

# Graduate Education for a New Century

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Most students find graduate school one of the most intellectually stimulating and satisfying experiences of their education. Since graduate students are expected

to possess the intellectual maturity to determine their own course of study, to set their own pace, there is a very rapid sense of personal responsibility and control that sets it apart from the undergraduate experience. The ability to delve into a subject as deeply as one wishes can be both satisfying and rewarding--as well as unlikely to occur again in one's later career.

The relationship between the graduate student and the faculty evolves from mentorship toward collegiality. Toward the latter stages of their studies, many graduate students acquire knowledge in a narrow area exceeding that of their faculty supervisor. At this stage, the learning relationship passes from the parent-child character of undergraduate education to the peer-to-peer relationship characterizing collaborators and colleagues. In fact, many faculty members will acknowledge that some of their closest friends were their graduate students. This is natural, since the bonds between the faculty and graduate students are strong in almost every discipline. Faculty members and their graduate students work together and learn together.

So, too, graduate education introduces students to the many diverse roles in the academy--as students, teachers, scholars, and faculty colleagues. In summary, graduate education can be a most enjoyable experience, since one can develop a true love of scholarship, drawing upon the reputation of their institution and their faculty mentors--yet not subject to the other pressures of the academy such as grantmanship or achieving tenure.

However, life as a graduate student is not without stresses, foremost among them being the concern about future employment. Like many of my colleagues, my own graduate education occurred during the mid-1960s. While the post-Sputnik emphasis on science had attracted many of us into further studies, the Vietnam War and the end of the Apollo program brought a significant downturn in the job prospects for PhDs. While the rumors of PhDs driving taxicabs was a bit exaggerated, it nevertheless was a time of some concern.

In fact, it was a time much like today, when questions were being raised about the needs of our society for PhDs and whether our doctorate programs were being responsive to societal needs.

### The Problem: Mismatches

Today, there are many mismatches in graduate education between what we do and what society needs. Many believe there is a mismatch between the number of PhDs we are currently producing and the job opportunities available to new graduates. There may well be a mismatch between the narrow, focused nature of PhD education and the broader educational requirements of most careers in which PhDs will find themselves. And almost certainly there is a major mismatch between the expectations of new PhDs, who generally expect to become academicians just as their dissertation advisor, and the reality of the job market they will face.

Is there an oversupply of PhDs? While unemployment rates for recent PhDs have remained very low, there do seem to be far more seekers of faculty positions or research scientists than there are available positions. There are also some worrisome indicators of weakness in the market, such as the substantially longer delays in the initial placement of new graduates. These signs suggest that the current oversupply of PhDs--at least for the academy--will continue and may well worsen in the near term as federal budget cuts hit even harder.

One can identify an array of possible causes for these mismatches:

### The Post-Cold War Blues

The United States system of graduate education is arguably the most effective system yet devised for advanced training of faculty and scholars. By carrying out graduate education in the same institutions where a large portion of the nation's basic research is done, our research universities have created a research and training system that is one of the nation's great strengths--and the envy of the rest of the world.

Yet this system evolved when the demand for research was either stable or rising. The national security demands of the Cold War and domestic priorities such as health care and the environment stimulated federal support of the academic research infrastructure, which drove similar commitments to graduate education.

This situation is now changing. The end of the Cold War, the rapid growth of international competition in technology-based industries, and a variety of constraints on research spending have altered the market for PhDs. The three traditional areas of employment for PhDs--universities, industry, and government--are all experiencing very significant changes.

### Foreign PhDs

The quality of America's graduate programs have long served as a strong magnet for attracting outstanding international students. In fact, over the past decade, most of the growth in the graduate student population in American universities has been a result of the growth in the number of foreign nationals enrolled in these programs. The enrollment of domestic students has remained relatively flat or even declined in some cases.

Because of the advanced, highly specialized nature of American graduate training, many of these foreign students have been unable to find employment in their home countries which take advantage of their newly learned skills. Hence, a significant fraction of US educated foreign nationals attempt to enter the American job market. While the domestic employment of these students represent an extraordinary human resource for this country--and a significant brain drain from their home countries--they do intensify considerably the competition for the limited job market for faculty and research positions.

