



## Doctoral Education: Reform on a Weakened Foundation\*

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### Graduate Education and U.S. Prowess in Science and Technology

Since the 1950s, graduate students have come to play a pivotal role in the American research enterprise. At the nation's major research universities, graduate students sustain the productivity and overall excellence of faculty in science and engineering. The quality of a university is often judged by the ranking of its doctoral programs, and those programs rise and fall on their ability -- or failure -- to attract excellent faculty and graduate students. In addition, universities are increasingly viewed as the engine that drives U.S. progress in science and technology.

It does not seem much of a leap to conclude that if graduate students are essential to the university research enterprise and the latter is essential to U.S. economic progress, then graduate students are essential to U.S. economic progress. Not surprisingly, a wide range of stakeholders have taken a lively interest in graduate education and tend to view with concern perceived threats to the preeminence that U.S. graduate education achieved in the last century.

Recognizing the national interest in ensuring a smooth flow of talent into the U.S. science and engineering workforce, these stakeholders have been troubled by the declining share of doctoral degrees awarded to U.S. citizens and concerned to better align the educational experience with the needs of today's marketplace. As a result, various efforts have been made to increase domestic participation in research and education in these fields and to advance a broader reform agenda.

While these initiatives have much to recommend them, they are being undertaken in the context of another disturbing trend -- sharp decreases in the amount of state support for America's public research universities. In this article, I suggest that increasing domestic participation and other elements of the reform agenda may be difficult to achieve in the environment of increasing resource scarcity in public higher education.

### Historical Context

The excellence achieved by U.S. graduate education in the twentieth century did not occur serendipitously. Rather, it grew out of visionary public policy that has shaped U.S. higher education in two readily identifiable phases. The first of these was the land grant movement in the second half of the nineteenth century, which led to major public investments in higher education across the nation. As a result, access to universities grew on an unprecedented scale.

Building on this foundation was the vision of a federal-university partnership advanced by Vannevar Bush as World War II came to a close. In *Science: The Endless Frontier* (1945), Bush advocated that federal funds be invested in university research with the goal of increasing U.S. scientific capital and with the expectation that the investment would pay dividends for the U.S. economy, its national security, and the

health and welfare of its citizens. Complementing *Science: The Endless Frontier* was John Steelman's less well-known *Science and Public Policy* (1947), which designated graduate education as the proper training ground for future scientists. Both Bush and Steelman stressed the importance of integrating research and education, insisting that research is required for the teaching of science.

Over the next half century, these visions of a federal-university partnership became fully institutionalized. In 1995, an influential science policy paper titled "Allocating Federal Funds for Science and Technology (The Press Report)" asserted that "a distinctive feature underlying the excellence of the U.S. research and development system is the substantial reliance on university-based research." The report recommended that "federal science and technology funding should generally favor academic institutions because of their flexibility and inherent quality control and because they directly link research to education and training in science and engineering." As parsimoniously expressed by the National Science Board in the 2004 edition of *Science and Engineering Indicators*: "U.S. universities and colleges are major contributors to the nation's scientific and technological progress. . . . Academia is a national resource (emphasis mine) whose vitality rests on the scientists and engineers who work and study there."

### Initiatives to Reform Graduate Education

In this context, concerns about the health of graduate education in the sciences have serious implications. Universities have pondered ways to make graduate education more attractive and meaningful, and since the mid 1990s, they have been joined by professional associations, federal agencies, and foundations in calling for reform in doctoral education.

Prompted by lengthening time to doctoral degree and doctoral attrition, the AAU Association of Graduate Schools published a booklet titled "Institutional Practices to Improve Doctoral Education." (1990) AGS deans urged that:

- Graduate student participation in research and teaching should be pedagogically motivated and designed as an educational experience;
- Innovative coursework should be integrated into the curriculum to provide information and training necessary to pursue careers in current and emerging job markets;
- Faculty teaching and mentoring should help students develop a clear sense of professional responsibility and ethics; and
- Student progress and performance should be evaluated within well-articulated departmental expectations.

Here and elsewhere in the reform agenda, several themes arise frequently: increasing interdisciplinary training, diversifying the academy by increasing the representation of women and ethnic minorities in

science and engineering, and preparing PhDs for careers beyond the academy. In 1995, the Committee on Science, Engineering, and Public Policy devoted virtually all of its report on *Reshaping the Graduate Education of Scientists and Engineers* to occupational issues: a more versatile education for a changing global marketplace.

