

Workshop Report

**Support of Graduate Students and
Postdoctoral Researchers in the Sciences and
Engineering: Impact of Related Policies &
Practices**

Sponsors:

National Science Foundation
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Executive Summary

On June 17-18th, 2004, the National Science Foundation (NSF), the National Institutes of Health (NIH), and the Council of Graduate Schools (CGS) sponsored a workshop at the Washington, D.C. headquarters of the American Association for the Advancement of Science (AAAS) to discuss emerging issues, research, and current practices related to financial support for graduate students and postdoctoral researchers.

The meeting, which was attended by 101 graduate students, postdocs, faculty from science, technology, engineering, and mathematics (STEM) fields, graduate deans, labor economists, and representatives from federal agencies was one in a series of events designed to examine and provide recommendations that will enhance our knowledge and improve practices and policies associated with graduate and postdoctoral education and research training.

The specific goal of this workshop was to consider the role and impact that student financial support plays in encouraging U.S. citizens to pursue and complete doctoral and postdoctoral studies in STEM fields. The research and resulting discussions highlighted elements of the graduate student and postdoctoral support packages including mode, duration, amount of stipend, health care and other benefits; and indicators of student progress such as completion rate and time to first professional position. The workshop deliberations set the stage for developing best practices and outlining a research agenda on these topics, as well as building a community of researchers, educators, and stakeholders to maintain an ongoing dialogue in this critical area.

The particular topic for this meeting was driven by the recent dramatic changes in NSF stipend policy. Over the last 5 years, the stipends awarded by the premier NSF programs for supporting graduate students have doubled, from \$15,000/year to \$30,000/year. Although the increase in the NSF stipend level has a direct effect on a relatively small fraction of the total population of STEM graduate students throughout the country (about 2%, or 5,000 students), the change has elicited ripple effects throughout both the graduate and postdoctoral enterprises. In some cases, the policy changes have resulted in stipend levels for graduate students that exceed salaries of postdocs. Considering the greater likelihood that new PhD graduates in STEM fields will accept at least one postdoctoral position coupled with the increasing length of the postdoctoral research position, the workshop addressed the challenges and needs of both populations.

Labor economists made several presentations on the topic of quantity versus quality. The preliminary findings indicated that among those who complete the doctoral degree, financial support in the form of stipends helped to reduce time-to-degree (TTD), and that the average quality of doctoral students (as measured by GRE scores) declines as the availability of awards per applicant increases. An important observation was that for many of today's scientists, the time spent in graduate school and postdoctoral research represents approximately $\frac{1}{4}$ of a scientist's career (6 years of grad school + 4 years of postdoc = 10 years of 40 year career). It was noted that uncertainty in obtaining autonomous positions may differentially affect minorities and females, and it was recommended that the whole pipeline be examined, including the postdoctoral years.

If the goal that national science workforce policy seeks or needs to maximize is to produce high quality researchers as quickly and cheaply as possible, stipends are an important tool, but we must also improve career attractiveness. Freeman suggests that we consider alternatives to current funding models, particularly the distribution of funds during the course of a graduate career and the time to first professional position. (He suggested, for example, guaranteeing five years of graduate support to the PhD).

Other research sessions noted that generally speaking, doctoral students in science and engineering fields received more than one mode or type of support throughout their graduate career. On average, students received 2.5 types of support ranging from fellowships, to teaching or research assistantships, to self-support. Research assistantships were the most frequent type of support and were common in four of the top five combinations of financial support.

A panel consisting of a group of representatives from a series of stakeholder focus group meetings was held to lay issues on the table. The focus groups were held with members of the National Postdoc Association, the Council of Scientific Society Presidents (CSSP), a group of graduate students, a group of AAAS fellows (representing recent graduates), and from a group of graduate deans. A number of concerns about the current state of affairs were voiced during the session, as were a few suggestions and possible courses of action. Two of the most prominent points among the panelists were the need for support packages that provide at least basic subsistence and the need for health care coverage. The focus groups that represented greater numbers of junior members of the research community cited the uncertainty of obtaining a professional position at the end of extensive graduate and postdoctoral periods as the most critical problem.

The workshop agenda also focused on university and national issues related to stipend level vs. cost-of-education (COE) allowance. A number of graduate deans questioned the government's priorities in raising stipends, but not COE allowances. Economists in the audience insisted increasing stipends is the only meaningful tool of enticing citizens into otherwise not particularly attractive science careers. Federal agency representatives pointed out that the political reality is that it was not a choice between stipends or COE; it was higher stipends or nothing. Nevertheless, it was clear that COE allowances that are insufficient to cover tuition, fees and benefits put a great strain on universities.

The final day of the workshop included a set of breakout groups focusing on a potential research agenda, best practices for universities, and variables for setting stipend policy. Joan Lorden, reporting for the focus group on creating a research agenda, again noted the poor measures for graduate students, stating, "We don't know who's coming to graduate school and why. We don't know very much about the experiences of students...while they're in graduate school, and we don't know where they go when they leave." The group studying stipend policy re-iterated the theme that stipend level wasn't as useful a focus as considering support packages. In reporting from the group discussing university practices, Les Sims noted, "The communication and clear understanding of expectations (between faculty and research assistants) was a very strong point in the discussion."

Conclusions

The workshop participants concluded that money does, in fact, matter. However, the relationship between financial policy and outcomes is not straightforward. To those in the process, while stipends are important, career prospects are of equal or greater importance. Relevant measures include the attractiveness of early career positions and the time it takes to secure a permanent position. Furthermore, evaluating either time-to-degree or length of postdoctoral appointment independently is not as important as investigating the time to first professional position.

The effect of stipend policy can be asymmetric. Most felt that while slightly higher stipends may not necessarily attract students, poor stipend policies could certainly drive many away. Stipend policy must account for no less than, and preferably better than, a minimum level of subsistence, of which health care is a mandatory aspect, particularly as graduate and postdoctoral appointments become longer.

- A recommendation of the workshop is that support be examined as a total package. Few students use a single mode of support, so understanding the efficacy of any particular mode (fellowship, research assistantship, etc) is difficult and almost irrelevant. An option was discussed to create federal-university partnerships, where students are offered 5-year packages comprised of federal fellowship support along with institutionally funded research and teaching support for the duration of the graduate degree program. Selected NSF Graduate Research Fellowships were suggested as possible sources of funding for a pilot project.
- A final recommendation, or challenge, of the workshop was that in our roles as educators, we need to know more about graduate education, from successful models to the needs of modern graduate students and postdocs. NSF has already begun to implement this recommendation through the addition of a specific call for proposals to study graduate education as part of the ROLE (Research on Learning and Education) program.

More information, including copies of all presentations, handouts, and transcripts, as well as participant information, can be found at: http://www.ehr.nsf.gov/dge/support_workshop.html

Workshop Report

On June 17-18th, 2004, the National Science Foundation (NSF), the National Institutes of Health (NIH), and the Council of Graduate Schools (CGS) sponsored a workshop at the Washington, D.C. headquarters of the American Association for the Advancement of Science (AAAS) to discuss emerging issues, research, and current practices related to financial support for graduate students and postdoctoral researchers.

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The specific goal of this workshop was to consider the role and impact that student financial support plays in encouraging U.S. citizens to pursue and complete doctoral and postdoctoral studies in STEM fields. The research and resulting discussions highlighted elements of the graduate student and postdoctoral support packages including mode, duration, amount of stipend, health care and other benefits; and indicators of student progress such as completion rate and time to first professional position. The workshop deliberations set the stage for developing best practices and outlining a research agenda on these topics, as well as building a community of researchers, educators, and stakeholders to maintain an ongoing dialogue in this critical area.

The particular topic for this meeting was driven by the recent dramatic changes in NSF stipend policy. Over the last 5 years, the stipends awarded by the premier NSF programs for supporting graduate students have doubled, from \$15,000/year to \$30,000/year. Although the increase in the NSF stipend level has a direct effect on a relatively small fraction of the total population of STEM graduate students throughout the country (about 2%, or 5,000 students), the change has elicited ripple effects throughout both the graduate and postdoctoral enterprises. In some cases, the policy changes have resulted in stipend levels for graduate students that exceed salaries of postdocs. Considering the greater likelihood that new PhD graduates in STEM fields will accept at least one postdoctoral position coupled with the increasing length of the postdoctoral research position, the workshop addressed the challenges and needs of both populations.

Research Sessions

Tanwin Chang’s discussion throughout the first research session focused on the question of quantity versus quality in the STEM graduate education pool. The preliminary findings of his research team, under the leadership of economist Richard Freeman, indicated that among those who complete the doctoral degree, financial support in the form of stipends helped to reduce time-to-degree (TTD), and that the average quality of doctoral students (as measured by GRE scores) declines as the number or quantity of awards per applicant increases. Dr. Chang also pointed out the surprising truth that for many of today’s scientists, the time spent in graduate school and postdoctoral research represents approximately ¼ of a scientist’s career (6 years of grad school + 4 years of postdoc = 10 years of 40 year career). Respondent Bill Zumeta made two

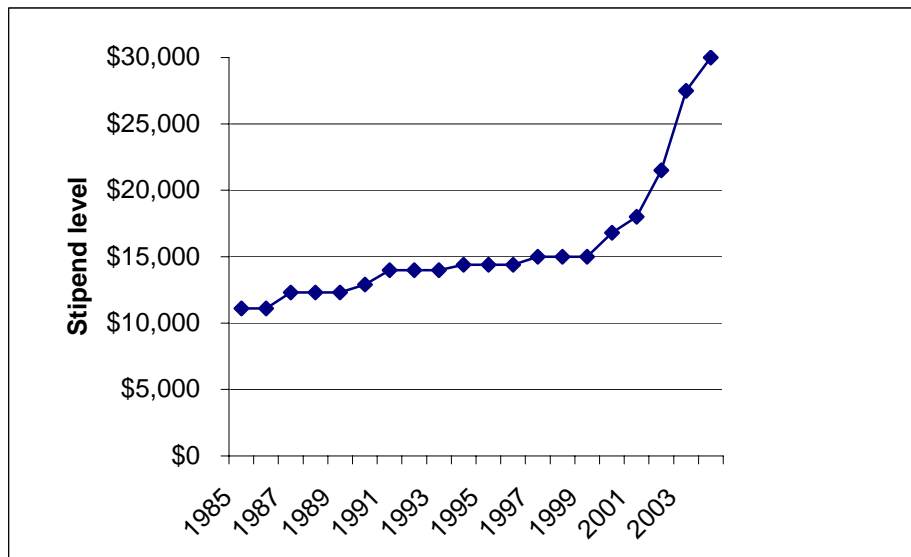


Figure 1: A History of NSF Graduate Fellowship Stipend Data

principal points. He first noted the uncertainty in obtaining autonomous positions, a sub point being that this may differentially affect minorities and females, and second, he recommended looking at the whole pipeline including the postdoctoral years.

The discussion topics in the second research session, provided separately by Joan Burrelli and Michael Nettles, offered different types of insight on the financial support problem. Dr. Burrelli noted that generally speaking, doctoral students in science and engineering fields received more than one mode or type of support throughout their graduate career. She found that on average, students received 2.5 types of support ranging from fellowships, to teaching or research assistantships, to self-support. Research assistantships were the most frequent type of support and were common in four of the top five combinations of financial support. Dr. Nettles highlighted a number of ways in which graduate schools, particularly graduate deans, can draw attention to and positively influence the graduate student and postdoc support models. He argued that increased attention to student funding options, mentoring activities, and research productivity are necessary next steps for graduate deans.

The afternoon panel consisted of a group of representatives from a series of stakeholder focus group meetings. The focus groups were held with members of the National Postdoc Association, the Council of Scientific Society Presidents (CSSP), a group of graduate students, a group of AAAS fellows (representing recent graduates), and a group of graduate deans. A number of concerns about the current state of affairs were voiced during the session, as were a few suggestions and possible courses of action. Two of the most prominent points among the panelists were the need for support packages that provide at least basic subsistence and the need for health care coverage. The focus groups that represented greater numbers of junior members of the research community cited the uncertainty of obtaining a professional position at the end of extensive graduate and postdoctoral periods as the most critical problem.