So too, the disintegration of the Soviet Union and Eastern Bloc has triggered a mass exodus of talented scientists and engineers to the west. These have flooded the marketplace in many specialities such as physics and mathematics.

Furthermore, the downsizing of the national defense effort, coupled with a reorientation of industrial research laboratories away from basic research toward product research, has both reduced employment opportunities in the federal and industrial sector, while releasing into the marketplace scientists and engineers formerly employed in these areas.

### Decoupling from the Marketplace

It has become increasingly clear that the forces driving the production of PhDs are decoupled from the marketplace. More specifically, there is little relationship between the supply of PhDs and the demand for them.

In most universities, the size of the PhD programs and the production of doctorates is driven primarily by the need for university teaching and research assistants. In science, in particular, PhD production is driven primarily by the level of research funding and not the needs of the marketplace.

This is in part because we, as a nation, have not paid adequate attention to the function of graduate programs in meeting the country's varied needs. There is no clear human resources policy. Rather, PhD production is regarded as largely a byproduct of research activity. The simplifying assumption has apparently been that the primary mission of graduate programs is to produce the next generation of academicians. Today this assumption is patently wrong.

### Misdirected Goals for PhD Programs

The majority of PhD programs have traditionally seen their role as training the next generation of academicians, that is, as self-replication of the graduate faculty. It is questionable whether this narrow definition of the PhD serves well even the academy and the basic research enterprise, much less broader society. Today and in the future, the majority of PhD graduates will work outside the academy. The training of doctorates needs to reflect these broader roles in industry, business, government, and education.

The process of graduate education is highly effective in preparing students whose careers will focus on academic research. At least some component of our graduate programs should continue such a focus. But graduate education must also serve better the needs of those whose careers will not center on research. More than half of new PhDs will find work in non-academic, non-research settings, and our graduate programs must prepare them for these broadened roles. Furthermore, most academic positions will be in colleges and universities which do not stress research.

The disparity at the graduate level, between graduate education and the needs of our nation has led some to suggest that doctoral education, rather than the crown

jewel of American higher education, may be at the root of many of our problems. Dr. Robert Atwell, former executive director of the American Council on Education, has noted that many faculty in our research universities are out of touch with the mainstream of higher education—not to mention societal changes and fiscal realities—and so they go on trying to clone themselves in the persons of their graduate students, to assist in their research. As a result, many new PhDs who find jobs in nonresearch colleges become frustrated and often pressure these institutions toward becoming research universities—which implies, of course, offering PhDs. It could well be that the research/graduate university paradigm has created a pecking order in American higher education that is out of touch with the need of the nation and the academic marketplace.

### Unrealistic PhD Student Expectations

Many new PhDs have far too narrow a set of personal and career expectations. They think that what they know is how to solve certain highly technical and specialized problems. Of course what they actually know that is of lasting value is how to formulate questions and partially answer them starting from powerful and fundamental points of view. Most do not understand that this is what gives them any edge they may have over young people of their own age who are already out in the workplace without PhDs but with a six-year head start in experience.

### The Nature of Graduate Education

The success of the United State basic research endeavor to date has relied to a large extent on individual effort, as reflected in the investigator-initiated grant process. This emphasis on individuals is strongly reflected in the promotion and tenure system at research universities. It is also reflected in our approach to graduate education.

PhD training is best described as an apprenticeship. Graduate students are expected to attach themselves early and tightly to individual professors. They are expected to focus on a very narrow slice of disciplinary investigation in their studies and their dissertation.

Although graduate students are expected to explore thoroughly and deeply a narrow intellectual area in their dissertation research, the hope is that in this process, they will acquire a powerful methodology for formulating and solving broader problems. In this sense, the purpose of doctoral education is to learn how to learn at a very sophisticated level. In a paradoxical sense, through such specialized inquiry, the PhD students acquires training that is well-suited to broader investigation. Ironically, it is this specialist experience of the PhD that provides training for a later role as an advanced generalist. Unfortunately, few PhDs student recognize this feature of graduate education, perhaps because few faculty acknowledge or value it.

