Ph.D. Completion *and* Attrition:

Policy, Numbers, Leadership, and Next Steps

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Council of Graduate Schools

Ph.D. Completion and Attrition: Policy, Numbers, Leadership, and Next Steps

COUNCIL OF GRADUATE SCHOOLS

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FOREWORD

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At CGS we know that doctoral education in the United States is the model for much of the rest of the world. The strengths of doctoral education are reflected both in the excellent preparation of graduates and in the capacity to produce research and researchers that are primary contributors to economic growth and social stability. These results come at a price: doctoral education is very expensive, both in financial terms and in terms of effort and time invested by doctoral students, faculty members, and others who collectively sustain the enterprise. Concerns about increases in financial cost and in the time required to complete a degree are reflected in several national reports that recommend changes in doctoral education to better meet the needs of the nation and to prepare graduates for available career options. These recommendations have spawned a variety of national reform movements focused on the "effectiveness" of doctoral education.

But of all of the discussion swirling around the topic of "reform" in Ph.D. education, the most urgent issue from the CGS perspective is our collective inability to demonstrate that graduate education is successfully graduating high numbers of the students it admits into its doctoral programs. CGS is committed to improving our knowledge of factors that are most strongly coupled with low Ph.D. completion rates and to providing model interventions that can reduce attrition and increase completion.

Between December 2002 and April 2003 the Sloan Foundation and the National Science Foundation supported the Council of Graduate Schools to engage key stakeholders in a national discussion about how to address the challenge of Ph.D. completion. We hope that the following monograph, which includes highlights from that discussion, will direct national attention to the need to test and adopt practices that promise to facilitate doctoral degree completion.

Debra W. Stewart
President
Council of Graduate Schools

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INTRODUCTION

This publication developed out of a white paper produced by the Council of Graduate Schools in the summer of 2003. That white paper served as a starting point for discussion among major stakeholders to address the issues of completion and attrition in Ph.D. education and put to the test those practices that we believe will result in higher completion rates. In April 2003, the Council of Graduate Schools, with support from the Sloan Foundation and the National Science Foundation, convened a group of experts at the Airlie House in Warrenton, Virginia, to take up these challenges. What follows are the results of the literature review that preceded that discussion, as well as some of the findings that resulted. The publication addresses the literature on attrition and completion across disciplines, since the effect of discipline is only one of several factors that shape completion outcomes for Ph.D. students. We are also motivated by a conviction that those models that will increase completion in doctoral education can and should redound to the benefit of all graduate students.

PH.D. COMPLETION AND ATTRITION

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C onventional wisdom holds that only 40 to 50 percent of students who begin Ph.D. programs in the United States actually complete their degrees. Yet, to date there is no longitudinal study of graduate student completion that covers a large number of universities, disciplines, and students to support this assertion. Smaller studies with differing methodologies have shown Ph.D. completion rates ranging from a low of 33.4 percent (for students in the humanities and social sciences [Bowen and Rudenstine 1992])[1] to a high of 76 percent (for students in biomedical and behavioral sciences supported on National Research Service Award training grants from the NIH [Pion 2001]). Thus, it appears from the perspective of national studies that, under highly favorable conditions, no more than three quarters of students who enter doctoral programs complete their doctoral degrees. While we do not attempt to define an acceptable level of attrition, we believe that it is critical to develop a normative consensus about completion, to understand the scope of the issue, and to promote practices that minimize the negative effects of attrition.

This publication is designed to facilitate discussion by addressing three questions:

1. **The Policy Question**
   What are the conditions under which attrition is acceptable; what factors shape the completion targets all may adopt?

2. **The Numbers Question**
   What do we know about current completion rates?

3. **The Leadership Question**
   What does research tell us about how graduate schools might most effectively lower attrition and increase completion?

These topics provide the framework for an action agenda for graduate schools and other stakeholders in the Ph.D. education enterprise.

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[1] English, history, and political science students in large programs (figure 8.1).

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THE POLICY QUESTION: TARGETING UNACCEPTABLE ATTRITION

The policy question at stake in this discussion is simple: *What level of attrition is acceptable and what level of completion should stakeholders demand?* Obviously, not all attrition is bad, and some attrition is unavoidable.

Unlike undergraduate and professional education, there is a degree of uncertainty associated with Ph.D. education that inevitably results in some attrition. Beyond some beginning course work, the experience of each Ph.D. student is individualized and varied. Ph.D. students bear a greater responsibility for defining the scope of their educational experience than do other students. Further, the degree requires initiative and creativity, and the award of the degree depends upon the individual performance of a student in completing original research in the area of study. These elements contribute to the variable time-to-degree observed in Ph.D. education and to the attrition that occurs in every program.

