institutions of higher education have been joining forces with local school districts in increasing numbers on such tasks as upgrading teachers' knowledge and skills, providing summer and after-school learning opportunities for junior-high- and high-school students, sharing equipment and other instructional

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materials, and strengthening curricula. Moreover, members of the general public often have access to special learning opportunities through the schools' libraries, lecture series, concerts, special courses, and other cultural activities.

And a vibrant institution of higher education helps attract new business and industry to the community and in some cases "spins off" new economic activities of various types.

In the wake of the extraordinary advances world-wide in communications and transportation -- and the attendant globalization of commerce --, the service and outreach activities of institutions of higher education, especially the RIUs, continue to grow in both scope and intensity. Most often, these activities are carried out by faculty members acting on their own rather than on behalf of the school per se. But universities occasionally become engaged as corporate entities in their own right in addressing some need in the community or in capitalizing on some business opportunity.

Faculty Consultantships for External Organizations

As enrollments and research programs swelled during the last half-century, faculty in certain disciplines began to serve as an important source of expertise to external organizations. Business,

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governments, and other organizations began to tap this expertise to help them address their particular challenges. In some disciplines, such faculty consulting has become an important source of technology transfer as well as an important source of supplementary faculty income. For example, commercial organizations -- especially those in the investment banking, chemical, pharmaceutical, and computer industries -- rely heavily on the critiques and recommendations of academicians from many different domains of scholarship. Within many universities and most disciplines, the concept "one day per week for consulting" has come to figure prominently in the mores of academic life and the terms of university employment.

At best, interactions with industry and other external organizations give academicians a hands-on role in transferring the fruits of their scholarship to the economic and social marketplace. Moreover, direct exposure to the realities of the marketplace and the limitations of industrial technology often kindles new leads for university-based scholarly agendas and teaching programs.

At their worst, consultantships can cause faculty members to reduce their interactions with both colleagues and students and result in diminished contribution to the core life of the university. It is PCAST's view that, while such external relationships must be

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monitored by individual institutions to avoid conflicts of interest, the benefit of this two-way flow of information and expertise is highly advantageous to the nation.

The Biotechnology Revolution

The flowering of the biotechnology industry is creating so many opportunities for formal faculty/industry and university/industry ties that the changes are qualitative as well as quantitative. Since the mid-1970s, an ever-increasing fraction of university-based scientists in molecular and cell biology and related disciplines have entered commercial affiliations as collaborators, board members, officers, or founders -- and, sometimes, all of these roles at once! Today, many leading academic scientists with expertise relevant to the biotechnology industry maintain at least one industrial affiliation.

Paralleling the new industry-related opportunities for faculty members are new types of university/industry ties at the corporate level. Most of these are cooperative research agreements. Much less common are those instances where universities launch commercial ventures stemming from the research of a faculty member or invest in companies with which they already are related.

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The preliminary returns from these new and more experimental additions to the classical university/industry relationship are encouraging. In an increasing number of areas, the fruits of university research are being harvested for commercial development as rapidly as ideas, capital, and regulatory controls allow. At the same time, the new linkages increase the likelihood that emerging business opportunities will give basic scientists -- in both the companies and the collaborating universities -- stronger incentives, clearer leads, and broader perspectives for probing fundamental life processes.

In recent years, state governments have recognized that successful university/industry relationships -- not only in biotechnology but also with respect to information technology, materials, and other commercially relevant areas -- have the potential to stimulate growth in their regional economy. Toward that end, many universities -- particularly state universities --, either on their own initiative or at the behest of the governor or legislature, have set out to intensify their efforts in technology transfer and commercialization of research results. Often this involves the establishment of a "research park" near the campus to enable small companies to take advantage of faculty members' expertise, university facilities, and subsidized space.

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In addition, encouraged by the patent-law amendments at the beginning of the 1980s that assigned to not-for-profit institutions and small businesses the first rights to inventions produced by their staff under research awards from the federal government, many universities began to extend their efforts with respect to the management of intellectual property -- a process that continues to evolve rapidly. Included are such activities as assisting faculty members with patent applications, licensing commercially promising inventions to speed technology transfer and generate new revenue streams for both the university and the inventors, and countering infringements on university-owned patents.