The CSSP emphasized the national need for STEM graduates for the partnership between science and entrepreneurship. CSSP plans to work with the CGS on a systematic study of people who have obtained science degrees to learn about their experiences as a guide to future national policy. Specifically, they raised the following issues:

- CSSP recognizes that research in the American academy and across the nation is dependent upon the highest quality graduate and postdoctoral education.
 - CSSP will participate in any venues thought likely to advance the number and quality of U.S. graduate students completing science and mathematics degrees.
- CSSP hypothesizes that financial support is only one problem in STEM graduate education. CSSP intends to work with CGS on a systematic study of people who have obtained science degrees in an effort to better understand the challenges and opportunities that we face as we attempt to address this multifaceted issue. Factors in the study will include those listed below
 - Would the graduate repeat her/his career? Why/why not?
 - What does the graduate see as the factors that provided excellent preparation for their post-degree future, what factors were lacking?
 - What factors does the graduate see as creating optimism about their own career future, what factors engender pessimism?
 - What career path does the graduate student anticipate?
 - What opportunities does the graduate foresee in that career path? What roadblocks?
 - Would the graduate recommend the same career to friends? Why/why not?
 - Rank importance of various factors such as confidence in obtaining a long-term position, earnings vs. foregone earnings, benefits, family issues, and faculty role model opinions.
- CSSP hypothesizes that attractiveness of positions early in the professional career may be as important or more important than compensation during the period of graduate study and postdoctoral development.
- CSSP recognizes that any long-term solution to the challenges facing graduate education at American universities must include robust and sustained efforts to ensure student development of creativity, problem solving and critical thinking skills throughout the K-16 system.
 - CSSP anticipates the need to work with multiple partners to address this issue.
- CSSP believes that the partnership between science and entrepreneurship will continue to drive economic development and innovation in the national and global economy and the American research universities can and should play a lead role forging the leaders of this partnership.
 - CSSP will work with its member societies and universities to develop training opportunities that provide both entrepreneurial and science skills.
- CSSP recognizes the critical nature of foreign-born graduate trainees to the future of international science as well as on the sustainability of the American research university.
 - CSSP will continue to work with all engaged parties to assure that the United States government understands all aspects of the complex issue surrounding visas and national

security and to work to develop options such as embassy affiliated scientific fellows in the diplomatic corps to expedite processing.

The Postdoc focus group recommended limiting the number of Ph.D.s in those fields that are market-saturated. The postdocs wanted mutually agreed upon conditions for their positions and also a greater emphasis on training rather than only producing research for their supervisors. The postdocs took the radical stand that a reduction in the number of awards to support postdocs would be acceptable in exchange for addressing the concerns of the remaining ones. Specific opinions and recommendations of this group are below:

- Is money a factor in the decision making process when choosing schools and postdoctoral positions?
 - The general consensus of the focus group was that anyone who values money will likely opt out of an advanced science degree either during their undergraduate studies or before the completion of their dissertation. It should be noted that this is anecdotal evidence.
- What are the largest problems with the current system from a postdoc's viewpoint?
 - Lack of training. Since the emphasis is focused on production, learning other skills that would benefit a future scientist is deemphasized.
 - Substandard compensation and benefits. The low cost of postdocs is good from a societal viewpoint in the short term but may result in long-term disincentives.
 - Time to independence. Longer postdoctoral positions result in an increase in the age at which independence is reached.
 - The large amount of risk aversion by the funding agencies towards young scientists.
 - The requirement to choose between career and family life, especially for women who seek academic positions.
 - Postdocs have been forced to engage in an arms race where training has been neglected in favor of production. This is brought about by the reliance upon publication number as an indicator of skill/accomplishment.
- What are the most desired items?
 - Training-Many in the focus group said they would suffer lower pay and benefits for short periods of time if they were acquiring new skills to enhance their career choice.
 - Benefits (i.e. health care, retirement, etc.)
 - A definition of what the duties of a postdoc are. Is it a postdoc's job to further an established scientist or to establish his/her own research interests? Or is it both? Do we need to think of a new paradigm?
 - Payment that is commensurate with education and training.
- Where should the money come from?
 - Reduction in the overall number of postdoctoral awards in the short term.
 - Reallocation of grant money available from established programs to early career awards.
 - Increased investment in training budget
- Recommendations
 - Limit the number of Ph.D.s across all disciplines beginning with those that are market saturated. This problem is exacerbated by the general attitude that more scientists are better.
 - Develop new systems of mentoring that include multiple advisors and nontraditional research and coursework.
 - Create new postdoctoral awards that give portable monies to the postdoc.

- Create a program of cost sharing with industry to create an entrepreneurial postdoc. This would allow industry to engage in research that may have fundamental and applied rewards.

The report from graduate students actually was a summary from several groups of students, including a convening of student at the annual meeting of the Conference of Southern Graduate Schools, and several convenings of graduate students in Florida. Kelly Browning, President of the Graduate and Professional Student Organization at the University of South Florida, reported on the following main themes:

- *Health Care*: Providing health care is essential, and is the single largest financial factor for graduate students (e.g. even if stipends aren't that high, if health care is covered it's much less of a problem). Several students observed that the demographics of graduate school are shifting; students tend to be older and/or married, and less likely to have coverage through their parents, even when getting an MS. The change in demographics makes health care an even higher priority.
- *Funds for Professional Participation*: Surprisingly, many students stressed, that to them, adequate funding to actively participate in their professions through travel to professional meetings was a higher priority to them than additional salary. They would prefer fellowship awards to include a research or travel allowance rather than additional stipend.
- *Career Uncertainty*: The students attending the meeting felt that stipends didn't play a huge role in their decision to pursue an advanced degree, and even less so in what field they chose. However, while passion for the subject matter was the guiding role in their choice of field, a major concern was the ability to have a stable career once graduate school was completed. Many were not optimistic about their future options for staying in the field of their choice after graduate school.

Similar themes were echoed on the report from the AAAS Fellows focus group. The AAAS Fellows attending the focus group were a mix of recent PhD graduates, people recently completing postdoctoral appointments, and those in mid-career, many of whom had chosen to leave academia for other career paths.

After a presentation by NIH and NSF panelists, the fellows were asked to respond on a range of issues, including ranking their priorities on financial issues. An hour of spirited discussion followed. Three major themes emerged:

- Stipends can only have a negative, not positive effect on career decisions. No one felt another couple of thousand dollars in grad school stipends would have influenced their career decisions **so long as** a minimum standard of living could be maintained. So, while too little money would drive them away, a little more would not attract them.
- Health Care is part of a minimum standard of living. Some decisions were predicated on health care concerns (both career and family decisions)
- The **biggest** factor in deciding to pursue advanced study, or to stay in science and engineering, was not a financial factor relating to grad school, but rather **uncertainty** about future careers. This uncertainty manifested in two main ways:
 - Uncertainty about requirements to complete the PhD; this often seemed like a murky road, with no clear understanding of what had to be done to reach the end of it, and this was discouraging.

- Uncertainty about future career options. In many cases, they knew that once they graduated, there might be one or multiple postdocs for an indefinite number of years; followed by a job hunt, which may or may not lead to a job, which may or may not provide financial security. Many had friends who left for law, business, or medical school to find a clearer path.

The biggest financial issue was early career finance, not grad school finance, as long as minimum standards were met.

The graduate deans report was based on a focus group breakfast held at the CGS annual meeting in December 2003. Dean Howard Jackson of the University of Cincinnati reported on the issue from the perspective of the deans. Unsurprisingly the list of issues included:

- Tuition support
- Stipend support
- Health insurance support
- Housing options
- Travel support

Other issues that were in some sense a subset of these overarching issues included: questions concerning doctoral mentoring and time to degree; the availability of support from university communities of women, of minorities, and of international students; special concerns of married students; and special concerns for first year graduate students.

Stipends level concerns included the issue of support for first year students who are rarely on research assistantships. If graduate students are supported on fellowships (either NSF or internal university fellowships), the group expressed some concern about integration into the departmental culture. Questions of how the transition from higher stipend fellowships to normal RA and TA funding takes place were also raised.

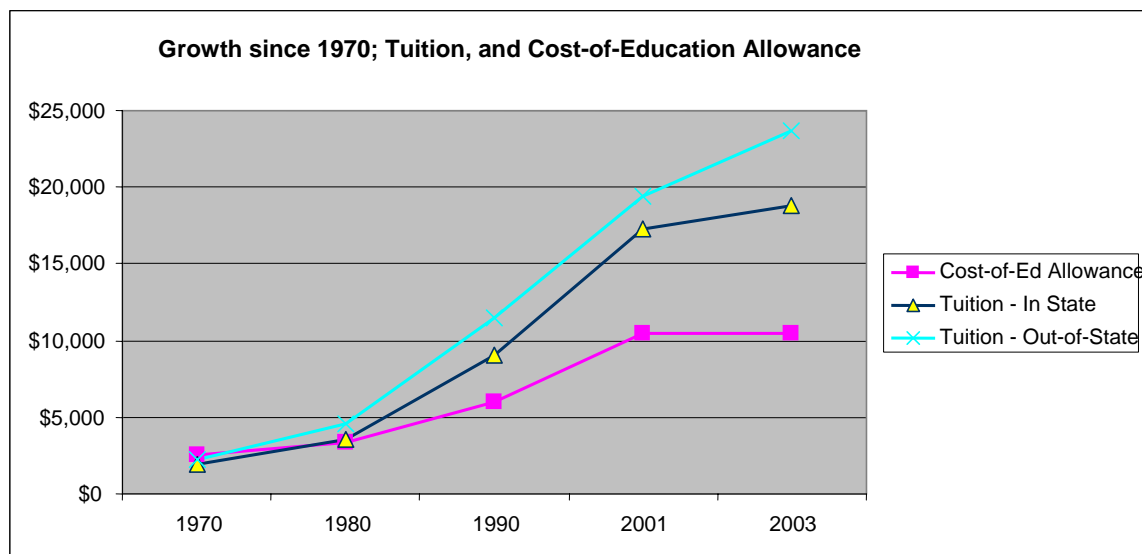
The stipend level concerns also are embedded in the larger issue of the size of NSF or NIH grants, which are not rising, with the suggested increases of graduate student stipends. This is hardly a new issue, but it is not being addressed in any imaginative way at this time. A corollary to this concern is the support of postdocs. As the graduate student stipend rises, are fewer graduate students being supported and more postdocs?

Graduate deans discussed the need for a more holistic view of the costs of graduate education. They emphasized that support is more than just stipends; the integration of students into their programs and how stipend and tuition support in various forms can be used to facilitate this integration is a key issue. Different forms of support may be more critical at different times in a student's career, and different students may have different needs. Support should be structured to lead to desired outcomes – independent scholars, well prepared teachers, researchers able to work in interdisciplinary environments, etc. Although time to degree was a significant concern, the group also was interested in professional development opportunities including some teaching experience for all graduate students. One suggestion to address the time to degree was to provide “last year” support to graduate students.

As in all the other focus groups, support for health insurance was regarded as a key factor. At one university, which supports health insurance at the 50% level, a survey indicated that the single most important factor in their losing students to other programs was the “insufficient” health insurance support.

The health care and early career themes were the most repeated topics throughout the panel and all of the focus group meetings throughout the year.

Cost-of-Education Allowance



Once the wish lists, provided by the focus groups, were out on the table, the workshop agenda focused on university and national issues related to stipend level vs. cost-of-education (COE) allowance. While stipends have increased in the past few years, COE allowance has remained constant. Particularly at NSF, while the fellowship stipend level has doubled since 1998, the COE remains unchanged during that time period. Over a longer time period, tuition increases have significantly outpaced COE increases, and the recent spike in tuition cost nationwide has exacerbated the problem. This has resulted in a subtle policy shift. While for decades, the COE allowance actually subsidized universities hosting fellows and trainees, in recent years the allowance often results in a substantial shortfall. Jeff Reimer, the Associate Dean of the Graduate School at UC-Berkeley, provided background on the situation and discussed how the shortfall was being managed at Berkeley. Walter Schaffer of the National Institutes of Health presented the process by which the NIH arrived at their formula for computing cost of education. The NIH approach was predicated on the assumption that training was a shared responsibility of the university and the agency. As a result, the NIH provides allowances for some costs, such as travel and health care, and a graduated scale for providing tuition, with only a percentage of tuition beyond a certain cap paid.