Students may leave a doctoral program for a wide variety of reasons. They may transfer to other fields or other universities to pursue their doctorates, they may leave doctoral study for professional programs in law or medicine, or they may be lured away by attractive employment opportunities. Some students may come to realize that the requirements of doctoral study do not meet their expectations, and others will be unsuccessful in meeting the expectations of the program.

If students do decide to leave, or if they are asked to do so, this decision should be made earlier rather than later. Research suggests that most students depart in their first two or three years [Nerad and Cerny 1991; Nerad and Miller 1992]. But it is not uncommon for students in some fields to spend six to eight years in a doctoral program and then withdraw without completing a degree.

While recognizing the distinctive features of doctoral education and the inevitability of some attrition, it is important to define what constitutes acceptable parameters for attrition and to promote those practices that minimize the costs to students, institutions, and funders. It is also essential from a national policy perspective to develop the domestic talent pool in all fields. Staunching Ph.D. attrition and increasing completion are critical to achieving this goal.

❖ **Why is it Important to Understand Ph.D. Attrition and Completion?**
Achieving the right policy perspective on desirable completion rates hinges on learning more about actual patterns of attrition and completion, including information on how those patterns vary by field and by

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socio-demographic group. That point was made boldly in the 1996 NRC report on graduate attrition, *The Path to the Ph.D.*: "Our confidence in the effectiveness of graduate education in the United States depends to a large extent on the statistics that describe the outcomes of the enterprise." A system for providing more complete and accessible information about graduate completion and attrition is in the interests of federal agencies (which must decide how to fund doctoral education and where to direct those funds), of research universities (with responsibility for recruiting students, providing the education, and granting the degrees), and doctoral students. A more transparent system of data-sharing on graduate completion and attrition is particularly important for prospective students who must decide whether and where to spend a significant portion of their lives in pursuit of a Ph.D. degree.[2]

Doctoral education poses a different and arguably greater challenge than undergraduate education in terms of generating statistics. Challenges relate to the decentralized and customized nature of the doctoral degree; the natural variation in Ph.D. training due to disciplinary differences; the lack of consensus, even within broad fields, on what constitutes "bad attrition"; and the empirical differences in how completion rates are derived across institutions, even controlling for all of the above [NSF 1997; NSF 1998].

Thus, meaningful resolution of the policy question depends in part on an empirically grounded understanding of current completion and attrition rates and on community agreement about the way that attrition and completion should be defined and measured.

THE NUMBERS QUESTION: *WHAT DO WE KNOW ABOUT COMPLETION RATES?*

This section attempts to capture what is known about completion and attrition rates of doctoral students. However, the discussion of the empirical studies must be introduced with the caveat that there is not complete agreement on either the definitions of completion and attrition or the methodology appropriate for measurement.

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[2] Completion and attrition statistics are available for most undergraduate institutions. The Student Right-To-Know Act (as amended by the Higher Education Technical Amendments of 1991) requires public disclosure of relevant graduation-rate information for undergraduate students enrolled in colleges and universities receiving federal financial assistance [NSF 1998]. The NCAA graduation-rate reports provide a clearinghouse for data on enrollment, completion, and time-to-degree for college athletes [ibid.]. Professional schools and programs are able to provide similar information at the postbaccalaureate level.

❖ Definitions of and Methodologies for Measuring Attrition and Completion

For most analysts, attrition measures "that proportion of the entering cohort into a doctoral degree program that does not complete the graduate program undertaken" [NSF 1998, p.3]. But problems arise over how to identify (a) the cohort and (b) the proportion who do not complete the program. Graduate institutions differ in the ways they define when a student begins and who is, and who is not, a doctoral candidate. A cohort may be identified: (a) in the first postbaccalaureate year, (b) when officially admitted to candidacy, or (c) upon completion of a required master's degree [NRC 1996]. Different definitions of the cohort may exist even within the same institution. To complicate matters further, some students may enter a master's program and then switch into a Ph.D. program, not all students define themselves as doctoral candidates, and others do so primarily in order to obtain financial support [NSF 1998]. Studies that restrict the cohort to those who have completed their master's degree requirements may not reflect early attrition. Studies that include all students in their first postbaccalaureate year count those students who may never have intended to pursue a Ph.D.

Interrupted enrollment patterns present other definitional problems. As Bowen and Rudenstine [1992] state: "The main complication in studying all aspects of the effectiveness of graduate education—and certainly in defining and measuring completion rates—is that students pursue doctorates, on and off, over many years." As an illustration of the magnitude of the "stopping out" phenomenon, note that Nettles and Millet found that fully 11 percent of the completers they surveyed had discontinued their studies at some point [forthcoming]. To treat non-enrolled students as non-completers will not account for students who ultimately return and complete their degrees. Tracking intentions is much more difficult than tracking enrollment, and students are not always likely to announce their intentions.

Transfer students further complicate efforts to define completion and attrition. A person contributing to one department's attrition rate may be contributing to another department's completion rate. The difficulty of tracking transfer students from one program to another within an institution is compounded by that of tracking students who transfer from one institution to another.