These changes have, however, also created a new set of tensions and challenges for higher education. Consider the following questions: Do the newly expanded and intensified linkages between academe and industry create conflicts of interest that somehow undermine independent scholarship, distort educational programs, or compromise stewardship of public funds? Will even the appearance of conflicts of interest erode public confidence in university scientists and administrators? Must universities regulate their faculty members' external ties more closely than heretofore; and, if so, can such regulation be effected without abridging traditional academic freedoms? How effectively universities meet the challenges embodied in such questions will have an important

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bearing on their future role in these and related matters.

CONCLUSION

America's RIUs have been molded by events of the last half-century into uniquely important yet uniquely fragile institutions. Never before has the nation been more dependent upon their contributions to teaching and scholarship as well as their services to both community and industry. Never before have the universities enjoyed more opportunities to exploit their individually special capabilities. Never before have these institutions faced more uncertainty as to the overall level of resources they will command for the foreseeable future or the staying power of any particular sponsor. And, thus, never before have universities been forced to plan more carefully and make those choices with respect to mission and priorities that will determine their institutional characteristics for many years to come.

Each university must confront the contemporary challenge on its own, seeking that configuration of activities, affiliations, and priorities that offers the best prospects for fulfilling its mission. The federal government, for its part, must work continually to nurture US colleges and universities as they make and progressively readjust their choices. In particular, it must

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encourage systematically those ties with governments, communities, industry, and other organizations -- but only those ties -- that advance higher education while meeting national needs.

SENSITIVE CLOSE HOLD

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SECTION III :

FINDINGS AND RECOMMENDATIONS

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DRAFT**Findings****SENSITIVE CLOSE HOLD**

America's RIUs--public and private--have served the society that supports them through a complex, interdependent, and evolving set of privileges and obligations. These institutions have, in response to a new set of demands, changed mightily in the last fifty years. Their portfolio of responsibilities has evolved to include critical aspects of both the educational and research functions of society's current economic, political and cultural life. As a result, America's RIUs continue to make a large number of critical contributions to our national life. Indeed they--along with other institutions of higher education--have become central institutions in our society, producing much of the human capital and new knowledge on which modern life depends. There remains, however, considerable diversity within the system as each university has selected and developed its own distinctive way to meet the obligations in education and scholarship.

At the current time, however, the RIUs are facing several complex and interrelated challenges whose symptoms seem to have appeared rather suddenly. First, a large number of RIUs face a growing gap between their expected revenues and the costs of sustaining their current portfolio of commitments, and considerable controversy about whether this gap results from inadequate support for the RIUs or inadequate management by the RIUs themselves. Second, there appears to be a growing crisis of confidence and self-confidence regarding the capacity of these institutions to continue to serve the most critical needs of our society. On the

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one hand, there is a general anxiety about the capacity of advanced education and science to achieve adequate social benefits. As a result, there is an associated waning of faith in the underlying values of science and those institutions committed to the scientific enterprise. This contrasts sharply with the early post World War II era which seems--in retrospect--to be a time of heroic new beginnings, great expectations, and almost unlimited faith in knowledge and education. Ironically, the more we have invested in education and scholarship, the less we seem to value it. Perhaps this more recent anxiety stems from a broader set of issues that deal with important changes in America's place among nations, or perhaps it is the fear that the world ultimately may be harmed by the many products, processes, and ideas that have come--through the RIUs-- to define much of our contemporary life. This waning of confidence has been abetted in addition by real but so far isolated cases of scientific fraud and misuse of funds.

Second, internally there seems some uncertainty in parts of the university community regarding the continuing vitality of the university's core informing values of free inquiry, scholarly integrity, trust in rationality, or some other verifiable form of knowing, the obligation to communicate new ideas to others and belief in the essential unity of the human race. Finally, both internally and externally there is a growing perception that the educational programs of the RIUs are failing to meet their responsibilities. This concern often centers on the lack of adequate commitment to and incentives for teaching as opposed to

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scholarship, although there are also many concerns and controversies with respect to the nature of the curriculum and its role in a number of areas, from preserving our common memory to encouraging more study in science and engineering.