A number of graduate deans questioned the government's priorities in raising stipends, but not COE allowances. Economists in the audience insisted increasing stipends is the only meaningful tool of enticing citizens into otherwise not particularly attractive science careers. Federal agency representatives pointed out that the political reality is that it was not a choice between stipends or COE; it was higher stipends or nothing. Advocacy of the COE issue is not usefully directed at the agencies, but rather at federal political units. It was also noted that COE allowances are applicable only to a select few traineeship and fellowship programs, effecting less than 20% of federally supported graduate students, and a very small fraction of the total STEM graduate student population. Nevertheless, it was clear that COE allowances that are insufficient to cover tuition, fees and benefits are putting a great strain on many institutions.

While issues of support for underrepresented students were present, to varying degrees, in each of the workshop sessions, Margaret Daniels Tyler and Anthony Rene provided additional targeted information.

They discussed strategic financial considerations in enhancing the minority presence in STEM graduate cohorts. Dr. Tyler made the key observation that “relationship building is the corner stone.” Dr. Rene outlined specific NIH programs available for minority students.

The second day of the workshop began with a series of observations about STEM trends from Alan Leshner. According to Dr. Leshner, a tension exists among the needs, types, and levels of available support for graduate and postdoctoral researchers. Assistantships serve multiple functions and must prepare trainees, graduate students, and postdocs for a wider range of places to work. He also notes that two of the most rapidly changing trends in science and its conduct are the roles of industry and technology. Industry is providing a greater share of support for research and researchers, and is similarly performing a greater share of the research. Where science once drove changes and developments in technology, the reverse is quickly emerging as the stronger truth. Another point is that as “big science”, that is, larger team science, continues to grow, multidisciplinary training is essential. Dr. Leshner concluded with two questions regarding the future of our research agenda – first, are our training approaches appropriate for the science enterprise of the future? Second, are we financing training in appropriate ways?

Richard Freeman continued the discussion of the research agenda by questioning what science workforce policy seeks or needs to maximize. His initial response was that our national agenda must change and that we need to produce high quality researchers as quickly and cheaply as possible. In order to increase the number of U.S. citizens completing the doctoral degree in STEM fields, stipends are an important tool, but we must also improve career attractiveness. He suggests that we consider alternatives to current funding models, particularly the distribution of funds during the course of a graduate career and the time to first professional position. (He suggested, for example, guaranteeing five years of graduate support to the Ph.D., essentially the same suggestion as was made by Dean David Chapman during the Dean’s Focus Group and the CGS annual meeting in December 2003.) Dr. Freeman’s closing, “radical thoughts:” the costs of spending money for stipend payments in order to increase the supply of quality researchers are minute compared to other government expenditures, yet the benefits are potentially enormous for the economic and research agenda.

Breakout Groups and Workshop Summary

The final day of the workshop included a set of breakout groups focusing on a potential research agenda, best practices for universities, and variables for setting stipend policy. Joan Lorden, Provost of UNC-Charlotte, provided the report for the breakout group focusing on research agenda. The strongest theme sounded was our poor understanding of graduate education stating, “We don’t know who’s coming to graduate school and why. We don’t know very much about the experiences of students...while they’re in graduate school, and we don’t know where they go when they leave.” It was noted that there exist only very poor measures of quality on both the input and output sides. It was also noted that while there have been fellowship/traineeship studies; little work has been done to examine students on research assistantships.

Les Sims of the Council of Graduate Schools reported on universities’ “best ideas” on the financial issues for STEM graduate students and postdocs. Chief among these ideas was that university leadership should be involved in public policy decisions on these issues. After the policies have been established, universities should do their best for their students including holding harmless the students from undesirable consequences, as well as help the STEM education mission for the Nation. There was interest in the idea of assuring first and fifth (last) year Ph.D. support for graduate students. This has the corollary of suggesting federal agencies provide temporal flexibility in the relevant awards. Finally, it was noted, “the communication and clear understanding of expectations (between faculty and research assistants) was a very strong point in the discussion.”

Walter Goldschmidts of the National Institutes of Health reported from the breakout group discussing important variables for determining stipend policies. The central conclusion is that STEM training is a partnership activity, not solely the responsibility of either the universities or the federal agencies. Another point, which echoed themes from throughout the workshop, was that the topic of stipends is better transcended by the more inclusive notion of packages. The number one issue for federal agencies is to fulfill the purposes of their programs, which may not be in line with university goals. Agencies emphasize outcomes, which include aspects of accountability, equity and quality.

Judith Ramaley, the Assistant Director for Education and Human Resources from the National Science Foundation, closed the meeting by providing a summation and forward steps. Dr. Ramaley posed several questions that the workshop raised that remain challenges for federal policy:

- What is the proper role for the federal government?
 - Note that federal government provides 20% of the support, universities 40% and self-support 40%.
 - Should the federal government play a leading or following role in packaging support and shaping university priorities?
- What are appropriate policy goals for investing in graduate education?
- What are we learning about the effects of federal stipends, institutional support and tuition changes et al.?

Dr. Ramaley went on to say that modern graduate/postdoc study does not fit the patterns of the past and that all of the partners, the federal agencies, universities and others, should take this into account, and remember that graduate education is a partnership.

Conclusions

Several themes emerged over the course of the workshop:

- Current measures for graduate student quality are poor, which distorts any meaningful effort to determine impact of financial policy. Development of better indicators and more tracking of student success and careers are a necessity.
- While it is not clear how attractive stipends make graduate/postdoc science careers, it is clear that inadequate support can be a barrier. The provision of adequate health care coverage is an essential part of the decision to pursue a STEM graduate/postdoc career.
- A policy of supporting students end-to-end would be a good best practice. Collaboration is necessary between federal agencies and universities to develop a best practice policy (e.g. universities offer graduate students five years of support where 2-3 years are provided by a federal fellowship with the remaining years funded through university guaranteed research and teaching assistantships.)
- The most important single topic to those currently affected, that is, graduate students, postdocs and recent postdocs, is that of uncertainty. The principal uncertainty is that of finding a suitable professional position after a lengthy time spent in graduate and postdoctoral work. The secondary uncertainty was the amount of time to this first professional job. The time to degree, within this overall time, was relatively unimportant.

- The economists at the meeting said that paying higher stipends induces better-qualified students into STEM fields. The economists also said that providing a larger number of traineeships and assistantships lowered the average quality (as measured by GRE score) of the overall pool of STEM students.
- The graduate deans at the workshop were generally pleased at the recent increase in stipends. They were concerned about inequities, real or perceived, with similar graduate students being paid various amounts. It was noted several times that the pay inequities are more readily accepted for graduate fellows, which are perceived as being awarded on the basis of individual merit through national competition. Traineeships, on the other hand, are not perceived in the same way, and there may be more resentment in this case.
- The graduate deans are concerned about financial support for their institutions and, in this setting, that took the form of their wanting the cost of education paid to institutions for fellows and trainees to increase. On both of these issues, most participants recognized that the number of people involved in federal traineeships and fellowships is small (about 20% of the total graduate students supported by NSF) and so is important primarily as an example.

The workshop participants concluded that money does, in fact, matter. However, the relationship between financial policy and outcomes is not straightforward. To those in the process, while stipends are important, career prospects are of equal or greater importance. Relevant measures include the attractiveness of early career positions and the time it takes to secure a permanent position. Furthermore, evaluating either time-to-degree or length of postdoctoral appointment independently is not as important as investigating the time to first professional position.

The effect of stipend policy can be asymmetric. Most felt that while slightly higher stipends may not necessarily attract students, poor stipend policies could certainly drive many away. Stipend policy must account for no less than, and preferably better than, a minimum level of subsistence, of which health care is a mandatory aspect, particularly as graduate and postdoctoral appointments become longer.

A recommendation of the workshop is that support be examined as a total package. Few students use a single mode of support, so understanding the efficacy of any particular mode (fellowship, research assistantship, etc) is difficult and almost irrelevant. An option was discussed to create federal-university partnerships, where students are offered 5-year packages comprised of federal fellowship support along with institutionally funded research and teaching support for the duration of the graduate degree program. Selected NSF Graduate Research Fellowships were suggested as possible sources of funding for a pilot project.

A recommendation, or challenge, of the workshop was that in our roles as educators, we need to know more about graduate education, from successful models to the needs of modern graduate students and postdocs. NSF has already begun to implement this recommendation through the addition of a specific call for proposals to study graduate education as part of the ROLE (Research on Learning and Education) program.

More information, including copies of all presentations, handouts, and transcripts, as well as participant information, can be found at: http://www.ehr.nsf.gov/dge/support_workshop.html

Notes/Opinions From Workshop Co-Chairs Barnhill and Stanzione

(Disclaimer: This section represents the personal views of the workshop co-chairs, and does not represent the official views of the NSF, NIH, or CGS).

The sense of the workshop co-chairs was that the single most important message from the workshop was that the attractiveness of early careers in the sciences must be systemically addressed. Long apprenticeships with poor compensation, but of known duration and career outcome are the hallmark of the medical disciplines, and seldom are seen as discouraging students from entering, or resulting in attrition. Law and business students spend shorter periods in training, but receive no financial support during the process, and this is not a deterrent. The two large differences between these professional careers and the sciences are that the career at the end has a high probability of being rewarding, and the period of training is for a well-defined duration. These careers achieve success where STEM doctoral education fails, and the success is achieved without any attention to student financial support policies. The co-chairs feel strongly that as long as the career path for scientists and engineers with PhDs is poorly defined and not clearly rewarding at its conclusion, problems of attracting and retaining sufficiently many STEM graduate students and postdoctoral researchers will persist. While financial support policy can be used to partially compensate for these costs, it is likely that the compensation levels required to fully remediate these factors would exceed what national policy permits.

The co-chairs further feel that STEM graduate education, and therefore stipend policy, suffers from contradictions of purpose. While the graduate education community views graduate education and, to a lesser degree postdoctoral training as a workforce development problem, the fact remains that graduate students and postdocs are the workhorses of the scientific research enterprise. The relationship between graduate students and postdocs with faculty is both a labor-management relationship and a student teacher one. It is important to recognize that any change in stipend policy has large ramifications in the cost of producing scientific research. As Richard Freeman pointed out, the ever-lengthening postdoc phenomenon is perhaps largely the result of an attempt to build a stable, cheap labor force for science. Structural changes in the normal operation of the research enterprise are likely needed to remedy this problem, probably in the form of permanent staff scientist ranks supplanting long-term postdocs. Clear graduate support policies require clear policy goals. The tension between the two goals of producing affordable high quality research while simultaneously producing a science workforce will continue to make national policy difficult. This tension exceeded the scope of this workshop on financial support of graduate students and postdoctoral researchers and would comprise a worthy topic for a future workshop.

There is considerable discussion and disagreement about whether there are too many or too few STEM graduates for national needs*. The answer is 'yes' to both possibilities. There are too many STEM graduates so narrowly trained that their expertise cannot be applied in a variety of venues (cf. the COSEPUP report on broadening the Ph.D.). There are too few STEM graduates with the appropriate training, both in science/engineering and also in teamwork and communication, who can tackle current big societal problems. There is also the implicit assumption that all disciplines in Science and Engineering have equal workforce needs. Federal investment in workforce development may be better served by targeting specific areas of national significance (such as security) or clearly demonstrated market demand.

*See also The Pan-Organizational Summit on the U.S. Science and Engineering Workforce, meeting summary, published by the National Academies, 2002, pp 3-4.