❖ Empirical Studies

Problems of definition notwithstanding, completion and attrition studies have been conducted on various cohorts of students over the past fifty

years. Table 1 presents a summary of fifteen completed studies; abstracts of each study follow. Numbers, conventions, and parameters differ in each study, but some relationships have remained relatively constant. Completion rates tend to be highest in the physical and life sciences and lowest in the social sciences and humanities, higher for men than for women, and higher for majority students than for minority students. In addition, demographic studies show that completion rates are higher for foreign nationals than for U.S. students and permanent residents and higher in smaller programs than in larger programs.

In 1960, Berelson produced an "impressionistic" study that asked faculty members and deans to estimate graduate student attrition from the cohort who entered in 1950. Faculty members and deans estimated different percentages (20 percent and 40 percent, respectively), and the study did not survey students.

In one of the earliest studies that followed, Tucker [1964] examined a cohort of students entering doctoral programs in the years 1950–1953 at 24 universities and found an overall attrition rate of 38 percent. This longitudinal study found the highest attrition rate of 50 percent in the humanities, a rate of 41 percent in the social sciences, 29 percent in the physical sciences, and 29 percent in the life sciences.

In their book *In Pursuit of the Ph.D.,* Bowen and Rudenstine [1992] studied cohorts of students who entered doctoral programs in six fields in the years 1962–1976 at ten top-ranked research universities. They also studied students who received prestigious national fellowships, including NSF Graduate Research Fellowships, and entered doctoral programs during the same cohort years. In a cohort of students entering between 1967 and 1976 at eight of the universities, they found completion rates in the natural sciences to be 65 percent; in the social sciences, 58 percent; and in the humanities, 50 percent (figure 7.1). When the same data are disaggregated by gender (men/women), we see completion rates of 65/59 percent in natural sciences, 56/51 percent in social sciences, and 52/45 percent in humanities [figure 7.2]. Disaggregated completion rate data with respect to size of program revealed higher completion rates in smaller programs than in larger ones. The completion rates in a cohort of English/history/political science students was 33 percent for large programs and 61 percent for smaller programs; in economics, 45 percent for larger and 65 percent for smaller programs; and in math/physics, 54 percent for larger programs and 73 percent for smaller ones [figure 8.1]. This general trend persisted when data were further disaggregated with respect to gender [figure 8.2]. Bowen and Rudenstine found the completion rates of the National Science Foundation Graduate Research

Table 1

Author	Institutions	Years Addressed	Type of Study	Rate	Disciplinary Effects*	Gender Effects	Other Significant Variables
Berelson		1950	Attrition	20–40%			
Tucker	24	1950–53	Attrition	29–50%	H > S > P > L		
Bowen & Rudenstine	10	1962–76	Completion	50–65%	H < S < N	Men higher	Smaller cohorts higher completion than larger
Espenshade & Rodriguez	11	1962–76	Completion	50–54%			Foreign students higher completion than U.S. students
NSF GRF		1979–88	Completion	71–74%	S < P < L	Men higher	White students higher completion than minorities
NIH NRSA		1975–2000	Completion	76%			
Nerad & Cerny	1	1978–79	Completion	37–72%	H < P < L	Men higher	
Miselis et al.	1	1976–78	Completion	33–75%	H < S < N		
Zwick	3	1978	Completion	13–82%	H < S < N	Men higher	White students higher completion than minorities; foreign students higher completion than U.S.
Golde	2	1980–89	Attrition	11–61%			Public higher attrition than private; no cohort size effect
Lovitts	2	1982–84	Attrition	33–68%			Integrated students more likely to complete
Canadian cohort		1992	Completion	46–74%	H < S < P < L		
Medical Research Council of Canada		1970–79	Completion	74%			
Attiyeh	31	1989–93	4-yr persistence	30–66% (Avg. 43%)		No effect	Greater $, higher GRE, master's degree led to higher persistence
Case & Blackwelder	many	1990–91	2-yr persistence	80%	Only math considered		

* H = *Humanities*, S = *Social Sciences*, P = *Physical Sciences*, N = *Natural Sciences*, L = *Life Sciences*

Fellows who entered between 1962 and 1976 to be 59–65 percent for natural sciences and 52–59 percent for social sciences [figure 7.2].