While reform efforts have had salutary effects in enhancing interdisciplinary training, improving professional socialization, and increasing the participation of previously underrepresented groups, I am concerned that we may be neglecting the national resource -- the U.S. higher education system -- which is the foundation for U.S. pre-eminence in graduate education. I refer here to the decline in state support for America's great public research universities, which award 70% of U.S. doctoral degrees and comprise almost 70% of the top 100 U.S. universities as measured by federal investment in academic research.

### **The Bottom Line**

For more than a century, the business plan of these universities has relied on state funding. As that funding has been incrementally withdrawn, the business plan is faltering. In California, this has been glaringly evident. In the 1960s, state funds provided more than 60% of the budget for the University of California and UCLA. At UCLA that percentage has declined to less than 25%. Paralleling this divestment has been a steady decline in the adequacy of financial support going directly to graduate students.

There are signs that the decline in state funding has put in motion a chain of consequences that may operate at cross purposes to the preservation of a great national resource. In this environment of increasing scarcity, there are risks that doctoral education in science and engineering will become both less accessible and less attractive to young people.

The AAU graduate deans attached a very important postscript to the recommendations (outlined above) for improving doctoral education: Adequate and reliable funding is necessary to attract students to pursue advanced degrees. This may well provide a clue to today's situation.

Four years ago, the University of California's Commission on the Growth and Support of Graduate Education issued a report, *Innovation and Prosperity at Risk: Investing in Graduate Education to Sustain California's Future* (2001)—a title that sharply captures its conclusions. California's investment in graduate education in the 1960s and 1970s paid off in many of today's innovations, the Commission said. Now, however, UC campuses have a lower proportion of graduate students than comparable universities. If graduate students are necessary for a healthy university research enterprise and a growing base of science and technology to fuel the economy, then California is clearly in trouble.

As for the national context, University of Wisconsin Chancellor John Wiley recently pointed out that public universities rely on state taxpayers for the economic resources that private universities draw from wealthy donors. However, the per capita investment in public higher education is about \$221 nationwide, an inadequate sum when laid against the heavy responsibilities public universities have been asked to shoulder.

As a result, public universities have changed in a number of ways that may directly and indirectly impede the flow of talent into graduate education and undermine their long record of contributions to American science and technology.

### **Higher Tuition and Declining Access**

Looking for ways to balance the budget in the face of declining state contributions, public universities have found the easiest and most obvious alternative: raising tuition and fees. Once free or almost free to residents of their respective states, these universities have increased fees and tuition to the point where the cost of attendance is on a par with private universities. At the University of California, fees for California residents have increased from \$2,200 to \$8,900 since 1990. On top of that, nonresidents must pay tuition, which has increased

from \$6,400 to \$14,700 in the same period.

This hits hardest at students of limited means, in particular, underrepresented minorities, many of them from working class or even impoverished families. While many programs have encouraged them to pursue doctoral education and helped them prepare for its rigors, the increasing costs of doing so work against this tide. Graduate study, even in the sciences, is increasingly subsidized by loans and families. Minority students are less likely to have family resources they can call on.

As tuition has risen, state contributions to fellowship and scholarship support have not increased commensurately. Because research assistants draw support primarily from federal sources, graduate students in science and engineering have fared better than their colleagues elsewhere. Nevertheless, changes in university support are affecting them indirectly.

It is telling that graduate students in these fields routinely refer to their faculty PI's and mentors as their "bosses." After the first year of graduate study, students typically find themselves dedicated almost exclusively to the research of the professor who provides their financial support. As a result, they have little time to acquire the breadth of interdisciplinary knowledge and the professional skills that employers and others say our graduating PhDs lack. Graduate study is no longer a period when students can be free of mundane cares while they enrich their minds in the extraordinary intellectual environment universities offer. Instead, it is replete with financial insecurity, significant financial sacrifice, and of even greater significance, insecurity about what lies ahead.

### **The Academic "Career Path": Is This What You Want to Do?**

The dwindling supply of state money has also led public universities to rely more and more on raising money from outside sources. Faculty invest energy in identifying, applying for, and managing research and training grants, and university deans and presidents devote an increasing amount of time to soliciting contributions and endowments.

University of Wisconsin Chancellor John Wiley has noted that it would take \$1.3 trillion in endowments to replace taxpayer support. At present, the total endowment for public and private universities is about \$200 billion, so any dramatic increase in endowment support is unlikely.