Appendix A: Workshop Agenda

Thursday, June 17, 2004

7:30 a.m. – 8:30 a.m.
2nd Floor Atrium

Continental Breakfast and Coffee

8:30 a.m. – 9:00 a.m.
2nd Floor Auditorium

Welcome and Opening Remarks

Robert Barnhill, Council of Graduate Schools/National Science Foundation Dean in Residence

Bianca Bernstein, Director, Division of Graduate Education, National Science Foundation

9:00 a.m. – 10:15 a.m.
2nd Floor Auditorium

Research Findings I

Chair: Joan Lorden, Vice Chancellor for Academic Affairs and

Provost, University of North Carolina at Charlotte

Speakers: Tanwin Chang, Policy Analyst, Science and Engineering Workforce Project, National Bureau of Economic Research

Daniel Goroff, Professor, Department of Mathematics, Harvard University

Respondent: William M. Zumeta, Professor and Associate Dean, University of Washington

10:15 a.m. – 10:30 a.m.
2nd Floor Atrium

Coffee and Refreshment Break

10:30 a.m. – 12:00 p.m.
2nd Floor Auditorium

Research Findings and Strategies

Chair: Orlando Taylor, Graduate Dean and Vice President for

Research, Howard University

Speakers: Joan Burrelli, Senior Analyst, Division of Science Resources Studies, National Science Foundation
Michael Nettles, Executive Director, Center for Policy Research and Evaluation, Educational Testing Services

Respondent: Suzanne Ortega, Vice Provost for Advanced Studies, University of Missouri - Columbia

12:00 p.m. – 1:00 p.m.
2nd Floor Atrium

Buffet Lunch

1:00 p.m. – 2:30 p.m.
2nd Floor Auditorium

University Panel: Reports from Focus Groups

Chair: Carol Lynch, Vice Chancellor, Research, and Dean, Graduate School, University of Colorado at Boulder

1:00 p.m. – 2:30 p.m.
2nd Floor Auditorium

University Panel: Reports from Focus Groups

Panel: ***Representing the Graduate Students Focus Group:***
Kelly Browning, President, University of South
Florida Graduate and Professional Student
Organization
***Representing the Council of Scientific Society
Presidents Focus Group:***
Tony Frank, Vice President for Research and
Information Technology, Colorado State University
***Representing the National Postdoc Association
Focus Group:***
Samuel Howerton, Postdoctoral Fellow, National
Research Council
Representing the Graduate Deans Focus Group:
Howard Jackson, Vice President, Research, and
Dean for Advanced Studies, University of
Cincinnati
Representing the AAAS Fellows Focus Group:
Daniel Stanzione, AAAS Fellow, Division of
Graduate Education, National Science Foundation
Respondent: William Berry, Director for Basic Research,
Military Services and Defense Agencies

2:30 p.m. – 2:45 p.m.
2nd Floor Atrium

Coffee and Refreshment Break

**2:45 p.m. – 4:00 p.m. University and Federal Perspectives on the Cost of Education
Allowance**
2nd Floor Auditorium

Chair: Daniel Stanzione, AAAS Fellow, Division of
Graduate Education, National Science Foundation
Speakers: **University Perspective:** Jeff Reimer, Professor of
Chemical Engineering, University of California,
Berkeley
Federal Perspective: Walter Schaffer, Acting
Director, Office of Extramural Programs, National
Institutes of Health

4:00 p.m. – 4:15 p.m.
2nd Floor Atrium

Coffee and Refreshment Break

4:15 p.m. – 5:15 p.m.
2nd Floor Auditorium

**Financial Considerations in Enhancing the Minority Presence
in Graduate School**

Chair: Don Thompson, Deputy Assistant Director,
Education and Human Resources, National Science
Foundation
Speakers: Margaret Daniels Tyler, Executive Director, Gates
Millennium Scholars Program

Anthony René, National Institute of General
Medical Sciences, National Institutes of Health

5:15 p.m. – 6:00 p.m.
2nd Floor Auditorium

Open Discussion of Day One

Moderator: Robert Barnhill, Council of Graduate
Schools/National Science Foundation Dean in Residence

6:00 p.m. – 7:30 p.m.
2nd Floor Atrium

Reception with wine, hors d'oeuvres, and a string trio

Friday, June 18, 2004

7:30 a.m. – 8:30 a.m.
2nd Floor Atrium

Continental Breakfast and Coffee

8:30 a.m.
2nd Floor Auditorium

Welcome

Lewis Siegel, Dean, Graduate School, Duke University

8:30 a.m. – 9:00 a.m.
2nd Floor Auditorium

National Perspectives on Traineeships and Support

Alan Leshner, Chief Executive Officer and Executive Publisher,
Science, American Association for the Advancement of Science

9:05 a.m. – 9:45 a.m.
2nd Floor Auditorium

Future Research and Policy Questions

Richard Freeman, Director, Labor Studies Program, National
Bureau of Economic Research

9:45 a.m. – 10:00 a.m.
2nd Floor Atrium

Coffee and Refreshment Break

10:00 a.m. – 11:00 a.m.

**Graduate and Post-Doctoral Financial Support Breakout
Groups**

*Abelson Conference
Room*

Research Topics on Financial Support

Moderator: Jim Dietz, Associate Program Director, Division of
Research, Evaluation and Communication, National
Science Foundation

Auditorium

Important Variables for Setting Federal Stipend Policy

Moderator: Walter Goldschmidts, Acting NIH Research
Training Officer, National Institutes of Health

*Haskins Conference
Room*

Best Practices for Universities

Moderator: Leslie B. Sims, Senior Scholar in Residence and
Director, External Grants Programs, Council of Graduate Schools

11:15 a.m. – 12:00 p.m.

Groups Report Back for Discussion

2nd Floor Auditorium

Moderator: Judith Ramaley, Assistant Director, Education and Human Resources, National Science Foundation

12:00 p.m. – 12:30 p.m.

2nd Floor Auditorium

Summary of Findings – Where Do We Go From Here?

Judith Ramaley, Assistant Director, Education and Human Resources, National Science Foundation

12:30 p.m.

Adjournment of Meeting

Appendix B: Participant List

SPEAKERS AND MODERATORS

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Appendix C: Speaker/Attendee Bios

BIOGRAPHIES OF SPEAKERS, MODERATORS AND ATTENDEES

Speakers and Moderators

Robert Barnhill is the CGS/NSF Dean in Residence for the current year and one of the organizers of this workshop. He is on leave as VP for Research at the University of Kansas. His administrative research area is research competitiveness and sustainability. Under his watch as VP for Research at Arizona State University and the University of Kansas, external funding doubled in five years at each place. He founded the academic discipline, Computer Aided Geometric Design. He is currently Chair of AAAS COSEPP.

Bianca L. Bernstein is the Director of the Division of Graduate Education at NSF; previously she was the Dean of the Graduate School at Arizona State. She received a baccalaureate degree from the UC, Berkeley, and a master's and Ph.D. in Counseling Psychology from UC, Santa Barbara.

William O. Berry is the Director of Basic Research, Office of the Director of Defense Research & Engineering, Department of Defense.

Kelly Browning is a doctoral candidate in Criminology and has been the Graduate and Professional Student Council President at the University of South Florida for the past two years. During that time Ms. Browning has focused on the financial, academic and cultural needs of graduate students both locally and nationally. Additionally, Ms. Browning has a research consulting business that is currently examining the climate of graduate student life at USF.

Joan Burrelli is responsible for the congressionally mandated NSF report "Women, Minorities and Persons with Disabilities in Science and Engineering. In addition to producing the Women and Minorities report, Dr. Burrelli is the Project Officer for the NSF Survey of Earned Doctorates.

Tanwin Chang examines science policy in support of the Science and Engineering Workforce Project at the NBER. He received his BA and PhD degrees in Physics from the University of Chicago and Emory University respectively.

James S. Dietz is with the Division of Research, Evaluation and Communication at NSF.

Tony Frank is Vice President for Research and Information Technology at the Colorado State University.

Richard B. Freeman is the Director of the Labor Studies Program at the National Bureau of Economic Research. Additionally he holds the Herbert Ascherman Chair in Economics at Harvard University, and a Senior Research Fellow and Visiting Professor at the London School of Economics. He has previously held faculty positions at the California Institute of Technology, Yale University, and the University of Chicago.

Walter Goldschmidts is the Acting NIH Research Training Officer, National Institutes of Health.

Samuel Howerton is an analytical chemist and current National Research Council (NRC) postdoctoral fellow at the National Institute of Standards and Technology (NIST). He is a representative of the Policy Committee of the National Postdoctoral Association (NPA).

Howard E. Jackson is presently Vice President for Research and University Dean of Advanced Studies, Professor of Physics, and Distinguished Teaching Professor, at University of Cincinnati, Cincinnati, Ohio. He continues to carry out funded research on experimental condensed matter physics with a focus on semi-conductor self-assembled quantum dots.

Alan Leshner is the CEO of the American Association for the Advancement of Science and the Executive Publisher of the journal *Science*; previous appointments include the National Institute on Drug Abuse, NIMH, and Bucknell University. Dr. Leshner has an undergraduate degree from Franklin and Marshall College, and M.S. and Ph.D. degrees from Rutgers.

Joan Lorden joined the University of North Carolina at Charlotte as Provost and Vice Chancellor for Academic Affairs in 2003. She received a BA from the City College of New York and a PhD in psychology from Yale University. She was elected Chair of the Board of Directors of the Council of Graduate Schools in 2003 and during 2002-03 she was the Dean in Residence in the Division of Graduate Education at National Science Foundation.

Carol Lynch is a biologist and VP for Research and Dean of the Graduate School at the University of Colorado at Boulder. She was President of the Western Association of Graduate Schools and served on the Council of Graduate Schools board. She is on the GRE board and the executive committee of the Council on Research Policy and Graduate Education.

Michael Nettles is the executive director of the Center for Policy Evaluation and Research in the Research & Development Division at Educational Testing Service. He was a professor of education at the University of Michigan and served as the first executive director of the Fredrick D. Patterson Research Institute of the United Negro College Fund.

Suzanne Ortega is a Professor of Sociology and Vice Provost for Advanced Studies and Dean of the Graduate School at the University of Missouri. She is past-Chair of the Midwestern Association of Graduate Schools and is the Chair-Elect of the Council of Graduate Schools Board of Directors.

Judith A. Ramaley is the Assistant Director, Education and Human Resources Directorate at NSF. She also holds a presidential professorship in biomedical science at the University of Maine-Orono and is a fellow at the Margaret Chase Smith Center for Public Policy. She previously was president of the University of Vermont and Portland State University. She has also held positions at Indiana University, University of Nebraska, SUNY, and the University of Kansas. She received a bachelor's degree from Swarthmore and doctorate from UCLA.

Jeff Reimer is Associate Dean, Graduate Division at UC Berkeley. He is also a professor of chemical engineering and faculty scientist at the E.O. Lawrence Berkeley National Laboratory. Professor Reimer teaches undergraduate and graduate chemical engineering, particularly introductory courses in mathematical modeling of physical and chemical phenomena, including industrial and environmental chemistry. His responsibilities in UC Berkeley's Graduate Division include campus-wide reviews of academic programs and oversight of information systems that support graduate students.

Anthony René, is Assistant Director for Referral and Liaison, National Institute of General Medical Sciences, National Institutes of Health.

Walter Schaffer is the Acting Director, Office of Extramural Program at NIH.

Lewis Siegel is Vice Provost and Dean of the Graduate School, Duke University. He is the 2004 Chair of the Board of Directors of the Council of Graduate School, and Chair of the Research Committee for the Graduate Record Examination Board.

Les Sims was Graduate Dean at the University of Iowa from 1991-2001. He is Senior Scholar in Residence at the Council of Graduate Schools. Since 2001 he has directed the Best Practices mission of CGS.

Dan Stanzione is an AAAS Fellow with NSF, and an organizer of this workshop. He previously served on the faculty at Clemson University in Electrical and Computer Engineering, and at the end of his term at NSF will become the Director of High Performance Computing for the Fulton School of Engineering at Arizona State.

Orlando L. Taylor is Vice Provost for Research, Dean of the Graduate School, and Professor of Communications at Howard University. Prior to joining the Howard faculty in 1973, Vice Provost Taylor was a faculty member at Indiana University. He also has served as a Visiting Professor at Stanford University and Visiting Scholar and the Carnegie Foundation for the Advancement of Teaching.

Donald E. Thompson is Director of the Human Resources Development Division at NSF. Previously he was vice president for research and dean of the Graduate College at the University of Western Michigan University.

Margaret Daniels Tyler is currently serving as Executive Director of the Gates Millennium Scholars Program (GMS). Previously, Ms. Tyler was Manager of Global Diversity for McKinsey & Company. She has also served as Chief of Staff to the President of Norfolk State University, and in several positions over almost twenty years at the Massachusetts Institute of Technology (MIT), including Director of Master's Admission for the Sloan School of Management, and Associate Dean of Graduate Education.

William Zumeta is Professor and Associate Dean in Daniel J. Evans School of Public Affairs and Professor in Educational Leadership and Policy Studies at the University of Washington. His doctorate is from the University of California, Berkeley.

Attendees

Alexandra Achen is an NSF Intern working on the Postdoctoral Initiative effort. Undergraduate student of economics and mathematics at the University of Michigan, planning to pursue graduate studies in economics.

Chuck Ambler is Dean of the Graduate School and Professor of History at the University of Texas at El Paso--a Hispanic majority research institution. He currently has a Sloan Foundation grant to encourage minority institution and student participation in Professional Science Master's degree programs.