The more recent NSF Graduate Research Fellowship Final Evaluation Report shows 11-year completion rates of 71 percent (fellows from the 1979–1983 cohort) and 74.0 percent (fellows from the 1984–1988 cohort) [NSF 2002]. When the data are disaggregated by discipline, 11-year completion rates are substantially higher in engineering/math/physical sciences and biology/life sciences than in social/behavioral sciences [table G11]. Because support varies across disciplines at most institutions, data on these fellowship students are important, as they allow a look at the impact of other variables in the absence of the confounding variable of financial support. The NSF evaluation report also includes 11-year completion rates for all NSF Fellows (Graduate Research Fellows, Minority Graduate Fellows, and Women in Engineering Fellows) disaggregated by gender (men/women): 70/64 percent for the 1979–1983 cohort and 74/72 percent for the 1984–1988 cohort. The 11-year completion rates for the NSF Minority Graduate Fellows are reported as 50 percent for the 1979–1983 fellows and 61 percent for the 1984–1988 fellows.

The National Institutes of Health sponsors the prestigious National Research Service Award (NRSA) training grant and fellowship program, which funds students pursuing doctoral degrees in biomedical and behavioral sciences. Among students supported between 1975 and 2000, approximately 76 percent completed the Ph.D. within five years following NRSA support [Pion 2001].

Espenshade and Rodriguez [1997] used the Bowen and Rudenstine data (with the addition of data from an eleventh university) to compare the performance of U.S. citizens and permanent residents with that of foreign nationals in six fields. They found a 50.3 percent Ph.D. completion rate among the U.S. group and a 54.1 percent Ph.D. completion rate among the foreign group.

Nerad and Cerny studied the November 1989 status of a cohort of students from Berkeley entering in 1978 and 1979. Preliminary findings indicate that 58 percent of the students had completed the Ph.D., 24 percent of the students left within the first three years, 10 percent left ABD, and 8 percent were still pending. Completion rates varied with respect to discipline: 72 percent in biological sciences, 69 percent in physical sciences, 39 percent in the arts, and 37 percent in languages and literature [NRC 1996, figure 2.3]. Women had a 47 percent completion rate; the completion rate for men was 63 percent.

A study by Miselis, McManus, and Kraus [1991] of students from five graduate groups entering between 1976 and 1978 at the University of

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Pennsylvania reported 10-year completion rates of 60–75 percent in the natural sciences, 33–54 percent in the social sciences, and lower rates in the humanities. They found more early attrition in the natural sciences and more late attrition in the humanities [NRC 1996, figure 2.5].

Zwick published a study investigating nearly 5,000 students from 11 departments in three universities who entered in the fall of 1978. Her study showed that minorities and women tend to have lower candidacy and completion rates than white students or male students, respectively. In two of the three schools, foreign students had higher candidacy and completion rates than white U.S. students. She found that graduation rates after eight years were higher in physical science departments than in the social sciences and humanities, and that GRE scores and undergraduate grades had only marginal association with completion within the first four years of graduate study.

Golde, in an unpublished work "Towards a Taxonomy of Patterns of Doctoral Student Attrition," examined attrition rates of cohorts entering doctoral programs in the 1980s at two unnamed universities, one private and one public. Among twenty-four departments examined at the private university, attrition rates ranged from 11 to 44 percent. Among thirty departments examined at the public university, attrition rates ranged from 15 to 61 percent. She did not find, as Bowen and Rudenstine had, that smaller cohorts led to lower attrition. Golde also proposes ways of categorizing the timing of graduate student attrition.

In *Leaving the Ivory Tower* [2001], Barbara Lovitts surveyed students, directors of graduate studies, and faculty members from nine departments in each of two universities ("Rural University" and "Urban University"). She surveyed a total of 816 students entering between 1982 and 1984 and found overall attrition rates of 33 percent at Rural University and 68 percent at Urban University.

Recently, a large group of Canadian universities completed a study of 10-year completion rates from their 1992 cohort of Ph.D. students. They found average completion rates of approximately 46 percent in the humanities, 55 percent in the social sciences, 70 percent in the physical sciences, and 74 percent in the life sciences [Berkowitz 2003]. The life sciences completion rate exactly matches earlier Canadian data. In addition, 74 percent of the students who received stipends from the Medical Research Council of Canada during the 1970s completed the Ph.D. [Pion 2001].

Attiyeh's 1999 study of students enrolled in doctoral programs from 1989 to 1993 in five disciplines looks not at completion, but at persistence through the fourth year of graduate school. His studies of

8,138 students from 31 universities revealed higher persistence for students with greater financial support, higher GRE verbal or quantitative scores, and a master's degree. He did not find citizenship, gender, ethnicity, or age to be consistently related to persistence.

Another persistence study by Case and Blackwelder [1993] found that 80 percent of the 135 mathematics students entering research universities in 1990–1991 persisted through two years in graduate school.

Nettles and Millet have recently undertaken the largest survey to date of American doctoral students, resulting in a sample of over 9,000 students from 21 institutions and 11 fields of study. Their data and analyses are still forthcoming.

