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NEW INITIATIVES IN EXPANDING HUMAN KNOWLEDGE: THE ROLE OF THE MAJOR RESEARCH UNIVERSITY

The major research university in the United States has a key role to play in the expansion of human knowledge and in making the benefits of such an expansion of knowledge available to society. My remarks will concentrate on four interrelated points: that American major research universities have demonstrated a remarkable capacity to advance knowledge; that their most significant contribution consists of advanced education in research; that their future ability to continue this contribution depends on a new relationship with industry; and that an internal restructuring of the research university has already begun and appears likely to become a matter of high priority.

Let us begin by reminding ourselves that discovery has been part of the university mission for less than 200 years. For centuries, the university had functioned primarily for the purpose of transmitting, extending, and propagating received knowledge. Only after the Enlightenment — and particularly after the reform of the Prussian university by Wilhelm von Humboldt — was the university set free from the bonds of religious orthodoxy and transformed into an institution of unfettered inquiry. In America, the British collegiate model of higher education was transcended by graduate study for the doctorate only a little more than a century ago. It is worth noting that the Ph.D., awarded in the United States only after the Civil War, is based on a dissertation that makes an *original* contribution to knowledge, something that would have been virtual heresy a century ago. And the full explosion of science and technology in the university — born of the redefinition of scholarship as inquiry, as search for provable truth — occurred only after World War II. Driven initially by national security needs and fueled by billions of federal dollars, major American research universities emerged as a national arsenal of basic research.

Today, about 200 American universities offer comprehensive programs for advanced graduate and profession-

al research, but only 100 of these receive 85 percent of all federal research grants. Ten among them alone receive 25 percent of all federal funding for research, and only 50 to 60 are normally regarded as major research universities. More than half of all basic research in this country is carried on at universities, and federal expenditures in 1981 for university basic research amounted to \$4.3 billion. The university research enterprise has become vast, the costs enormous, and the expansion of human knowledge astounding.

One might now proceed to enumerate the specific research concentrations within the major research universities and list at least some of the aspects of new knowledge or processes that they have spawned. For once, however, let us recognize that the university remains an educational institution, and that its character is defined by its fundamental commitment to the convictions that teaching and research cannot be separated and that *together* they represent its mission. If one were to liken the university to an industrial plant, its product is not so much research per se but graduates, and its most expensive product is the trained researcher. The university does not produce research for its own sake. Its scholars conduct research in the practice of their scholarship, which also includes the training of junior scholars. Their scholarship involves basic research, whose application is carried on largely by industry and government outside the university, but industry and government must have university-trained scholars to conduct applied research.

With such fundamentals in mind, let us look only at the Ph.D. and at a little history. Five hundred and sixty Ph.D.s were awarded by American universities in 1920, just under 4,000 in 1947-48 (3,989 to be exact), and 33,600 will be awarded in 1985-86. Over half of them are granted in the physical and natural sciences, mathematics, and engineering. Nearly half of the Ph.D.s in these areas are now entering industrial employment, while another 10 percent will work for government, and less than a quarter of them will remain in higher education.

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In recent years, there has been much talk about technology transfer: the problem of translating university-centered basic research into new industrial products and processes quickly and efficiently. The problem is real, but much discussion has tended to overlook the fact that the most vital aspect of technology transfer is the translation of university-trained talent into industrial employment. Newly minted Ph.D.s bring along the most recent research as part of their training, and they represent the indispensable new personnel for the industrial laboratories engaged in applied research and development. As the single largest employer — in fact, the majority consumer — of new Ph.D.s in science and engineering, American industry clearly has a big stake in the major research universities that produce this human commodity.

At this moment in the rapid evolution of the major research university, however, research support from the federal government is dwindling, and the appropriate response from American industry is not yet fully manifest. Federal funding for university research has run into two major and inevitable problems: unaffordable costs and the gradual attrition of the mobilization of universities for national defense, a mobilization that began in World War II and lasted through the Cold War but waned during the Vietnam War and after. As a result, the vital core of the university's competence — state-of-the-art facilities and instrumentation and the ability to attract and support graduate doctoral candidates — is eroding. According to a current study by the American Association of Universities, spending on academic research and development facilities and equipment has been relatively flat since 1968 in current dollars, and in constant dollars it has declined by 78 percent between 1966 and 1983. At the same time, federally funded graduate fellowships in physical sciences and engineering declined from 51,000 in 1968 to approximately 1,500 in 1984. In the meantime, costs keep rising. The same study finds that the typical university investigator in 1970 needed equipment costing \$8,000 and access to departmental equipment costing \$116,500. By 1979, these figures had climbed to \$43,800 for the investigator and \$741,000 for the department. The bottom line is the visible and accelerating deterioration of facilities, instrumentation, and graduate student support throughout America's major research universities. The problem is even more serious for the nation's undergraduate colleges, which produce the undergraduates qualified to embark on graduate or professional research and training programs.