Yet today's research problems are becoming increasingly complex, and their solution requires interdisciplinary teamwork. The training of new PhDs

currently is often too narrow intellectually, too campus centered, and certainly too long. The acceptance of overspecialization can result in a lack of both perspective and self-confidence. New PhDs often believe themselves ill-prepared to venture outside their specialty. This is due in part to the lack of serious requirements for breadth in the typical graduate curriculum. It is also due to the fact that there is little or now encouragement and a lot of implicit discouragement for one who wants to depart from the straight and narrow.

## What to Do?

To address these challenges, we need to consider possible actions at various levels: the graduate department or programs, the university, and at the national level of the higher education establishment.

### The Department Level

Actions at the department or program level are likely to be most effective in addressing the challenges to graduate education. Some have suggested right-sizing programs by applying constraints on PhD production directly to faculty, in effect, academic birth control. While limiting each graduate faculty member to the production of just a few PhDs over a career might seem to lead to population control, the situation is a bit more complicated.

First, most PhDs do not train other PhD students. Indeed less than one-fifth of PhDs become involved in graduate education. A National Science Foundation study noted that at 1991 rates, the subset of senior faculty in doctorate-granting institutions currently produce an average of 10.7 new PhDs over their 30 year careers. When spread out over all PhDs, this amounts to only 1.7 new PhDs produced per existing PhD. If we were to discount foreign students, then this reproduction rate drops to less than 1.0--certainly not sufficient for "birth control" restrictions.

There also does not appear to be a compelling case for draconian limitations on foreign student enrollments in our graduate programs. Most foreign PhD graduates remaining in this country make significant contributions to the national interest. Further, there is already some indication that the rapidly evolving economies in those nations sending the largest numbers of students to American universities are beginning to create major growth in job opportunities. As a consequence many foreign national doctorates, both new and experienced, are beginning to return to their home countries.

Far more effective would be efforts to challenge programs to develop alternatives to teaching or sponsored research needs as the primary drivers of the size of their graduate programs. Perhaps more use of external advisory committees capable of assessing both placement and position opportunity data would be a way to achieve better accountability.

While many faculty already participate in efforts to place their PhD graduates, there should be a broader acceptance of responsibility for placing graduates. Indeed, this might be one way to stress the importance of aligning PhD training with society needs. Graduate students should certainly receive more up-to-date and accurate information about career opportunities. This should not only be provided directly by the graduate program or department, but academic units should consider assigning a faculty member as an ombudsman for graduate placement. In fact, perhaps each faculty member who accepts the responsibility of the chair of a dissertation committee should also be asked to accept a personal responsibility for the placement of their PhD student!

### The Institution Level

At the university level, there is clearly a need to encourage a broadening in PhD requirements. While we must retain the paradigm of research training that is the acknowledged strength of the current system, we must also undertake changes if our academic institutions and their graduates are to make their optimal contribution to society. We need to redesign doctoral programs that emphasize disciplines at the borders between fields, as well as programs that include interaction among scholars within different disciplines. Careful attention will need to be given to striking the right balance between training individuals capable of spanning fields and those with deep understanding of a highly specialized field.

It also seems clear that a greater number of job opportunities will be available to PhDs who have experience and connections beyond the campus. To produce more versatile graduates, programs should provide options that allow students to gain a wider variety of skills. They should be discouraged from overspecializing.

It is also important in some fields that universities develop integrative, practice-oriented degree programs that better respond to the needs of industry, perhaps through a redefinition of the masters degree or an alternative form of the doctorate.

There has been strong interest expressed at the national level in making available internship experiences to graduate students. Some have suggested that every graduate student should have the opportunity to spend time in an appropriate setting outside the university. Internship programs that provide students with experience in industry, government, or different types of academic institutions could prove useful in achieving the objective of broadening graduate education. In fact, one might even consider teaching internships, in which doctoral students interested in academic careers spend a period on the campus of a different type of educational institution--perhaps a liberal arts college or a community college.

Yet another challenge at the university level is reducing the time to degree. The time required for the PhD has steadily increased for the past several decades, doubling in some cases to over 10 years. Universities, their graduate programs, and their faculty simply must accept the responsibility to reduce the time to

degree. The primary objective of graduate education should be the education of students. The value of such activities as working as research assistants or teaching assistants should be judged according to the extent that they contribute to a student's education. A student's progress should be the responsibility of the entire department or program and not under the control of a single faculty advisor.