In a metasynthesis of data from 118 sources, Bair and Haworth [1999] consistently found that attrition was lower in the laboratory sciences than in the social sciences and humanities. They reported that attrition levels are positively correlated with time to degree and difficulty with the dissertation. In addition, they found that the following attributes were positively correlated to persistence and/or completion of the Ph.D.: extent and quality of the relationship between student and advisor, student involvement, student satisfaction with academic program, peer interaction, funding (especially teaching assistantships and research assistantships), motivation, and commitment to career. They failed to find correlations between completion and a large number of input variables, including undergraduate GPA, GRE scores (with the exception of GRE advanced test scores), Miller Analogies Test scores, undergraduate major, origin of baccalaureate degree, possession of a master's degree, and time between degrees. They found that smaller programs have higher completion rates than larger ones.

Taken together these studies, although varied in methodology, suggest that completion rates are sensitive to variables that are not simply a function of the personal attributes of students. The concluding section addresses what we know about the variables that institutions can control that have the potential to alter completion rates.

THE LEADERSHIP QUESTION: *WHAT CAN GRADUATE SCHOOLS DO?*

❖ **Institutional Factors that Influence Completion and Attrition**

Attrition rates of 50 percent or more would be a scandal in any professional school, but seem to be accepted in doctoral education as part of the natural order [Breneman 1977].

Attendees at the CGS Airlie House Conference on attrition and completion included several graduate deans whose efforts to define completion goals and implement responsive programs belie Breneman's 1977 observation. But the efforts underway are only a beginning. These efforts, and those to come, will be empowered by a deeper understanding of those specific factors that maximize success. The Ph.D. Completion-Attrition Kaleidoscope displayed below characterizes those categories and factors that we now believe facilitate Ph.D. completion.

Extending from the center of the kaleidoscope are student qualities, then institutional factors, and finally socio-demographic variables. Most students admitted to a specific graduate program have the academic ability to complete that program. Hence, the principal focus is on institutional factors—variables over which administrators and faculty members have some control. We also recognize that socio-demographics matter for many graduate students, hence all of the factors described below need to be viewed through the lens of gender, age, ethnicity/race, and citizenship. This perspective is particularly important in light of the need to increase the number of U.S. citizens earning Ph.D.'s in science, engineering, and mathematics.

1. Selection Process
There are two sides of the selection process in graduate school: students select departments, and departments select students. While departments

The Ph.D. Completion-Attrition Kaleidoscope
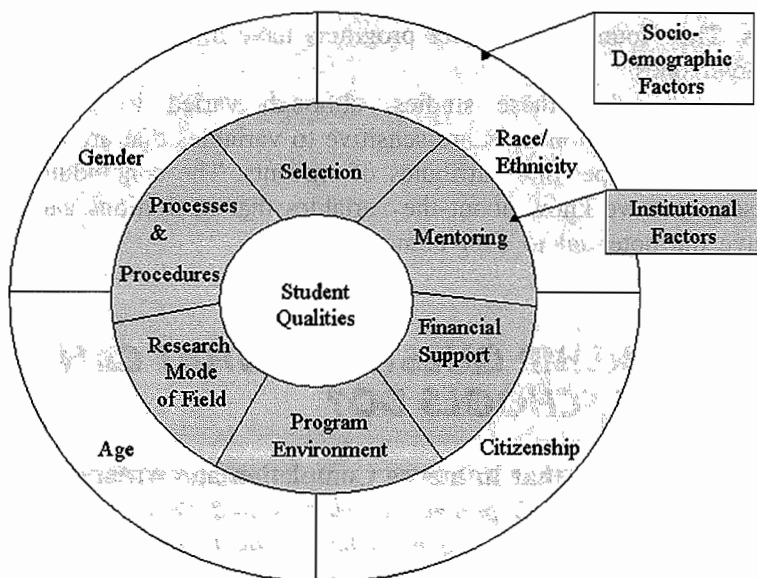
select students based on their demonstrated abilities, credentials, talent, and potential, students often select departments based on their prestige, the compatibility between their faculty's research interests and their own, and their placement records as well as other factors such as size, location, etc. It is the shared responsibility on the part of both the university and the student to consider this mutual selection process not just in terms of academic reputation, but also in terms of fit. Better selection can result in higher completion rates. However, this does not mean selecting better students, it means selecting students for a better match [Berkowitz 2003; Lovitts; Nelson and Lovitts 2001; Golde 2000; Tinto 1993].

Consider the completion rates of NSF Graduate Research Fellows or NIH National Research Service Awardees. Arguably the strongest U.S. graduate students in their fields, NSF Graduate Research Fellows have gone through an extremely rigorous selection process. However, as noted above, they complete their Ph.D.'s at a rate hovering around 75 percent, a rate only slightly higher than that of other doctoral students in science. This is consistent with the findings of Lovitts and others who have found that student quality, as measured by standard input variables such as GPA or GRE, has little impact on completion [Lovitts 2001; Bair and Haworth 1999]. These results demonstrate the impact of factors other than academic preparation and strength of application on the success of students in doctoral programs.