Rebecca Aanerud is the Associate Director of the Center for Innovation and Research in Graduate Education. With the director, Maresi Nerad, she undertakes research on a variety of issues associated with graduate education, in particular career paths of PhD recipients, family and career paths of graduate students and faculty, and innovations associated with the IGERT programs.

Janis Andersen has served as a department chair, chair of the faculty senate, academic consultant to the Chancellor of the California State University and Associate Dean of Graduate and Research Affairs. She is Interim Dean of the Graduate Division at San Diego State University. She is a professor of communication, widely published, a past board member of national and international organizations, a past president, and a member of several journal editorial boards.

Ronald M. Atlas is Graduate Dean, Professor of Biology, and Co-director of the Center for the Deterrence of Biowarfare and Bioterrorism at the University of Louisville. He is author of nearly 300 manuscripts and 20 books. He is a fellow in the American Academy of Microbiology and has received the ASM Award for Applied and Environmental Microbiology, the ASM Founders Award, and the Edmund Youde Lectureship Award in Hong Kong.

Connie Atwell was formerly the Associate Director for Extramural Research at NINDS, NIH and co-chair of the Research Business Models Subcommittee of the NSTC Committee on Science. She now serves as a consultant to that subcommittee.

Moges Ayele is Director of the National Highway Institute at the DOT.

Benita Barnes is a fourth year doctoral student in the Higher, Adult, and Lifelong Education Program at Michigan State University. Her research centers on doctoral education. She is the President of the National Association of Graduate-Professional Students.

P.S. Benepal is Director—Multicultural Alliances with the USDA. He manages Alaska Native-Serving and Native Hawaiian-Serving and Hispanic-Serving Institutions, Science and Education Resources Development Programs at the Cooperative State Research, Education and Extension Service.

Katie E. Blanding is the Graduate Student Researchers National Program Manager in the Office of Education at NASA. She has a B.S. and M.Ed. from Tuskegee University, and PhD in Higher Education Administration from the University of Wisconsin, in Madison, Wisconsin. Prior to NASA she was the Assistant Director of the Office of

Research and Development, at Alabama A&M, and the University Affairs Officer, in the Research, Development and Engineering Center at the U. S. Army Missile Command, Redstone Arsenal, AL.

Eugene F. Brown is a Professor of Mechanical Engineering at the Virginia Polytechnic Institute and State University. He currently serves as Program Director for the Graduate Research Fellowship Program at the National Science Foundation.

Heath Brown is Director of Research and Policy Analysis at the Council of Graduate Schools. Brown has previously worked as a researcher and policy analyst at the Congressional Budget Office, the Center for Washington Area Studies, and the American Bus Association. He has a B.A. from Guilford College, and an M.A. in International Affairs from George Washington University where he is completing his doctorate in international affairs and public policy.

Lara Campbell is a Senior Program Associate at AAAS where she works with the Research Competitiveness Service to provide review, evaluation, and guidance to the science and engineering community on the development of quality research programs. She also manages three of the AAAS Science and Technology Policy Fellowship Programs.

Lynda Carlson is Director of the Division of Science Resources Statistics, NSF. SRS is the federal statistical agency with responsibility for data and analysis on the science and engineering enterprise. Dr. Carlson is a fellow of the American Statistical Association. Prior to NSF, she was at the Energy Information Administration, DOE.

David Chapman is Professor of Geophysics, Dean of the Graduate School, and Assoc. Vice President of Graduate Studies at the University of Utah

Jolie Cizewski is Vice Dean of the Graduate School and Professor of Physics at Rutgers University, New Brunswick. She currently is the PI on an NSF grant (Experimental nuclear physics) and co-PI on NSF GK12. She has been a Fellow at APS and AAAS.

Lenore Clesceri is Acting IGERT Program Director, NSF and President of Clesceri Associates Ltd. She has a Ph.D. in biochemistry; her research interest is biogeochemistry.

Mary Delong is Director of Graduate Partnerships Program that links NIH laboratories with Universities in research training of Ph.D. graduate students.

Ed Derrick is Director of the AAAS Research Competitiveness Program, which provides programmatic peer review and guidance to the research community on the development of quality research programs.

Dennis Deturck is Professor of Mathematics at the University of Pennsylvania, does research in differential geometry and partial differential equations, and directs Penn's Access Science GK-12 program.

Deba Dutta is Professor of Mechanical Engineering at the University of Michigan, Ann Arbor and on leave at NSF as IGERT Program Director.

Joan Esnayra is a Program Officer with the Board on Higher Education and the Workforce at the National Academies in Washington, DC. She is study director for an evaluation of the NIH minority research training programs.

Sally K. Francis is Dean of the Graduate School at Oregon State University. She provides leadership and oversight of all areas of graduate education. OSU is a Doctoral-Research-Extensive university.

Maryrose Franko is Senior Program Officer for Graduate Education at HHMI (predoc, physician postdoc and medical student fellowships); Creator of GrantsNet; Co-developer of BWF: HHMI Course in Scientific Management and the resulting guide 'Making the Right Moves'.

Helen Frasier, 2004 Policy and Research Intern at CGS and Associate Director of Academic Affairs at Georgetown University, received her Ed.M. from Oregon State with a major in College Student Services Administration. As

supervisor of Georgetown's student services unit, she has played an important role in the complete overhaul of student service processes. Ms. Frasier is a Ph.D. candidate in Educational Policy at the University of Maryland, College Park, where she plans to write her dissertation on the costs to both students and universities of extended time-to-degree in graduate programs.

Bill Galey is Director of Graduate Programs at HHMI. He oversees programs in predoctoral, postdoctoral, and medical research training as well as the HHMI-BWF Laboratory Management Initiative. Prior to joining HHMI Dr Galey directed graduate programs at the University of New Mexico for over 10 years.

Moheb Ghali is Vice Provost for Research and Dean of the Graduate School at Western Washington University. He is President of the International Society for Research on Inventories, and past President of the Western Association of Graduate Schools.

John Godfrey is Assistant Dean at the Rackham Graduate School at the University of Michigan whose responsibilities include international education and graduate fellowship programs and training grants.

Maureen Grasso currently serves as dean of the Graduate School at The University of Georgia. Prior to her appointment at Georgia, she was an administrator with the Graduate School at the University of North Carolina, Greensboro serving as associate dean and then interim dean. At UGA, Grasso holds an academic appointment as professor of textile sciences in the department of textiles, merchandising and interiors in the College of Family and Consumer Sciences.

Jim Griffin is at The Institute of Education Sciences in the U.S. Department of Education and oversees Post- and Predoctoral training programs for education research.

Madeleine Hamblin directs the Office of Graduate Affairs and is responsible for federal fellowships at the University of Chicago.

Richard Harpel is the Director of Federal Relations for Higher Education at the National Association of State Universities and Land Grant Colleges (NASULGC). He is responsible for the association's interests in student financial aid and institutional support, as well as basic scientific and health research, legal affairs, higher education finance, and federal rules and regulations.

Peter Henderson is at the National Academies.

Mark Herbst reports to the Director for Basic Sciences in the Office of the Secretary of Defense. He works on policy development and implementation in areas concerning research, graduate education, universities, and grants and agreements.

Milton Hernandez is the Director of the Office of Special Populations and Research Training, NIAID and oversees the training of approximately 1600 young scientists per year.

Lorretta Hopkins is a Senior Staff Associate in the Division of Materials Research at NSF.

John Jackson is an Einstein Fellow with the National Science Foundation, promoting STEM and the GK-12 program.

Mi Sarah Jung is on the Evaluation Team, Administration Department, Korea Research Council for Industrial Science and Technology.

Charlotte Kuh, an economist, is Deputy Executive Director of the Policy and Global Affairs Division at the National Academies. She is interested in the changing structure of the STEM workforce and in the assessment of doctoral programs.

Evangeline D. Loh is the Executive Secretary of the AAMC Group on Graduate Research Education and Training (GREAT).

Barbara Lovitts is author of the book "*Leaving the Ivory Tower: The Causes and Consequences of Departure from Doctoral Study*". Among the things the book addresses is the role of type of financial support in attrition and retention in ways not related to the monetary value of the support.

Cyndi Lynch is the Director of Fellowships and Professional Development at Purdue. She is interested in trends and support for graduate students.

Rich McGee Prior to joining the NIH Graduate Partnerships Program in 2003, Dr. McGee led graduate student and minority student development activities at 3 universities, most of which included NIH funding mechanisms. In 2002-2003 he was the Chair of the AAMC Group on Graduate Research Education and Training (GREAT Group).

Victoria McGovern is a Senior Program Officer at the Burroughs Wellcome Fund, an independent private foundation whose mission is to advance the medical sciences by supporting research and other scientific and educational activities. She manages the Fund's career development programs aimed at career development of assistant professors.

Jack Mills is a psychologist by training with an emphasis in evaluation research and organizational effectiveness. He is working on numerous evaluations of programs designed to improve the academic achievement of minority students K-post-graduate. He is the owner of Choice Point Applied Research and is working with SACNAS.

Satomi Nassirian, who recently joined CGS as Program Manager, External Grants, received her M.Ed. from Harvard University, with a concentration in Administration, Planning, and Social Policy. She has managed educational and professional development programs and publications for the American Association of Collegiate Registrars and Admissions Officers (AACRAO) and other membership organizations; designed and developed training programs for the Gates Millennium Scholars program; and has administered a scholarship program for the Japanese Embassy in Washington, D.C.

Edna Nore is a summer intern at NSF in the Division of Graduate Education. She recently graduated from Oakwood College, Huntsville, AL (Biochemistry). She is originally from Florida and plans to obtain a Ph.D. in engineering.

Jim Orr serves as Chair of the Division of Biological Sciences and Professor of Molecular Biosciences at the University of Kansas. He has significant involvement with NIH %28NIGMS%29 sponsored Minority Student programs.

Stella W. Pang received her B.Sc. degree from Brown University in Electrical Engineering and Computer Science in 1997 and M.Sc. and Ph.D. degrees in Electrical Engineering and Computer Science from Princeton University in 1978 and 1981. She joined the University of Michigan in 1990. Currently, she is a professor in electrical engineering and computer science and the associate dean for graduate education in the college of engineering. Dr. Pang's research interests include nanofabrication technology for microelectromechanical, microelectronic and optical devices.

Nancy Pearson is the Training Officer for the National Center for Complementary and Alternative Medicine (NCCAM) at NIH. She is also a member of the NIH Training Advisory Committee and chairs a subcommittee of TAC that is a liaison to the National Postdoctoral Association.

Yokaira Peralta works at NSF. She is from New York City and graduated recently from Lehman College in Computer Information Systems.

Alan Peterfreund serves as an external evaluator for a number of programs that support graduate students in STEM disciplines. These include: NIH MORE programs at San Francisco State University (RISE, PREP) and NSF LS-AMP (SFSU) and GK-12 (SFSU, Northeastern and Harvard). He is the founder and owner of Peterfreund Associates.

Laura Petonito is an educator with twenty plus years of Federal service—DHS, VA and US Senate Committee. She has a special interest in STEM student recruitment, development and opportunities.

Jean Pomeroy is Senior Policy Analyst with the National Science Board at NSF.

Alan Rapoport is the senior analyst in the Division of Science Resources Statistics (NSF) responsible for the academic R&D chapter of Science and Engineering Indicators and interested in graduate education issues.

Alyson Reed is the Executive Director of the National Postdoctoral Association, providing staff leadership to this newly formed professional society representing postdoctoral scholars. Ms. Reed is an experienced non-profit manager and executive, having previously served as the Executive Director of the Maryland Commission for Women and of the National Committee on Pay Equity.

Harry Richards is currently the Dean of the Graduate School and Coordinator of the PFF program at the University of New Hampshire. He has been the NSF Coordinating Official for the campus and served as Associate Dean of the Graduate School.

Emilda Rivers has been with the Division of Science Resources Statistics (SRS) at the National Science Foundation since October 2003. She has seventeen years federal government service including Decennial Census evaluations and energy consumption survey-related efforts. Currently, she is working on the redesign of the Survey of Graduate Students and Postdoctorates in Science and Engineering and leading the SRS Postdoctoral Initiative effort.

Janet Bond Robinson is an Assistant Professor of Chemistry at the University of Kansas whose research in chemical education is funded by an NSF Career grant and investigates the development of chemistry graduate students while doing research (empirical chemical knowledge) and while teaching laboratories (pedagogical chemical knowledge). She has been the PI of a GK12 project at the University of Kansas since 1999.