These and other factors have produced a rather paradoxical set of symptoms, including the following:

- a. The RIUs are encouraged both to be more business like (e.g., focus on the "bottom line" and efficiency--etc.) and to be less business like (e.g., do not focus on the "mere" bottom line").
- b. The RIUs are encouraged both to do more scientific research (e.g, help with economic competitiveness) and to do less scientific research (e.g., do more teaching--etc.).
- c. The RIUs are encouraged both to cut costs and to maintain or increase the quality and quantity of their services.
- d. The RIUs are encouraged both to be the guardians and the critics of our cultural inheritance.

These and other such symptoms simply underline the sense that for many the RIUs are viewed as both essential to the continuing health and vitality of our economy and culture and in some way as inadequate to the task ahead.

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In more specific terms, PCAST finds the following:

The RIUs of the early 1990s are facing several complex and interrelated issues that have appeared with relative suddenness. Responses to these issues by the various RIUs themselves and by Federal and State governments have already begun to alter the conditions in which university research and education are undertaken. How (and whether) these issues are resolved in the next few years will profoundly affect the capacity of the Nation's RIUs to generate and apply scientific knowledge and to educate our scientific and technical workforce for the first decades of the twenty-first century.

For purposes of policy development, we have placed the issues into four general categories: erosion of public confidence; sudden financial stress; growing burden of time demands on researchers and on administrators; and lack of clear agreement on the terms for Federal reimbursement of the real but indirect costs of research.

A. Erosion of Public Confidence.

Society has invested academic researchers and university administrators with a considerable degree of public trust, and expects in return trustworthy behavior and sound judgements. Now, like many other institutions in contemporary America, science as an enterprise, and the university system itself, have both come under sharper public scrutiny and criticism -- which is likely to continue, and perhaps to grow, as long as public expectations for science and for universities remain high.

Two quite different types of activities have become increasingly subject to public criticism. The first type involves certain specific behaviors that most

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persons (scientists and administrators especially) agree are pernicious, such as scientific fraud or dishonesty in spending. While such cases have tended to become sensationalized in the media, the PCAST believes that they involve an extremely small fraction of researchers and administrators. The Federal government has, however, generally reacted by proliferating and tightening regulations and spending controls.

The second type of criticism involves disagreements about value judgements made by researchers and administrators about the fundamental allocation of their efforts and resources. This category includes topics such as whether universities are shortchanging teaching in favor of research; whether university researchers should develop more linkages with industry at the possible cost of more industry control of the research agenda; and whether universities are overstaffed compared to their missions and resources.

B. Sudden Financial Stress.

As discussed in Chapter II, during the 1980s Federal funding for academic research and development grew at a rapid rate. So, also, in many States, did State appropriations both for general support of their public institutions and for support of research. Many private universities raised tuition and gained income from endowments and investments. This growth in funding from several sources at once enabled a general expansion of the Nation's university research enterprise, and, at many institutions improvement of research breadth and quality.

The number of researchers and graduate students grew markedly in the 1980s in most fields; many RIUs increased the number of fields in which their faculty performed research; and the base of institutions mounting research programs broadened.

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By contrast, at the beginning of the 1990s, financial conditions for academic institutions changed markedly. Many States, faced with their own budgetary problems, began to reduce university funding. Private institutions slowed their rate of tuition increases, while general economic conditions reduced the rate of return by universities on their investments. And the Congress, for Fiscal Year 1993, provided very small increases in appropriations for academic research budgets of the National Institutes of Health and the National Science Foundation. Thus the resources furnished by several sources have abruptly levelled off.

Given the Nation's growing realization of the need to reduce the Federal deficit, the outlook for continuing cutbacks in many State budgets, the limited degree of flexibility for tuition increases and the general decline in return on invested funds, RIUs would be prudent to plan on the basis of severely constrained resources for the near term.