At this time, there is a dearth of data comparing alternative selection processes to completion outcomes. However, recommendations from student surveys suggest that students who make a program selection based on full information are more likely to complete [Lovitts 2001; Golde and Dore 2001]. Nelson and Lovitts [2001] suggest that departments should encourage prospective doctoral candidates to visit the campus so that they may learn as much about the department's specialties, strengths, and weaknesses as possible before they make their decision to enroll. Some students may prefer to apply to a department that admits more students than it intends to graduate, allowing borderline applicants to "prove themselves" at the university, whereas others may prefer a program which sets higher thresholds for admission but also expects fewer non-completers. Many researchers advocate that applicants and enrolled students should also have access to placement and employment information for recent doctoral degree holders in their field [AAU 1998; Nelson and Lovitts 2001; Golde and Dore 2001].

2. Mentoring
Mentoring is a key factor in student completion of a Ph.D. Although difficult to define, mentoring consists of a range of activities that

potentially involves the entire institution and implies a level of personal interaction, guidance, and nurturing that goes beyond the required duties of a research advisor [King 2003]. In some cases, students may find that these aspects of mentoring are adequately provided by the dissertation supervisor, while in other cases they may be better provided by other members of the department, by peers, by recent department alumni, or by others. Golde and Dore [2001] found that more than half (59 percent) of the students they surveyed could identify a second faculty member who served as a mentor, in addition to their primary research advisor.

Among those surveyed by Lovitts [2001], completers perceived their advisors as being more interested in them than did non-completers. Completers were more satisfied with their advisors than non-completers, and the more satisfied a student was with his or her advisor, the more likely was the student to engage in professional and departmental activities. While care, commitment, encouragement, and friendship may be "above and beyond" the formal responsibilities of a dissertation supervisor, they are among the attributes of a research mentor that are most frequently cited by students as essential to contributing to their timely completion of a Ph.D. degree [Golde 2000; Ferrer de Valero 2001].

Herzig studied the experience of women and minorities in mathematics graduate programs and described the effect of negative relationships with faculty members upon student decisions to leave doctoral programs. The study detailed the importance of students having a sense of "belonging" as a factor of success in Ph.D. programs—an idea similar to Lovitts' notion of integration.

More evidence to support the efficacy of mentoring is provided in a study by Preston [2003]. In a cohort of 33 women who earned bachelor's degrees in science at the same public university and who chose to enter a graduate (master's or doctoral) program in science, Preston found that 60 percent of the women who described themselves as "unmentored" completed their degree objectives, while 100 percent of the women who described themselves as "mentored" completed.

Golde and Dore found a strong correlation between student satisfaction with advisors and the number of criteria that students applied when selecting an advisor. Since mentoring is a highly personal activity, not all students seek out or benefit from the same qualities in a mentor. One quality that students may be encouraged to consider is faculty Ph.D. productivity. Some data exist regarding faculty members who produce high numbers of students with doctorates. They generally schedule regular meetings with each advisee, interact with students in colloquia,

spend more hours per week interacting with students in their studies and work, see students in informal as well as formal settings, collaborate on research papers and presentations, and coauthor papers. Nelson and Lovitts [2001] suggest providing students information regarding recent faculty Ph.D. production.

3. Financial Support
Financial support can be an important factor in completion, but more information is needed on the effect of funding on completion. It is difficult to determine the impact of the timing, amount, and type of financial support students receive, because students receive funds from different sources and at different times in their programs, systems for reporting funding may differ, and self-reporting by students may be inaccurate or incomplete [NSF 1998]. The availability and amount of research money varies by field and institution, and programs each need to analyze the effect of different types of financial support on completion rates for their students.

In Golde and Dore's study, only 57 percent of students surveyed reported having a clear understanding of the type and extent of the funding commitments from their program [2001]. As a result of such confusion, Ph.D. candidates may acquire significant levels of debt to compensate for inadequate funding or for funding that is poorly structured [Nerad and Cerny 1991; Golde and Dore 2001].

There also may be institutional and field differences that influence how additional funds affect completion. In some departments, more funds may translate into more students, not more money per student [Bowen and Rudenstine 1992]. An AGS/AAU study shows that departments tend to favor incoming students over those already matriculated in funding decisions [Russo 1997].

There is some debate over the relative effect of teaching and research assistantships on completion outcomes. Lovitts [2001] investigated the relationship of attrition rates to types of support. She found the lowest attrition rates among those with research assistantships (17 percent) and teaching assistantships (24 percent), followed by fellows with university-sponsored fellowships (31 percent), fellows with privately sponsored fellowships (39 percent), and those with no outside support (80 percent). Research fellowships enable students to focus on research and thus do not distract from a student's dissertation. [Tuchman 1999; Sheridan and Pyke 1994]. Research assistantships and teaching assistantships have both been found to be more advantageous than fellowships in reducing time-to-degree and increasing completion because they secure

departmental buy-in and facilitate integration, which has been shown to increase a student's chances of completion. [Bowen and Rudenstine 1992; Nelson and Lovitts 2001; Nettles and Millett forthcoming]. Though there may be differences in the relative merit of different types of support across fields, in all cases financial support has a positive effect on completion when it integrates students into the department, and a less positive or even negative impact when it isolates them from the department.