A recent national academy panel considered a proposal to develop three alternatives at the graduate level, each characterized by a fixed-time to degree:

- A one or two year M.S. degree program would be provided for all students, but with this being the terminal degree for those interested in other professional careers such as law, business, or medicine.
- The PhD itself would require two additional years of study including a dissertation (or a total of four years, including the M.S. degree) and suffice for most advanced positions in the public or private sector.
- For those students interested in careers in either the academy or basic research, further study beyond the PhD would be achieved through postdoctoral studies. This latter training would provide the highly specialized training to move to the cutting edge of research.

### The National Level

Several actions are also required at the national level. The re-direction of PhD training can only occur with a sustained commitment of the federal government to support new and innovative education initiatives. To foster versatility, there should be broadening of the mechanisms for the federal support of graduate students. The shift from portable fellowships and traineeships to the research assistantship as the predominant method of graduate student support in the early 1970s created a situation in which training is driven primarily by the needs of sponsored research projects.

Perhaps a more balanced effort, utilizing training grants, fellowships, and research assistantships, would allow more flexibility in graduate education. The National Institutes of Health have long used well-designed training grant programs to stress the development and support of graduate education in key areas, and this paradigm should probably be used more frequently in other areas of graduate study. Furthermore, the government should also look to increase the number of federal agencies that provide substantial training dollars, which will have the benefit of diversifying the nature of PhD training.

### A Role for the Federal Government

Since federal policies played a key role in stimulating the evolution of the American research university in the decades following World War II, it is reasonable to expect there is an appropriate role for government in addressing

some of the concerns about graduate education, particularly in science and engineering. There seems little doubt that the prosperity, security, and social well-being of our nation during an era of rapid technological change will require both an adequate supply of well-trained scientists and engineers and a scientifically literate populace. It is therefore alarming to note that the United States has not had a definitive, coherent policy for human resource development in science and technology for decades--since the massive efforts represented by the G.I. Bill in the 1940s and the National Defense Education Act in the 1960s. Instead, the nation has drifted on autopilot, with its human resource development largely determined as a byproduct of federal research and development programs rather than through a strategic consideration of national needs.

While there is a general consensus that the quality of the higher education and training of U.S. scientists and engineers has been second to none, there are signs of strain that will only increase with time. The current system tends to replicate itself by producing scientists and engineers trained for increasingly narrow--and increasingly limited--research and development roles, largely ignoring the broader interests of our best students, the increasing diversity of today's generation of students, and the complex and rapidly broadening roles in our society played by those with science and engineering training.

It seems imperative that the nation develop both a vision and a closely aligned federal policy concerning the development of human resources in science and technology capable of responding to the contemporary and future needs of the nation. This policy should be closely coordinated with parallel policies concerning scientific research and technology development and deployment. It should be executed through federal programs sustained for a sufficiently long period to yield the necessary changes in the academic culture characterizing science education and in broadening the roles that those with scientific and technical training will play in our knowledge-driven society. This policy should also respond to both the changing nature of national needs and the increasing diversity of the American people.

The majority of Ph.D. programs have traditionally seen their role as training the next generation of academicians, that is, self-replication. This narrow definition of the role of the Ph.D. does not serve well either the nation or the student. In the future, the majority of Ph.D. graduates will work outside the academy; and the training of Ph.D. 's needs to reflect these broader roles in industry, business, and education. Universities need to work together with the private sector to re-design the Ph.D. degree so that it prepares students for this more diverse future. Internship programs which provide students with experience in industry or government could prove useful in this objective of broadening graduate education.

Today's research problems are becoming increasingly complex, and their solution requires inter-disciplinary teamwork. The federal government will need to fund training programs that emphasize disciplines at the borders between fields, as well as programs that include interaction among scientists within

different disciplines. Careful attention will need to be given to striking the right balance between training individuals capable of spanning fields and those with deep understanding of a highly specialized field.

The re-direction of Ph.D. training can only occur with a sustained commitment of the federal government to support new and innovative education initiatives. It is important to continue and expand those federal programs designed both to develop the next generation of university faculty as well as to enable the current generation to better align its educational capacity and efforts with the science and technology needs of the nation. Federal research programs should be redesigned to remove any disincentives for teaching and to provide strong incentives for the involvement of both graduate and undergraduate students in research projects.