It would appear obvious that American industry, confronted with worldwide competition and the challenge

of new products and new technologies spawned by new knowledge, now has greater need than ever for the trained talent produced by the major research universities. Indeed, key companies in certain fields — notably pharmaceuticals, electronics, and biotechnology — have recently begun a selective process of large new investments in university research and training. Most industrial companies, however, still view financial support to university training and research as a component of their charitable contributions. Corporate philanthropy is admirable and significant, amounting to more than \$3 billion in 1983. However, less than 40 percent of corporate philanthropy is devoted to education, with, of course, an even smaller fraction assigned to higher education; even the \$3 billion level represents less than 1.5 percent of corporate *pre-tax* income. Even a doubling of corporate philanthropy — welcome though wholly unlikely as that would be — would do little to address the serious problem of the major research universities with respect to their competence to conduct advanced teaching and research of the highest quality.

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Unavoidably, the time has come for recognition by America's industrial corporations of their dependence on the trained talent produced by higher education in general and on the advanced training and research programs in science and engineering of the major research universities in particular. Unless enough persons trained at the graduate or professional stage and at the state-of-the-art level flow to industry from universities, industrial research and development will either languish or corporations will continue to develop their own advanced personnel training programs. Such corporate programs already are a growth industry. If they replace universities as corporate industry's principal source of appropriately trained personnel, the major research universities — and their basic research activities — will wither. A better solution would be an explicit investment — not a charitable contribution — by corporate America in the core competence of major research universities. Such a development, however, would require intimate partnerships not appropriate to corporate charity that are akin to partnerships of long standing developed earlier between federal sponsors and research universities. Those federal-university partnerships evolved during the long mobilization of universities in the interest of national security. The new industrial-university partnerships could properly evolve as part of a corporate mobilization for American reindustrialization.

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In this context, however, the largest question with respect to the continuing role of the major research university in contributing new initiatives to the expansion of human knowledge centers on the fitness of the institution itself. The pressures that sheer growth and the explosion of knowledge have applied to the institution have been enormous. It must be assumed, and sooner or later it will be demonstrated, that the university unavoidably has paid a price — a price in humanism and coherence — for the unbalanced growth of science and technology and scientism that occurred so swiftly, historically speaking, in so very brief an interval. It is also clear that the need for new partnerships with for-profit industrial corporations will add further to strains and stresses that already exist.

Rapid changes in the nature and content of knowledge are openly challenging the traditional and fundamental departmental structure. The old university before the Enlightenment had few faculties (philosophy, law, and medicine), with specialization centered around a few senior professorial chairs. The scientific modern American university developed many faculties, and even more specialization centered in a diversity of departments. Departments are more democratic and more flexible than chairs: they can and do change academic direction, merge or split apart, die away, be newly born, and even acquire new identities. But it is difficult for them to transcend themselves, even when the state of knowledge appears to have transcended them.

Thus, there is an increasingly visible problem. As the search for new knowledge demands new combinations or recombinations of academic competence from diverse departments, the university is being inundated with centers, institutes, or programs that are not small subefforts within departments but are larger superstructures that cut across departments. On the one hand, these new ventures tend to suffer because they cannot usually make primary appointments; that remains a definitive prerogative of a department. On the other hand, they tend to erode departments, most of whose members spend more and more of their time in the new cross-departmental superstructures. As enhanced knowledge strives for new restored intellectual coherence, the fault lines between departmentalized disciplines and interdisciplinary nondepartments shift and groan with portents of an organizational earthquake.

The difficulty is compounded by the individualization of research, which is a hallmark of federal research sponsorship. In plain truth, universities as such do not conduct research; rather, they harbor it. And the “it” they harbor is a great multiplicity of individual investigators, often paddling their own canoes or loosely moored in

their departments, but more or less compelled to be on their own. How so? On the advice of the scientific community, federal agencies, such as the National Institutes of Health and the National Science Foundation, who sponsor research, adopted a system of individual competition for support awarded by a process of peer review, a system splendidly open to all and fairly based on merit. Once the researcher has a grant, the university saves that part of the researcher’s salary that can be charged to the grant. Both the university and the researcher become dependent on the grant and successor grants for salary support; and the department helps the researcher administer the grant, in return for some departmental support engendered by the grant. This virtuous and, on the whole, manageable system nevertheless encourages some atomization. Two or more researchers, each with a separate grant, may find it complex to choose to collaborate, especially if their grants are anchored in different departments. The system tends to reward individual rather than cooperative achievement. And, at the same time, the system reinforces the department, if only as an administrative rather than an academic organization.

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Above all, federal sponsors, to their credit, have frequently been persuaded to support research primarily for the sake of research and teaching per se. For-profit corporate sponsors appear likely to be more task-oriented. Industrial corporations may also prefer to deal with the university as an institution rather than with a multitude of individual researchers. If university administrations respond with an effort to form new interdisciplinary and more task-oriented groups of researchers in response, such an effort may well engender resistance both from the departments and from individual researchers acculturated otherwise. Even academic rationales for the formation of such new groups may then become suspect as to their motivation. All in all, the prospective need for increased partnerships between the major research universities and industrial corporations seems likely to apply more strain to existing stress — and thus to accelerate the need, now growing slowly — to reconsider the university’s internal structures.

In conclusion, then, the American major research university remains vital to the task of enhancing human knowledge and has great capacity to contribute; but the university as an institution still must digest rapid and unbalanced growth, reemphasize the vital linkage of research and teaching, acquire new industrial investment to supplement federal sponsorship, and at least consider whether internal restructuring may not turn out to be its own most critically needed new initiative.