4. Program Environment
In addition to recommending formal processes and procedures that have been shown to be conducive to students' successful completion of their degrees, researchers find that students frequently mention informal elements that contribute to a supportive departmental climate. Such informal elements often include: opportunities to participate in department events, regular social gatherings, team sports, and a comfortable lounge with refreshments, professional publications, bulletin boards listing activities in the discipline, and visible recognition of student achievements [Nelson and Lovitts 2001].

What might appear to outsiders as purely social occasions are in fact often important professional opportunities for exchanging information about academic life. On such occasions, students discuss such topics as department "politics," departmental expectations, and advisor and course selection.[3] At the same time, socialization for its own sake is an important factor in graduate degree completion, particularly for underrepresented minority students who may feel isolated in departments where their numbers are few.

5. Research Mode
As table 1 on page 8 indicates, some fields (natural and physical sciences) consistently display higher completion rates than others (humanities). Such consistency suggests that these differences may be due in part to field-specific differences in the nature and organization of the research community. Researchers often note that the degree of social interaction characteristic of the sciences, where an apprenticeship model, research teams, and a laboratory environment prevail, can provide a more supportive environment than the dyadic relationship, individual research, and solitary time that those in the humanities often must endure [Nerad

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[3] Several participants at the CGS Airlie House Workshop on attrition and completion emphasized this point.

and Cerny 1991; Ferrer de Valero 2001; Nettles and Millett forthcoming]. Moreover, availability of research funding in a field generally is correlated with higher completion. Fields in which students are supported on research assistantships funded by a principal investigator's grant exhibit higher completion and lower time to degree [Nerad and Cerny 1991].

Nerad and Cerny [1991] found that the way a dissertation is defined also affects completion and time to degree. Some programs perceive the dissertation as a demonstration of the degree recipient's ability to do future research in the field, while other programs perceive the dissertation as an original, book-length contribution to the field. While joint authorship may be common in some fields, and may contribute to the candidate's dissertation research, other fields consider dissertation research and the final product to be a largely individual endeavor. Fields where laboratory work and dissertation research coincide are also typically higher in completion and lower in time to degree [Nerad and Cerny 1991].

6. Curriculum, Processes, and Procedure

Program requirements, such as a master's thesis, and discipline-specific requirements, such as foreign language proficiency and field research, may contribute to higher attrition and longer time to degree in some programs [Bowen and Rudenstine 1992; Ziolkowski 1990 cited in Ferrer de Valero 2001; Nerad and Cerny 1991]. Higher completion rates tend to occur in programs in which the qualifying exam process includes elements, such as a dissertation prospectus, that advance, rather than distract from, the dissertation process [Golde and Dore 2001].

Research suggests that formal annual evaluations tend to increase the numbers of students who complete, and are therefore preferable to sporadic and informal reviews [Nerad and Cerny 1991]. Golde and Dore, however, report dramatic variation among the disciplines, as well as institutional variation, in this respect [2001]. For example, they report that 70 percent of those surveyed in molecular biology received annual reviews, while this is true for only 35 percent in chemistry. Some form of progress-tracking, annually or each semester, allows the student and supervisor to meet and establish objectives for the year. This ensures that both students and advisors be held accountable for timely progress and for constructive feedback [Berkowitz 2003; Nelson and Lovitts 2001].

Studies differ in their conclusions about what types of employment students expect upon receiving their doctoral degrees. Researchers find that more than 50 percent of science Ph.D. recipients expect to find work

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in the nonacademic sector. Students may not always be honest about aspirations for a career outside the academy, however, because such career paths may not be perceived as legitimate by the faculty [Golde 2000].

Researchers argue that more transparency for students is needed, not only during the first weeks of a program, but throughout the entire program [Nelson and Lovitts 2001; Golde and Dore 2001]. Researchers call for more information about progress assessment and selectivity regarding qualifying exams; financial support; typical times-to-degree, and the amount of time that students can expect with their advisor; as well as data on attrition and completion, job placement, and faculty Ph.D. productivity.

Exit interviews have proven useful instruments for discovering causes of attrition that often go undiscovered [Golde 2000; Nelson and Lovitts 2001]. Golde advises that these interviews should be conducted by people whom the students regard as "safe," i.e., those not likely to be perceived as having the capacity to influence the student's future career.