These financial developments will make it all the more difficult for the Nation to continue as the world's leader in research, to continue providing the highest level of graduate education, and to continue offering full and equal opportunity in these areas to all of our citizens. Nevertheless, the US should not pull back from these goals. Keeping the research and education enterprise at the forefront will still require considerable investments in scientific infrastructure and instrumentation, while adhering to the principles of open competitive review and of assistance, where necessary, to "level the playing field" for all individuals and institutions.

C. Demands on Time of Researchers and Administrators.

The principal purpose of Federal support for academic research is to help provide at least a portion of the means for researchers to carry out productive work. The most critical need for researchers is unfettered time for conceptualizing, planning carrying out and circulating the results of their work.

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Four factors are increasing the stresses on time available to academic researchers and their institutions: the growing complexity of modern research problems; the increasing intensity of competition for research support; the sharpening of requirements for accountability for funds and for results; and efforts to find a more satisfactory balance among activities devoted to research, to education, and to service/outreach.

The outstanding productivity of the research enterprise has led, among other things, to ever more powerful equipment that permits closer examination and measurement as well as to increased capability of investigators to formulate and attack more complex research problems. While these trends have been true to some degree throughout the history of science, they have accelerated in recent years to the point where work on many problems now requires teams of researchers drawn from several disciplines and institutions. Taking productive approaches to modern research problems in all fields, and meeting public expectations for research in new areas (e.g., in the environmental and health sciences), requires more complex management strategies, with attendant needs for time for planning, priority-setting and general administration.

Funding pressures at the level of individual Federal programs are also pressuring investigators and teams. Although overall Federal funds for academic research grew during the 1980s, the raw ratio of awards to research proposals drifted steadily downward at the National Institutes of Health and the National Science Foundation, to about 30%, as the number of awards did not keep pace with the increased number of proposals. Many researchers, especially those in the early stages of their careers, report spending considerable amounts of time preparing and submitting proposals -- while they are attempting to establish independent laboratory operations and to develop themselves as teachers.

At the same time, increased requirements for accountability are being laid on by the Federal government. Prudent spending of Federal monies requires that

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researchers, their institutions and and support agencies be fully responsible for how the funds are used. This responsibility leads to requirements for various sorts of information from the researcher, notably detailed proposals, project reports and financial information about ongoing and completed work.

Except in the minority of cases where agencies contract for directed research efforts to meet their specific needs, the principles behind Federal support of academic research are those of financial assistance for specific proposed projects, and long-term investment in the general capacity of the university system to serve as the venue for research, teaching and service. In contrast to other situations where the government procures goods and services, the principles of assistance and long-term investment imply a light Federal hand, trusting researchers and institutions to carry out their activities in a responsible and productive manner. The issue is not whether accountability requirements are worthwhile in principle, but how much time they take away from productive research, teaching and service. The PCAST is concerned that the trend in requirements may go too far, to the point of diminishing returns both for research productivity and for accountability. In trying to regulate research activities, the Federal government must be careful not to sap the very vitality that has made the US system the envy of the world.

D. Lack of Agreement on Terms for Reimbursement of Indirect Costs.

During the PCAST public meetings and in correspondence, university administrators have made clear their viewpoint that the most nettlesome issue in the government-university partnership is the longstanding lack of ability to come to agreement on, and consistently administer, clear rules for Federal payment of indirect costs of research.

// Insert language describing the indirect costs issue, from the work of the OSTP - OMB - interagency task force; this will establish the basis for series of recommendations on this issue, and perhaps one on establishment of an agency-university council to discuss A-21 and other regulatory matters//

DRAFTRECOMMENDATION **SENSITIVE CLOSE HOLD**For the RIUs

1. The RIUs should realistically evaluate their expected revenue streams and size and configure their teaching and research programs in a manner that meets their responsibility to provide the nation with the highest quality services, makes the most productive use of resources under their care, and affords their most advanced students with a reasonable prospect of pursuing careers in the area of their specialized preparation, whether in industry, academia, government or other socially important institutions. In particular, the RIUs, their faculty, and their students must come to grips with the implications of a resource constrained environment and must guard against the danger of doing too much at the cost of the quality of their output. The RIUs must recognize that their capacity to do good science and train new generations of researchers and teachers may be greater (or less) than society's willingness to support such efforts.