Jim Schaefer has been Associate Dean for Academic Affairs and Financial Aid at Georgetown University for 12 years. Previously he was Assistant to the Dean of the Graduate School at the University of Minnesota.

Joan Schwartz received her B.A. degree from Cornell University and her Ph.D. from Harvard University, with training in Biological Chemistry. After postdoctoral training at Rutgers Medical School, Dr. Schwartz moved to the NIH and has spent her entire professional career there. She is now Assistant Director, Office of Intramural Research, OD, NIH.

David M. Shafer is Assistant Dean of the Graduate School at North Carolina State University.

Jennifer Slimowitz is a program officer at the National Academies on the Board of Mathematical Sciences and their Applications. She served as an AAAS Fellow at the National Science Foundation in the Division of Graduate Education for the 2002-3 year. She has a Ph.D. in mathematics from the State University of New York at Stony Brook.

Robert Sowell is the Graduate School Dean and Associate Vice Chancellor for Research and Graduate Studies and Professor of Biological and Agricultural Engineering at the North Carolina State University.

Tia Spencer is a doctoral student in Higher Education Administration at The George Washington University, with a concentration in Higher Education Policy. She is currently interning at the National Science Foundation under the guidance of Dr. Judith Ramaley, Assistant Director of the Education and Human Resources Directorate, and Dr. Donald Thompson, Deputy Assistant Director of EHR.

Andrea Stith is a Science Policy Analyst for the Federation of American Societies for Experimental Biology where she focuses on policy issues related to the education and training of young scientists.

M. J. Suiter is a geologist and educator with more than twenty-five years of experience. Suiter is currently a program director in the Human Resources Development Division of the National Science Foundation's Education and Human Resources Directorate (NSF/EHR). Her responsibilities are in programs focused on access issues and broadened participation and are implemented in K-12, undergraduate, and graduate education.

Fedora Sutton is the Program Director for the Plant Genome Research Program in the Division of Biological Infrastructure at the National Science Foundation.

Phil Sweany joined University of North Texas' Computer Science department in Fall 2003, having previously been a faculty member at Michigan Technological University where he was graduate director for the CS program for two different terms totaling 4 years.

Peter Syverson is Vice President for Research at the Council of Graduate Schools, with responsibility for the survey and analysis activities of the Council. His research has focused on the flow of talent through the higher education system and into careers. Most recently he conducted a survey that found widespread decreases in applications to U.S. graduate schools from international students. These declines were especially evident in STEM fields at major research universities.

Michael S. Teitelbaum, a demographer, is Program Director at the Alfred P. Sloan Foundation and was a member of the NRC Committee on National Needs for Biomedical and Behavioral Scientists that reported in 2001.

Ron Trewyn is Vice Provost for Research, the chief research officer at Kansas State University with responsibility for research administration and research compliance matters. As Dean of the Graduate School, he oversees graduate education administration and implements quality assurance measures for graduate programs offered at the university. As President of the KSU Research Foundation, he facilitates the protection and commercialization of university intellectual property.

Reneta Tull is the Program Director of PROMISE, Maryland's Alliance for Graduate Education and the Professoriate, a National Science Foundation funded tri-campus alliance, with UMBC the Lead Institution. Dr. Tull is also on the faculty of the Hearing and Speech Sciences Dept. at the University of Maryland College Park. She is trained as a Speech Scientist (Ph.D., Northwestern University) and has additional training in Electrical Engineering (M.S.E.E., Northwestern; B.S.E.E. Howard University). Tull previously served on the faculty of the Department of Communicative Disorders at the University of Wisconsin-Madison.

James Voytuk is Senior Research Program Officer at the National Research Council. Most of the studies he directs involve human resource issues. His current project is an assessment of the need for research personnel in the biomedical, behavioral, and clinical sciences.

Dr. Robert Webber has been with the National Science Foundation for nineteen years, serving in various positions within the Director's Office and in the National Science Board Office. He is currently working with the Board on broadening participation in science and engineering research and education.

Robert Weisbuch has served as President of the Woodrow Wilson Foundation since fall 1997. During that time the Foundation has engaged in such initiatives as The Humanities at Work The Responsive Ph.D. Teachers as Scholars and High School Early College. In all Weisbuch has emphasized the role of the Woodrow Wilson Foundation in connecting higher education to the social sectors beyond academia and in connecting the levels of education to each other. In all of these programs the Foundation focuses on great teaching.

G. E. O. (Otto) Widera is presently Professor and Senior Associate Dean of the College of Engineering at Marquette University. He was associated with the University of Illinois at Chicago during the period of 1965-1991 and served as Head of the Mechanical Engineering Department from 1982-1991. He joined Marquette, as Chair of the Mechanical and Industrial Engineering Department in 1991. During 1998-99 and 2003 he served as Interim Dean of the College and became Senior Associate Dean in December of 1999.

Jennifer Wingard is NASULGC Director of Academic Affairs, Research and Student Programs. She staffs the NASULGC Council on Research Policy and Graduate Education, and is interested in the substance of the workshop especially as it applies to increasing the number of minority PhDs annually.

Terry Woodin is Program Director in the Division of Undergraduate Education, NSF. She is Associate Professor of Biochemistry Emeritus at the University of Nevada, Las Vegas.

Eric Zimmerman is an intern at The Academies, working on a study on International Students. The topic of this event is highly relevant to the background work he is doing for the Committee.

Huang Zoe is a Health Scientist Administrator at National Heart, Lung and Blood Institute, NIH. She is an experienced Scientific Review Administrator and has reviewed a variety of grant applications and contract proposals, including individual career awards (Ks) and institutional training programs (T32 and T35).

Appendix D: Annotated Bibliography of NSF Efforts in Graduate Education 1995-Present

A Brief History of Graduate Education Activities at the National Science Foundation and the National Science Board Since 1995

A number of activities related to S&E graduate education have taken place at the National Science Foundation (NSF) and National Science Board (NSB) since the mid 1990s, especially since the release of the NAS COSEPUP report *Reshaping the Graduate Education of Scientists and Engineers* in 1995. These activities have taken many forms including: creation of task forces and working groups; workshops and conferences; data collections and analyses; formal (publicly distributed) and informal (limited internal distribution) reports, and new program development.

Background

The COSEPUP (Committee on Science, Engineering, and Public Policy), chaired by Dr. Phillip Griffiths (former member of the National Science Board), issued its report *Reshaping the Graduate Education of Scientists and Engineers* in 1995. (Report at: <http://www.nap.edu/readingroom/books/grad/>). The report focused on PhDs and discussed the changing context of graduate education and the employment trends and prospects for the employment of S&E graduates. It included discussions of unemployment and underemployment, the issue of foreign students, time to degree, and information needs. Major recommendations were:

1. *Offer a broader range of academic options.* To produce more versatile scientists and engineers, graduate programs are needed that allow students to gain a wider variety of skills. To foster such versatility, government and other organizations should adjust their support mechanisms to include new education/training grants to institutions and departments. In encouraging versatility, care should be taken not to compromise other important objectives.
2. *Provide better information and guidance.* Graduate students and advisors need up-to-date information about potential careers and employment. Students should be encouraged to consider career paths other than an academic research career. NSF should continue to improve the coverage, timeliness, and clarity of analysis of the data on the education and employment of scientists and engineers in order to support better national decision-making about human resources in S&T.
3. *Devise a National Human-Resource Policy for Advanced Scientists and Engineers.* No coherent national policy guides the education of advanced scientists and engineers. A national discussion group--including representatives of governments, universities, industries, and professional organizations--should deliberately examine the goals, policies, conditions, and unresolved issues of graduate-level human resources.

Recommendation 5.3.3 of the report was explicitly directed at NSF and stated

"The National Science Foundation and National Research Council should continue to improve the coverage, timeliness, and analysis of data on the education and employment of scientists and engineers to support better decision-making about human resources in science and technology."

NSB Task Force on Graduate Education

The National Science Board (NSB) Task Force on Graduate and Postdoctoral Education was established in June 1995 to examine the merits and mix of the several modes of funding support (e.g. research assistantships, fellowships, traineeships) used by NSF to support graduate and postdoctoral education, and the impact of the various modes of support on their experience and preparation. The Task Force was provided a great deal of information and background from a special NSF-wide data group staffed by the Division of Science Resources Statistics (SRS) and the Directorate for Education and Human Resources (EHR). In the end, the Task Force did not feel that there was sufficient data linking both the national data and NSF support data to make recommendations for major revisions in the mix of NSF funding.

In February 1996 the NSB Task Force delivered its report. The report noted that there were major institutional and disciplinary variation in time to degree, and that shorter time-to-degree occurred for students who were supported than for those who were not. The report recommended:

- Limited studies should be conducted on alternative modes of graduate support with defined goals and assessment criteria.
- SRS and/or SBE (Directorate for Social, Behavioral, and Economic Sciences) should support data collection and/or research on funding mechanisms and various aspects of graduate student education and employment
- Special attention should be paid to the role of foreign students in the STEM enterprise.

MPS Conference

The Mathematical and Physical Sciences Directorate (MPS) planned and hosted a conference in June 1995 on education and employment patterns of graduates in the physical sciences. The participants discussed many of the same issues raised in the COSEPUP report but concentrated on the physical and mathematical sciences. A report on the conference "Graduate Education and Postdoctoral Training in the Mathematical and Physical Sciences: Workshop Report" (NSF 96-21) was released some time after the workshop. The report made the following recommendations:

- 1) Mechanisms should be found to encourage a broadening of the training and educational experience of MPS graduate students.
- 2) Mechanisms should be examined for shortening the average time to the Ph.D. degree in the MPS fields.

- 3) The use of off-campus experiences, such as industrial internships, should be increased.
- 4) Efforts should be made to decrease gradually the proportion of graduate students funded as research assistants and to increase gradually the proportion funded by other mechanisms, including traineeships and fellowships, as well as novel, collective modes of support.

NSF's Women & Science Conference

"The Women & Science: Celebrating Achievements, Charting Challenges" conference was held in December 1995. It was a joint effort of the seven NSF Directorates. The purpose of the conference was to take stock of the achievements that women have made, assess what works best in the classroom and workplace, and to begin to chart a new course to address the challenges that remain. Due to the background of conference participants, much of the focus was on women in academia. Graduate education was one of many issues addressed. (Conference report at <http://www.nsf.gov/pubs/1997/nsf9775/>)

Engineering Workforce Project

The Engineering Workforce project also commenced during this period. The project explored the way engineering education—at all levels, not just the Ph.D.—related to career activities and outcomes. A major objective was to develop an engineering workforce profile examining such issues as: engineering education, careers, and occupational activities; engineers as managers; engineers in industry and government; engineering and computer-related operations; and engineers in the defense industry. SBE participated in the project both by providing funding along with ENG, CISE, and EHR and by providing staff oversight and guidance on use of SRS data. For the relationship between education and occupation see <http://www.nsf.gov/sbe/srs/issuebrf/sib99318.htm>.

Working Group on Graduate Support Activities

In late March 1996 a Working Group advisory to SMIG (the Senior Management Integration Group) was established to review the NSB Task Force Report on Graduate and Postdoctoral Education and suggest experiments for NSF 'pilot' activities. The Group delivered an internal report on May 15, 1996. The report outlined a portfolio of innovative activities to enrich U.S. graduate education and postdoctoral training that had been developed through both NSF-wide programs and discipline/Directorate-based programs.

Despite all the ongoing activities, the Group indicated that it believed the Foundation could and should do more. It suggested a set of pilot projects that would fine-tune and selectively expand the existing NSF portfolio, rather than encourage radical reinvention. A new inter-Directorate group was established to begin developing an integrated graduate education and research-training program for the Foundation.

Working Group on Graduate Education Data

In mid-April, 1996, a second Working Group, the Data Group on Graduate Education, was established (including two SRS representatives) and asked to develop, structure, and outline plans for the NSF in three areas:

- *Assessment of NSF's Role:* What information would help NSF assess its role, within the Federal context, in graduate education? What data are currently available for such a purpose?
- *National Data:* What principles should guide collection of data on graduate education at the national level, in order better to understand the Federal role? How should the national-level data coordinate with and complement agency-level data (using NSF as an example)?
- *Special Study:* If NSF were going to commission a study on differential effects of alternative mechanisms for funding graduate students (research traineeships vs. fellowships, for example), how should it be specified? How big does it need to be? What existing data would it draw on? How long should it take? What could be done in the short term?