DEANS AND RESEARCHERS REFLECT ON EFFECTIVE INTERVENTIONS

In April of 2003, graduate deans, researchers, data stewards, disciplinary experts, and students had an opportunity to reflect on what is known to date on attrition and completion.[4] Collectively, they agreed that great progress has been made in the national discussion on graduate degree attrition since the last major workshop held on this topic at the National Science Foundation in 1998 [Rapoport 1998]. Nevertheless, a national action agenda serving the interests of students and society has yet to be agreed upon and implemented in the United States.

In Canada, the federal government has recently turned its attention to the issue of graduate degree completion and time-to-degree, due to an anticipated labor shortage in the higher education system. The Canadian federal government dramatically increased funding to graduate education in order to address the future need to fill faculty positions. This funding is expected to help reduce time-to-completion and improve graduation rates. In the United States, similar projections have been made, but have yet to materialize due in part to an economy that has resulted in delayed faculty retirements and a surge in adjunct positions.

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[4] The CGS Airlie House Workshop on graduate degree completion and attrition, April (2003)

Graduate degree attrition negatively impacts not only student lives and the pipeline of the future faculty, but also the research enterprise. Student attrition entails the potential loss of important innovations, discoveries, and advancements in knowledge. Those convened at the Airlie Meeting discussed the need to change practices ingrained in the culture of graduate education, including practices of defining and measuring degree status as well as those of treating degree candidates while they are pursuing their degrees. While there was nearly universal agreement at the workshop that standardizing the measurement of attrition and completion would be beneficial, attendees also felt that this should not deter immediate experimentation with practices believed to improve doctoral degree completion rates.

Several institutions represented at the workshop have made significant improvements in graduate retention and completion rates through focused interventions such as:

- Use of completion data in graduate program or department review and in the fellowship allocation process

- Inclusion of graduate study supervision in tenure and promotion dossiers

- Data-sharing among deans, broken down by college, and among department chairs for intra-college department comparisons, conducted by the Graduate School/graduate dean

- Mandatory progress-tracking of students signed off by all parties, including student, supervisor, and departmental representative

- Career Center workshops on career transition, conflict resolution, advisor selection, etc.

- Regular student evaluations of supervisor and department

- Graduate student handbooks

Other practices that graduate deans have used to improve graduate degree completion rates include recognizing the pivotal role of graduate secretaries and taking a balanced fellowship allocation approach.

Graduate secretaries are often the best source of information for students who have been out of touch with their advisors and others in the department. Some graduate deans make it a priority to include graduate secretaries in graduate training, on listservs, and in tracking attrition.

Where fellowship allocations are structured to reward departments with high completion rates and minorities in those departments tend to have higher-than-average attrition rates, targeted minority fellowships can

help offset the possibility that some departments may become "risk averse" and decide to accept fewer minorities into the program. When feasible, such funding solutions may supplement other ways of addressing the problem of high minority attrition in a given department. Several deans and researchers at the workshop stated that while underrepresented minority students may have higher attrition in some programs where a support structure is lacking, when such support is in place, minority students either do not differ from, or complete at a much higher rate than, the graduate student population as a whole.

NEXT STEPS

Graduate completion and attrition occur within the context of a complex set of graduate education practices. Many institutions currently are engaged in "reform" efforts responsive to the issues discussed in this paper. There are also national initiatives designed to encourage innovation in doctoral education more generally, including Burroughs-Wellcome Interfaces, the Alfred P. Sloan and W. M. Keck Foundation's professional master of science programs, Preparing Future Faculty, the Responsive Ph.D. Project, the Carnegie Initiative on the Doctorate, and NSF's IGERT, GK-12, VIGRE, and AGEP programs. None of these initiatives, with the possible exception of the AGEP program, is designed with a primary goal of increasing completion rates among matriculated students. However, all should have effects in this direction. As new information emerges from each of these programs, it needs to inform any more targeted Ph.D. completion initiative that may emerge from this workshop.

Additionally, many groups have published recommendations for effective graduate education practices, some specific to a discipline or to ensure the success of women and minorities [Thomas, Clewell, Pearson, Jackson 1987 "The Quiet Crisis"]. Others are directed to graduate education more generally [Re-envisioning the Ph.D. 2000; Golde and Dore 2001].

Some researchers have concluded that more longitudinal analyses are needed, particularly those that combine qualitative and quantitative data to determine not just what is happening (how many students are leaving doctoral programs), but why. Tinto and Clewell [1997] support this view.

From the perspective of all of the stakeholders who have informed this monograph, we conclude that appropriate next steps must include a process that would engage institutions in a systematic, thoughtful, and well-evaluated project to pilot those interventions most likely to increase

completion in all fields. Graduate deans have always been innovators in graduate education, and at the end of the day it is to the graduate schools and the programs within that we will need to look for those experimentations and effective change. This monograph is designed to provide a solid foundation for continuing conversation about the actions required to ensure responsible and salutary innovation.

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