Besides its long-term impracticability, however, the new reliance on outside funding is changing the character of the university as an environment in which to work and study. First, public universities are moving away from the tenure track system, in which faculty were hired for entry-level positions as assistant professors, then made their way along a well-marked path to senior faculty status through their research, teaching, and university service.

Under pressure to produce cutting-edge research, universities are inclined to muster their hiring dollars so they can compete for senior research scholars and demonstrated rain makers who command big salaries and significant start-up funds. The budget is balanced by not filling faculty vacancies or by hiring less expensive part-time and non-ladder faculty.

How does all this look from a graduate student's perspective? As they scan the terrain for role models, graduate students are likely to find a dismaying picture. Research is a labor-intensive enterprise, and regular faculty account for the smallest category of research personnel in today's universities. The rest of the team is made up of graduate students, postdoctoral fellows, and various nonfaculty research personnel who depend heavily for support on the federal government -- with the resulting insecurity.

Instead of dreaming of the day when they will pursue their own research agenda, graduate students are more likely to envision an extended apprenticeship as a postdoctoral fellow and even after that perhaps a job managing someone else's research agenda. A faculty

appointment may well come without the security and status the tenure track confers. And should they reach the heights of principal investigator, they face the crushing pressure of constantly replenishing the funds for their own team.

Graduate students who hope to look outside the academy are unlikely to find much useful support or information among faculty members and other campus advisers. Faculty at research universities know their own careers better than anything else. They can't provide a role model of alternative career options or, in many cases, the connections to off-campus employers. Small wonder then that surveys of graduate students reveal significant insecurity about career prospects.

### Conclusion

If it continues, the declining enrollment of young Americans in American graduate schools will have grave consequences for the nation's prosperity and for its social fabric. Even the best-considered efforts to reform the existing system have had relatively little impact on this trend. Moreover, this focus on internal strategies has neglected the broader context in which graduate education occurs: the society it serves and depends on for resources. To use a domestic metaphor, it's possible that we've been renovating the kitchen and putting up new curtains while termites undermine the very structure of the house.

The plight of public research universities also has potentially grave consequence for the nation's prosperity and for its social fabric. Here's how an editorial in *The New York Times* describes the situation:

*The United States has been sabotaging its future for decades by starving the public colleges and universities that have moved millions of Americans into the middle class. . . . The gap between state aid and the real cost of an education is glaringly evident at the flagship public colleges, which often receive a pittance from the legislature while maintaining expensive, world-class programs that compete with those of top private colleges and universities. (February 16, 2004)*

If public universities are to preserve their historic role, their health must be secured. More than a century ago, the arrival of public higher education ushered in a new era of opportunity for Americans. Inaugurated 50 years ago, the federal university partnership has created astonishing advances in science and technology and a burgeoning in the American economy. The state divestment in pub-

lic higher education threatens to dismantle that century of accomplishment. This must not continue, certainly not without a debate.

To summarize, here are the danger signs that are already visible:

- Graduate student tuition and fees rise as fellowship support dwindles. Our largest untapped talent pool, underrepresented minorities, often lacks the economic resources to meet these rising costs. The idea that access to public universities should be determined by merit rather than wealth may become an artifact of the past.
- Increasing pressure on public universities to produce scientific and technological discoveries makes their research mission increasingly dominant and further strains overstressed budgets. The federal share of funding for research performed in academia has actually declined from 68% (1972) to 59% during the last thirty years while the institutions share has tripled in the same period, standing now at 20%. (*Science and Engineering Indicators*, 2004)
- Pressure to do more research with less money takes place in the context of the displacement of traditional university processes and growing inequality in faculty salaries. Junior faculty in science and engineering fields are increasingly scarce, and the tenure track has suffered serious erosion.

As graduate students enter this pressure-filled environment -- and, of more concern, as undergraduates contemplate career directions -- all of this must serve as a cautionary tale. Should we wonder, then, why they find doctoral studies in science and engineering less appealing and choose to put their talents to other uses? In addition, the financial condition of public universities contributes quite directly to access issues by increasing the cost of graduate studies for those least able to pay.

The linkage between declining domestic participation in doctoral education and declining state support for universities may go well beyond a mere coincidence of time. If we are to safeguard the nation's economic prosperity, we must attend to the well-being of the public research universities that are its keystones. When we have done so, we may find that young Americans have renewed interest in the graduate education that can secure their future and ours.

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