The Group's internal report, "Data for Monitoring and Analyzing Graduate Education," was presented to the Data Needs Committee of SMIG, consisting of Susan Cozzens (Office of Policy Support (OPS)), Cora Marrett (SBE), and Luther Williams (EHR) in July 1996 and then transmitted to the entire SMIG in August 1996. The main conclusions of the Working Group Report were that NSF currently collects very little information on the graduate students it supports, except for those applying to the Graduate Fellowship program, and that linkages between NSF internal data bases and national data bases are almost non-existent. The report's main recommendations were: decide how much career tracking of NSF supported graduate students is warranted; ensure that NSF can know how many graduate student fellows, trainees, and research assistants it supports in any given year, whether or not they are full-time students, and some indication of the extent of its support; formulate studies on a number of important issues such as relationship of graduate school experience to careers, dimensions of graduate school experience, and the differential impacts of mechanisms of support on time to degree.

Former SRS Division Director Ken Brown's Paper on Graduate Data

At the same time the Data Group was drafting its report, Ken Brown (former Division Director of SRS) was asked by Cora Marrett (AD of SBE) to prepare a paper independently recommending actions by the Foundation that would help meet its needs for information on graduate education.

Brown's July draft internal report, "Meeting the Foundation's Needs for Information on Graduate Education," recognized that acquisition of data is often expensive and was therefore cautious about recommending expensive new initiatives and focused more strongly on how to ensure that data are truly useful. Among his report's conclusions are: the NSF, NSB, and others will have a continuing need for data, not just on support mechanisms for graduate education, but well beyond; although NSF should always look for data to illuminate decisions, it should recognize that many questions are not quantifiable; the search for information should not be limited to

NSF-generated data, and must extend beyond the Foundation's resources into other Federal agencies and information-collecting organizations. The report recommended that: SRS should take a more active role in advising users of its data and deducing from their needs the specific changes to be made in its surveys; and NSF should have better access to external expertise on graduate education, either by setting up an external mechanism to get advice on the key issues of graduate education or by setting up internal groups to bring in experts and draft short pieces on future issues and corresponding data needs.

NSF Reports Redesign Group

At the same time, the NSF Reports Redesign Group, in existence for a little over a year, had been developing new electronic interim and final reports modules (for FastLane) that principal investigators would be expected to fill out on an annual basis. One of the sections considered for inclusion in these reports was a "participants" section that would collect the names of all participants in the project, including graduate students. For those graduate students that had significant participation in the project, additional demographic and tracking information would be requested including social security number and date of birth. Acquiring such information would permit career tracking of graduate students receiving NSF support and would ultimately be useful for evaluation of NSF programs relating to graduate education. These recommendations were never put into effect primarily due to concerns of privacy and undue burden on respondents.

Graduate Education Budget Initiatives for FY 97 and FY 98

In FY 96 NSF senior management made a decision to devote \$2 million of the FY 98 budget for graduate education activities. A plan was developed by SBE in mid-August 1996, with input from OPS and EHR, that would permit NSF to plan for improvements in the data compiled on graduate education, support the expansion of knowledge about graduate education and its consequences, and create partnerships to assure timely information on the graduate education endeavor.

In late August, staff members from SBE, EHR, and OPS participated in the development of a proposal for hastening the data enhancements for graduate education if monies from the 1996 Director's Opportunity Fund were to be made available in FY 97. Subsequently, \$1 million from the 1996 Opportunity Fund was allocated for data enhancements for graduate education in FY 1997.

New Inter-Directorate Graduate Education Group

In early September 1996, a new inter-Directorate Graduate Education Group, chaired by Cora Marrett, was established. The group was assigned responsibility for: overseeing a plan to implement the recommendations of the Working Group on Graduate Education Data; overseeing the preparation for and execution of a plan to spend funds in FY 97 to begin data improvement efforts; refining the plan for data improvement activities in FY 98; and serving as a means for bringing together issues and questions about graduate education information from across NSF. Elbert Marsh, Acting Assistant Director for Engineering, took over as chairperson of the group after Cora Marrett left the Foundation.

FY 1997 Graduate Education Data Initiatives

I. Begin Improving Linkages Between National Data and NSF Internal Data

The NSF Working Group recommended stronger linkages between NSF funding data and those from national surveys. Such data would permit analysis of trends in support mechanisms and outcomes such as time to degree, career choice, and career success. Three activities were initiated in FY97 to begin implementing the recommendation.

1. *Expanding the sample of the biennial Survey of Doctorate Recipients (SDR) to include all recent S&E PhDs who received NSF graduate fellowships.* This would enable the Foundation to track and analyze the careers of these students and to compare them with other groups. Since the new sample for the SDR was to be drawn in FY97, making an investment of funds in FY1997 would permit beginning this sample expansion immediately rather than waiting for the 1999 survey. Approximately 1000 holders of NSF Graduate Fellowship awards received S&E PhDs annually. Including the 1995 and 1996 PhDs in the FY 97 survey would involve an addition of about 2,000 individuals to the sample. The sample was expanded to include NSF graduate fellowships and the data were collected. Joan Burrelli analyzed the data while she was serving a detail in DGE. The internal report she produced looked at differences between NSF fellows, quality group 2 non-awardees, and other recent doctorate recipients in time to degree, debt, subsequent employment, and perceptions of the adequacy of their doctoral programs. The major findings were that NSF fellows took slightly less time to complete their doctorate, found jobs faster, had less debt, were more likely to have research assistantships, and were more likely to be in a tenure track position than other recent doctorate recipients.

2. *Enlarging the SDR sample by including more recent PhDs and examining the feasibility of speeding up the processing of the data for all new PhDs.* Widespread concern with the current labor market for new S&E PhDs at the time combined with the lack of both timely data and a large enough sample in the SDR to track their early careers highlighted a need for faster processing of SDR data for new PhDs and for further expansion of the SDR sample. The earlier availability of the data would provide quicker signals about the current labor market for new PhDs. The larger sample would permit better tracking of new PhDs through their early careers (e.g., how long one remains in a postdoc position). While the sample was expanded to include about 4,000 additional recent Ph.D.s, a change in contractor from the National Academies to NORC precluded the examination of speeding up the processing of the data for all new PhDs.

3. *Testing the feasibility of using university accounting and financial systems to identify by name graduate students receiving NSF support.* If university systems could be used to identify students receiving NSF support, the agency could reduce the reporting burden on PIs. The information could also supplement that derived from other surveys. Since NSF and universities were both examining or instituting changes in their data and information systems to further increased accountability at the time, it was felt that such a study would provide an interactive framework that might help identify best practices and assist both the Foundation and universities in implementing new approaches to gathering and storing information.

A workshop was held in June 1997 in which a number of individuals from a representative set of universities were brought together to discuss a number of questions relating to their financial and accounting systems, especially to the availability of student-specific information. If there were

consensus that this was a feasible approach, the next step would involve a review of the systems in about 20 institutions. Although it turned out that there was no consensus that this was a feasible approach, many of the participants thought that NSF might be able to collect two sets of data directly from universities: 1) aggregate data on race/ethnicity; and gender and 2) a list of individuals receiving NSF support, but including only public information (no social security numbers).

Integrated Graduate Education and Research Training Program

At about the same time the inter-Directorate data group was formed, another inter-Directorate group was established to develop an integrated graduate education and research-training program. The goal of the new program was to respond to the growing need for researchers/teachers educated beyond the boundaries of a single narrow discipline and to facilitate the integration of research and education outside traditional boundaries. This led to the development of the IGERT Program.

Human Resources Development Task Force (HRDTF) and Working Group (HRDWG) These entities were created to work on increasing the participation and success rates of women, members of historically underrepresented minority groups, and persons with disabilities in science and engineering at all levels of education. In September 1997, the HRDWG sponsored a roundtable discussion on strategies and tactics for increasing the participation and success rates of women, members of historically underrepresented minority groups, and persons with disabilities, as graduate students in science, mathematics and engineering, chaired by NSB member Dr. Claudia Mitchell-Kernan.

SRS/Professional Societies Workshop on Graduate Student Attrition

SRS, in conjunction with a number of science and engineering professional societies, held a Workshop on Graduate School Attrition on September 22, 1997. Participants included representatives of the academic research and graduate education administration communities, along with officials from disciplinary professional societies, NSF, and other government scientific agencies. The purpose of the workshop was to address key gaps in knowledge and data about the problem of graduate student attrition. Specific gaps addressed included knowledge and understanding of the overall extent of doctoral student attrition; factors that influence whether or not students complete their doctoral degrees; the impacts that such decisions have on their future earnings and labor force experiences; and further data that would be needed to assess more confidently the extent, causes, and consequences of graduate student attrition. The workshop focused on the problem of students who intend to obtain the doctorate rather than the master's as the terminal degree. (Summary of workshop: <http://www.nsf.gov/sbe/srs/nsf99314/start.htm>; transcript of workshop: <http://www.nsf.gov/sbe/srs/nsf98322/start.htm>)

Graduate Education Forum: Strengthening Graduate Education in Science and Engineering: Promising Practices and Strategies for Implementation

NSF funded the National Institute for Science Education (NISE) at the University of Wisconsin at Madison to organize a national conference on graduate education focused on practices and policies graduate departments and programs are modifying or instituting in response to concerns about the suitability of S&E graduate education. The conference was held in Washington, DC in June 1998. The conference was shaped by two primary purposes: 1. To share what has been learned about some of the featured practices for strengthening graduate education in science and

engineering, and 2. To learn from one another about alternative strategies for successfully implementing change and innovation.

The conference began by attempting to provide a foundation and framework for fruitful discussion by focusing on past, present, and future visions of graduate education in science and engineering. The remainder of the forum was organized around two sets of conversations. The first set focused on featured practices for strengthening graduate education in science and engineering at the individual, department, program, college, institutional, and inter-institutional levels. The second set focused on strategies for initiating and implementing change and innovation. Participants were invited to compare and contrast models of change and to describe alternate strategies for serving educational infrastructure, business and industry, and students and society. (Draft report at: www.wcer.wisc.edu/nise/Publications/Workshop_Reports_n_Proceedings/Vol7.pdf).

NSB Convocation on Graduate and Postdoctoral Education: The Federal Role
The Convocation on Graduate and Postdoctoral Education: The Federal Role was held at the October 8-10, 1997, NSB meeting in Houston, Texas. The symposium, which included presentations by a number of invited speakers, provided rich insights for the development by the Board of the comments and recommendations in its report on The Federal Role in Science and Engineering Graduate and Postdoctoral Education (see below). (Summary at <http://www.nsf.gov/nsb/meetings/1997/oct/opensess/start.htm>).

The Federal Role in Science and Engineering Graduate and Postdoctoral Education
This NSB paper, released in February 1998, responded to a request from the Assistant to the President for Science and Technology that the National Science Board provide its views on the status of graduate and postdoctoral education and the Federal role. It contributed to the ongoing review of the Federal/university partnership being conducted by the National Science and Technology Council in response to the Presidential Review Directive of September 26, 1996. (Report can be found at <http://www.nsf.gov/nsb/documents/1997/nsb97235/nsb97235.htm>).

In the paper, the Board identified some troubling issues that have emerged as a result of changes over the last fifty years, and offered recommendations to improve the effectiveness of the partnership for all concerned. The Board suggested new opportunities, particularly those offered by advances in communications technology, to expand the benefits of the partnership to a wider range of institutions in the academic research and engineering ecosystem, and to broaden the options for graduate students to experience environments outside the research university to supplement their core Ph.D. training. In addition, the Board drew attention to serious stresses in the partnership arising from administrative and accounting changes implemented by Federal funding and regulatory agencies. The Board provided recommendations in several areas: Federal support to the enterprise, breadth versus narrowness of graduate education, human resource policies, and impact of Federal regulatory and funding practices on the culture of institutions. Finally, the Board commented on outstanding issues to be negotiated between the Federal and university partners.