2. The RIUs should once again intensify their efforts to improve the participation of underrepresented minority groups and women throughout their education and research programs and at all levels of faculty and staff. Particular attention should be paid to increasing the number of women and underrepresented minorities in science and engineering.

3. The RIUs should review, in a searching and comprehensive

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manner, the nature and quality of their teaching programs, particularly in mathematics, science and engineering. New pedagogies--particularly at the undergraduate level--are almost certainly required. Attention should be directed towards such issues as the necessary degree of specialization, the rigidity of many current curricula, the reason for the sharp decline in interest in science during the undergraduate years, and the adequate performance of all those--including graduate TA's--participating in the teaching program. We further recommend that faculty develop a mentoring role with their graduate students as teachers in a manner that is analogous to their current role as mentors in the area of scholarship.

4. The RIUs should make every effort to involve undergraduate students in their research programs.

5. The RIUs should insist that all faculty have a meaningful involvement in teaching programs of the institution and that the faculty as a whole take responsibility for both the undergraduate and graduate teaching programs.

6. The RIUs' allocation of resources should better reflect the important on-going need for the infrastructure investments (e.g., equipment, library materials, computer and communications facilities--etc.) that are required for the highest quality teaching and research programs.

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7. The RIUs continue to explore potentially rewarding collaborations with other universities and colleges, with government and industrial laboratories and with other institutions with whom they share a common purpose. While it is critical to ensure that such collaborative support--rather than undermine--the primary educational and scholarly goals of the RIUs and their independence, we encourage thoughtful experimentation in this area.

8. While the RIUs can most effectively meet their civic responsibility by continuing to focus their efforts in the area of education--at all levels--and basic research, it is important that the scholarly and educational agenda be open to the critical contemporary concerns of our society.

9. The RIUs must show continuous evidence of a deep commitment to their primary tasks--education and scholarship--, to using society's resources with discrimination and care, to the capacity to make difficult decisions that may change the profile of its activities, to independent thinkings and responsiveness, and to an on-going determination to increase the participation of women and minorities. All this--and more-- will be required in order to quality for public and private support in a time when there are many other pressing and legitimate needs for society to face.

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SENSITIVE CLOSE HOLDFor the Federal Government

1. Recognize that the RIUs have a unique place in our overall R&D system, particularly in the critical areas of basic research and the generation of new human capital at the most advanced level. The Federal Government, therefore, should continue--in the nation's interest--to provide substantial support for university-based basic research and associated teaching programs. In the context of U.S. institutions and practices, this is an essential ingredient in preserving the nation's educational programs and its potential to sustain economic and cultural leadership. The current levels of support may fall short of achieving these goals.

2. The Federal Government should recognize that the most effective use of public investments in university-based research programs is achieved by:

a. giving the highest priority to basic research in the context of investigator initiated projects that receive appropriate competitive review.

b. ensuring that an adequate share of public investment in this area is allocated via a competitive review process to the infrastructure needs (e.g., equipment, communication and computational materials--etc.) of

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advanced education and research programs. Neither the RIUs nor the government should fall victim to the old illusion that worthy ends will justify inappropriate means. This is a self-defeating illusion which opens the entire partnership to a cynical interpretation of our efforts.

3. The Federal Government--in a coordinated way--should continue to provide significant support to large scale facilities and services (e.g., particle accelerators, oceanographic vessels, satellite and astronomical observations, large-scale data bases--etc.) that are essential to scholarly progress in many critical fields. Moreover, the federal government should be increasingly willing to pursue such projects in collaboration with international partners.

4. The Federal Government should pay the full cost (direct and indirect) of those university-based programs it sponsors. It is important to establish indirect cost policies that ensure that all federal expenditures are for appropriate costs and that the costs allocated to the federal government are for no more than their equitable share of the costs of operating and maintaining these research programs.