Workshop on Graduate Education Reform in Europe, Asia, and the Americas and International Mobility of Scientists and Engineers

SRS supported the workshop on “Graduate Education Reform in Europe, Asia, and the Americas and International Mobility of Scientists and Engineers,” held at the National Science Foundation (NSF) November 17-18, 1998. The objective of this workshop was to provide NSF, SRS, and the National Science Board with analyses of recent changes in graduate science and engineering education and international mobility of scientists and engineers among these regions. About a dozen international experts prepared country papers covering the main workshop topics: expansion of graduate capacity, educational reforms, the role of government and industry in supporting and employing S&E graduates, and the patterns of international mobility of scientists and engineers. (Proceeding of workshop at: <http://www.nsf.gov/sbe/srs/nsf00318/htmstart.htm>)

Ph.D.s' Ten Years Later Study

NSF provided supplemental funding for a study by Maresi Nerad and Joseph Cerny (University of California, Berkeley) on "Ph.D.'s--Ten Years Later." The major goals of the study were to: 1) develop understanding of outcomes of doctoral education in terms of program satisfaction and subsequent employment; 2) link doctoral education experiences to career outcomes; 3) evaluate the post-doctoral experience by discipline; and 4) provide career perspectives for graduate advisors and students. The study analyzed the career path of some 6,000 doctoral recipients who received their Ph.D.'s between 1983-1985 in biochemistry, computer science, electrical engineering, English, mathematics, and political science from 61 U.S. universities. Information was collected by means of a mail survey. In addition, in-depth interviews were conducted of 120 people (20 from each discipline) to learn more about the reasons why individuals chose a particular career path. The survey was distributed during the fall of 1996. NSF funded analysis of this data in 1997 and 1998. Some findings from the study can be found at www.educ.washington.edu/COEWebSite/Cirge/pdfs%20for%20web/cgs_9_2002.pdf.

NPSAS Graduate Support Study

NSF provided funding to MPR Associates to analyze the data for the graduate populations from the 1995-96 National Postsecondary Student Aid Study, sponsored by the National Center for Education Statistics (NCES) of the Department of Education. The study found that the way in which students financed their graduate education varied primarily by major field of study and type of institution. Assuming that financing a graduate education through grants and part-time assistantships (often related to the student's studies) would be preferable to taking out loans and working full time, graduate students in natural sciences and mathematics and those attending institutions classified as Research University I were more likely to receive preferable forms of financial aid, such as grants and assistantships. Graduate students in social sciences and psychology and those attending Master's/Baccalaureate institutions were less likely to obtain such financial aid packages. At the same time, science/engineering graduate students as a whole received more preferable forms of financial aid than their counterparts in the arts/humanities. That is, they were less likely to borrow and more likely to receive financial aid in the form of grants and assistantships. (The draft report—Financial Aid Profile of Graduate Students in Science and Engineering—can be found at: <http://nces.ed.gov/pubs2000/200011.pdf>)

Longitudinal Study of Beginning Graduate Students

SRS began to consider a new longitudinal study of beginning graduate students. It was felt that a longitudinal survey of beginning graduate students might be the only way to effectively collect information that could address issues such as: relationships of funding mechanisms to graduate

school experiences (time to degree, persistence, completion, transition patterns between fields or institutions, transition patterns from education to work, and integration of research and education) and other issues of the relationships between various graduate school experiences and subsequent career outcomes. These issues could not be addressed with existing surveys sampling only successful doctorate completers. Nor could they be addressed with administrative records that cannot be used to follow students to identify relationships among experiences at different stages of education and work. Although a good deal of background work was done, this project was ultimately rejected due to budget developments.

SRS Funded Study on Modes of Financial Support and Time-to-Degree

SRS funded Jerome Bentley of Mathtech to undertake a literature review and to carry out a two-phase study (still in draft) to look at the impact of graduate support patterns on both time-to-degree and career plans and outcomes for S&E doctorate recipients. The study used a multivariate analysis approach. Variables included in the analysis in addition to primary support mechanism included doctoral field, personal characteristics (for example, age, race/ethnicity, citizenship, marital status), parents' education, field and institution paths (that is, how often individuals switch academic fields and institutions), and cumulative debt. The study found relatively large differences in the simple averages of time to degree computed across alternative support mechanisms before the variables mentioned above were included in the analysis. However, much of the differences in average time to degree across support mechanisms disappeared when the effects of the additional variables were accounted for in the multivariate analysis. (For a summary of this work and the literature review see "Graduate Modes of Financial Support and Time to Degree" in chapter 6 of *Science & Engineering Indicators 2000* (<http://www.nsf.gov/sbe/srs/seind00/frames.htm>).

Modes of Financial Support in the Graduate Education of Science and Engineering Doctorate Recipients
This report was prepared by SRS staff to examine the matrix of support patterns of science and engineering (S&E) doctorates in 1995, showing the distribution of various modes of support to individuals. The data in this study show the complexity of support mechanisms and thus the limitations of analyses of the effects of only a single mode of support. New S&E Ph.D.s commonly used more than one mode of support during graduate school. Only 16 percent of 1995 S&E Ph.D. recipients reported using one mode of support and more than 40 percent used 3 or more modes of support. The average number of modes of support reported by these recipients was 2.5. Numbers of modes of support varied by field, sex, race/ethnicity, and citizenship. (Report can be found at: <http://www.nsf.gov/sbe/srs/nsf00319/htmstart.htm>)

DGE Spring Workshops on Graduate Education

Former IGERT Program Director Wyn Jennings organized an annual spring workshop on a variety of issues relating to graduate education for several years in the late 1990s.

NSF GK-12 Fellowship Program

The NSF Graduate Teaching Fellows in K-12 Education (GK-12) program was planned as a pilot effort in 1999. A formal program was requested and approved by Congress as part of NSF's 2000 budget. The program received such a positive response from colleges and universities that NSF allocated more funds than originally planned to the program. The National Science Foundation (NSF) made a first round of grants to researchers at 31 institutions nationwide. This program supports fellowships and associated training that enables graduate students and

advanced undergraduates in the sciences, mathematics, engineering, and technology to serve as resources in K-12 schools. Academic institutions apply for awards to support fellowship activities, and are responsible for selecting Fellows. The Fellows are expected to serve as resources for teachers in science and mathematics instruction. Expected outcomes include improved communication and teaching skills for the Fellows, enriched learning by K-12 students, professional development opportunities for K-12 teachers, and strengthened partnerships between institutions of higher education and local school districts. (For current program announcement see www.ehr.nsf.gov/dge/programs/gk12/.)

National Science Board Report on the Science and Engineering Workforce
In August 2003, the National Science Board issued a report entitled “The Science and Engineering Workforce: Realizing America’s Potential”. This report recommended a national policy imperative: “The Federal Government and its Agencies must step forward to ensure the adequacy of the US science and engineering workforce. All stakeholders must mobilize and initiate efforts that increase the number of US citizens pursuing science and engineering studies and careers”. Among the additional recommendations was one specifically targeted at graduate and postdoctoral education: “Federal support for research and graduate and postdoctoral education should respond to the real economic needs of students and promote a wider range of educational options responsive to national skill needs”. This report can be found at: <http://www.nsf.gov/nsb/documents/2003/nsb0369/>

DGE Workshop on the Future of Graduate Education
In the spring of 2003, NSF’s Division of Graduate Education held a workshop on the Future of Graduate Education, chaired by NSF/CGS Dean-in-Residence Joan Lorden and AAAS Fellow Jennifer Slimowitz. The goals of the workshop were to identify the potential impact of forces changing the future environment for graduate education and to define the characteristics that will be desirable for graduate education in the projected environment. Leaders from academia, government, non-profit private agencies, and business considered the potential impact on graduate education of demographic changes in the student population, the globalization of science, the revolution in information technology, the emergence of new disciplines, social and cultural considerations, and employment horizons. Proceedings of the workshop can be found at <http://www.ehr.nsf.gov/dge/InnovMTG.htm>, and a summary article was published in the June 2003 issue of the *CGS Communicator*.

Continuing Activities in Graduate Student and Postdoctoral Finance
During the past year (2003-2004), the current NSF/CGS Dean-in-Residence and AAAS Fellow have continued this overall theme, focusing particularly on graduate student and postdoctoral financial support. A summary of the activities to date appears in the May 2004 issue of *CGS Communicator*. A series of focus group activities on this meeting were held, including convenings of AAAS Fellows, graduate students, graduate deans, members of the National Postdoctoral Association, and the Council of Scientific Society Presidents. The culmination of these activities is the NSF/NIH/CGS Workshop, “Support of Graduate Students and Postdoctoral Researchers in the Sciences and Engineering: Impact of Related Policies & Practices”. Information about this workshop is available on the web at http://www.ehr.nsf.gov/dge/support_workshop.html

Appendix E: Workshop Invitation

Support of Graduate Students and Postdoctoral Researchers in the Sciences and Engineering: Impact of Related Policies & Practices

We cordially invite you to participate in a workshop organized and co-sponsored by the National Science Foundation, the Council of Graduate Schools and the National Institutes of Health. This two-day workshop will be held on June 17-18 2004 at the American Association for the Advancement of Science headquarters in Washington D.C.

Meeting participants will include graduate students, postdocs, STEM faculty and deans as well as labor economists and representatives from industry and research funding organizations.

The meeting is part of a series of events designed to examine and provide recommendations that will enhance our knowledge and improve practices and policies associated with graduate education and research training. This workshop will consider the role and impact that student financial support plays in encouraging U.S. citizens to pursue and complete doctoral and postdoctoral studies in Science, Technology Engineering and Mathematics. Linkages between elements of student financial support such as the mode, duration, and amount of stipend, as well as health care and other benefits, and indicators of student progress such as completion rate and time to first position will be examined.

The meeting will also explore the economic impact of the levels of graduate and postdoctoral compensation on the research enterprise and on the domestic scientific labor market. Our hope is that these deliberations will set the stage for developing best practices and outlining a research agenda on these topics. This workshop will also help build a community of researchers, educators, and stakeholders to maintain an ongoing dialogue in this critical area.

Hotel: A block of rooms is reserved at the Morrison Clark Hotel, at the group rate of \$179 (single). To reserve a room, call 1-800-222-8474 or 202-414-0503 before May 15, 2004.

Register online at: http://www.ehr.nsf.gov/dge/support_workshop.html

As space is limited, please register by May 1, 2004.

If you have any questions regarding the workshop, please contact Dan Stanzione at dstanzio@nsf.gov or 703-292-8121

Appendix F: Report from the Council for Graduate Schools Summer Institute
Dean Dialogue 1: Providing Competitive Graduate Student and Post-Doctoral Researcher Support

Robert Barnhill, CGS/NSF Dean in Residence at the NSF Division of Graduate Education and Carol F. Stoel, Science Education Administrator, DGE/NSF, led a dialogue at the CGS Summer Institute on July 11, 2004, to gather additional feedback from the field regarding issues addressed at the NSF/NIH/CGS Support Workshop. The Support Workshop had considered the roles of financial support in encouraging US citizens to pursue and complete doctoral and postdoctoral studies in science, technology, engineering and mathematics. Isaac Colbert, Dean for Graduate Studies at MIT, presided. Approximately 100 deans and associate deans participated in the session. After Dr. Barnhill reviewed briefly the results of the Support Workshop, the CGS participants, Graduate Deans, were asked to give their feedback on the topics in two categories—University Best Practices and Advice to NSF and NIH. Some responses were very helpful. A summarizing list follows.

Best practices:

- The University of Colorado Graduate School has developed a graduate students' Bill of Rights in effort to respond to needs of graduate students.
- Web site was set up to sell the interdisciplinary Ph.D. with information on site about specialization versus interdisciplinarity.
- The University of Puerto Rico is collecting longitudinal data on its students to examine low cost and its impact on recruitment/retention and quality.
- Some universities have set up health care pools for graduate students.
- Mentoring is always important for graduate students and postdocs.
- Some universities have developed means to provide some parity with disparities caused by the recent increase in NSF stipends.

Advice to NSF/NIH:

- Establish an "Advisory Council" from research universities and graduate schools to advise NSF on student financial package policies.
- In the future, consider the implications of trainees in a laboratory doing the same work but receiving different levels of stipends.

- Consider establishing a national graduate school student health insurance pool for which all graduate students and families would be eligible. The implication here was that if there were a large enough pool, rates could be lower and students at small and large institutions could participate.
- Include childcare as one of the considerations in designing and making student/postdoc support available.
- Consider limiting the years of participation in IGERT to two so that more students could be served.
- Encourage institutional support for Ph.D. work to be 5 years total and, within this limitation, allowing students greater flexibility in managing their own Ph.D. development.
- NSF and NIH should have the same policies.
- Conduct a longitudinal study across all doctoral programs to look at attrition, including the various reasons for students' leaving. Profile the students and model the study after pharmacological studies that look at more variables simultaneously.

COMPLICATION: A number of people raised the possibility of new U. S. Labor Department rules that will require that institutions keep an hourly wage record for all assistantships, etc.