5. The Federal government should continue to search for ways to streamline the administrative requirements associated with research grants. Appropriate accountability is essential, but excessive and

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inconsistent rules --agency by agency--does not promote the public interest. Unnecessary and/or redundant administrative requirements are a dead weight cast on the whole country.

6. The Federal Government--the Executive Branch, the Congress and the various agencies--should make a greater commitment to the education programs that are associated with the research efforts it both sponsors and is dependent on. *"Portable" fellowship programs should be established or enhanced.*

7. The Federal Government, particularly the agencies administering university-based research programs, should adopt some modest incentives to encourage researchers from different institutions (universities, industrial laboratories--etc.) to work more effectively together.

8. The OSTP should establish an ongoing forum where senior representatives of agencies that support research and education programs can have continuing discussions with senior representatives from RIUS regarding potential initiatives for enhancing the productivity of the federal investment in university-based research programs.

9. That the FCCSET process of coordinating federal investments in research programs be strengthened.

10. The Federal Government provide increased resources to programs aimed at attracting more women and underrepresented minorities to

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programs in mathematics, science and engineering.

PROPOSED OUTLINE FOR EXECUTIVE SUMMARY

(10/7/92)

I. SINCE WORLD WAR II: GREAT ACCOMPLISHMENTS

- **The Vannevar Bush vision**
- **Expanded opportunities for all Americans: The higher education system**
 - size and growth of system**
 - diversity of institutions and clientele**
- **The RIUs:**
 - unique role and contributions:**
 - research accomplishments, examples
 - human capital production
 - joint production process
 - partnership with the Fed gov.
 - complementary role of other HEIs (liberal arts, two year, HBCUs and other minority institutions, etc.)
 - educational importance of undergraduate and non-RIU research

II. THE PRESENT: ALL IS NOT WELL

- **Financial stress**
 - manifestations
 - short-term causes: economic downturn
 - long-term causes: rising demands, expectations and costs

Main PCAST message: More than a transitory phenomenon; RIUs, sponsors, clients all must adapt to new circumstances

- **Crisis of Public Confidence**

- **manifestations:**

- . **perceived erosion in teaching**
 - . **impatience about research results**
 - . **scientific fraud cases**
 - . **adversarial relations with Fed gov**
 - **public accountability squeeze**
 - **supply/demand squeeze on Fed resources**

- **cause: multiple functions, multiple supporters**

Main PCAST messages: Some perceptions are somewhat overblown; some issues are "real" and require adaptation; all supporters of RIUs must understand that they are supporting multifunctional institutions and not just discrete elements.

III. PUBLIC POLICY ISSUES

[Identify issues sequentially and, after each set, provide PCAST view. The following list is meant to be illustrative, not necessarily comprehensive]

- **Should the national R&D performance system be altered by:**

- **shifting university-based research to other performers?**
 - **shifting the university research portfolio (e.g. basic/applied balance)?**

- **What should be the Fed gov role re: universities?**

- **move toward institutional support?**
 - **support a more selective range of institutions?**
 - **support more physical infrastructure?**
 - **encourage more/less advanced degree production (esp. PhDs)?**
 - **provide more incentives for increasing teaching quality?**

- **What is the appropriate size/configuration of the RIU "system"?**

- **should the Fed gov attempt to influence the system?**
 - **if so, what mechanisms might be used?**
 - **regardless of Fed role, what size/configuration would serve national interests best?**

IV. LOOKING TOWARD THE IMMEDIATE FUTURE: PCAST RECOMMENDATIONS

Statement of what overall national S&T goal should be:

Sustain world-class research in all important areas of science and technology

Primary implications for RIUs:

- **Perform significant share of new knowledge production**
[Indicate role of RIUs relative to other performing sectors]
- **Produce human capital needed to perform the research and apply results**
[Address issue of how many PhDs is enough?]

General recommendations to RIUs:

- **RIUs, even as they are faced by resource limitations and pressures to meet other (non-S&T) goals, must maintain the highest quality standards in both research and education. Second rate efforts are worse than no efforts**
- **RIUs should develop and maintain strategies for bringing/maintaining activities in line with resources without jeopardizing quality standards**
- **RIU faculty and graduate students should have extensive interaction with industry (and other sectors of society) so that their (self-directed) research choices are informed by "real world" problems.**
- **RIU students (at all levels) should be exposed to a broad range of career opportunities. Their overall education should not leave them with the currently all too common impression that careers such as industrial research or high school teaching are second-rate alternatives to RIU professoriates.**
- **RIUs should be encouraged to expand their international cooperative activities and to "internationalize" all faculty and students that have not had previous international experience or background.**
- **RIUs should attempt to reduce instructional costs by raising teaching productivity through new pedagogical approaches (both technological and non-technological)**

General recommendations to the Federal government and other supporters of RIUs

- Support of RIUs must be viewed as an investment in the nation's future by the Federal government. As a matter of policy (with appropriate incentives) agencies must move away from a narrow "procurement approach" in granting funds to RIUs.
- Better informational and consultative mechanisms linking the various supporters of RIUs could mitigate the effects of over-compartmentalized, function-by-function support and could lead to better stability of support for the RIUs. A good starting point would be among Federal agencies.

Specific recommendations for the RIU-Fed relationship:

- A modified indirect cost policy [from A-21 task force]
- A government-wide facilities/instrumentation program
- A "portable" fellowship program

V. BEYOND THE HORIZON

[A short (one paragraph) "post-script" that anticipates some very profound changes in the longer term. All those involved with RIUs should be sensitive to the following trends and their implications and should monitor their effects.

- **Demographics:** changes in ethnic composition, geographic shifts
- **New student profiles, changing concepts of higher education:** more adult students, career shifts, continuing education and retraining.
- **Communications technologies:** distance education, electronically linked research teams and communities, implications for physical facilities for education and research
- **Multinational dimensions:** multinational higher education and research institutions are likely to become more prevalent

Quotes from Science- The Endless Frontier

Science Is a Proper Concern of Government

It has been basic United States policy that Government should foster the opening of new frontiers. It opened the seas to clipper ships and furnished land for pioneers. Although these frontiers have more or less disappeared, the frontier of science still remains. It is in keeping with the American tradition --one which has made the United States great-- that the new frontiers shall be made accessible for development by all American citizens.

Moreover, since health, well-being, and security are proper concerns of Government, scientific progress is, and must be, of vital interest to Government. Without scientific progress we could not hope for improvement in our standard of living or for an increased number of jobs for our citizens; and without scientific progress we could not have maintained our liberties against tyranny.

[NSF, 1980 edition, p.11]

Freedom of Inquiry Must Be Preserved

The publicly and privately supported colleges, universities and research institutes are the centers of basic research. They are the well springs of knowledge and understanding. As long as they are vigorous and healthy and their scientists are free to pursue the truth wherever it may lead, there will be a flow of new scientific knowledge to those who can apply it to practical problems in Government, in industry, or elsewhere.

[NSF, 1980 edition, p.12]

Alan -

*Are these the quotes you
wanted us to track down?*

THURSDAY, OCTOBER 8, 1992

8:30 AM - 9:00 AM

ARRIVAL AND COFFEE
Room 358
Old Executive Office Building

9:00 AM - 11:00 AM

FCCSET DISCUSSION:
Ad Hoc Working Group on
Research-Intensive Universities
Room 472
Old Executive Office Building

11:00 AM - 12:00 PM

DRAFTING DISCUSSION:
Project on Research-Intensive Universities
Room 472
Old Executive Office Building

12:00 PM - 1:00 PM

LUNCH
Indian Treaty Room
Old Executive Office Building

1:00 PM - 4:00 PM

DRAFTING DISCUSSION:
Project on Research-Intensive Universities
Room 472
Old Executive Office Building

FRIDAY, OCTOBER 9, 1992

8:30 AM - 9:00 AM

ARRIVAL AND COFFEE
Room 358
Old Executive Office Building

9:00 AM - 12:00 PM

DRAFTING DISCUSSION:
Project on Research-Intensive Universities
Room 472
Old Executive Office Building