<p style="text-align:center">**"Advancing STEM Graduate Education- New Directions at NSF"**</p>

<p style="text-align:center">**CGS Summer Institute- NSF Panel Summary, July 9, 2012, Boston, MA**</p>

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Panel Participants: NSF Directorate of Education and Human Resources (EHR) Panel:

- Richard Linton, NSF/CGS Dean in Residence rlinton@nsf.gov
  - The NSF Portfolio and Current Issues in STEM Graduate Education
- Melur Ramasubramanian, Program Director, DGE mramasub@nsf.gov
  - Interdisciplinary Graduate Traineeships (IGERT)
- Gisele Muller-Parker, Program Director, DGE gtmuller@nsf.gov
  - Graduate Research Fellowship Program (GRFP)
- Jessie DeAro, Program Director, Division of Human Resource Development jdearo@nsf.gov
  - Alliances for Graduate Education (AGEP 2.0)

Goals of Workshop:

- Alert graduate deans to recent developments, innovations and challenges impacting NSF funding mechanisms supporting graduate students
- Engage graduate deans in discussing current priorities and future strategies connected to NSF investments in graduate education

Questions to NSF Panel:

- Describe **new** directions and opportunities in NSF programs supporting graduate students within each of your areas of responsibility.
  - How are these advancing NSF's goals in areas such as broadening participation, workforce development, entrepreneurship, or interdisciplinary research?
  - What are the continuing challenges in NSF's support of graduate education?
  - Comment on the growing importance of graduate student professional training (e.g. recommendations in the CGS "Pathways into Careers" and NRC "Research University" reports) and the potential impacts on NSF's funding mechanisms.

Questions to Graduate Deans:

- How can NSF elevate partnerships with graduate schools to promote the institutionalization of effective practices (e. g. traineeship models, interdisciplinary education)? What are the barriers to implementation and examples of successful institutional approaches to address them?
- Ideas for other priorities or strategies that NSF should consider for STEM graduate education?

Summaries of Panel Presentations

1. **Overview of The NSF Portfolio and Current issues in STEM Graduate Education (Linton)**

General NSF Goals in Supporting Graduate Students

- Conduct NSF funded research
- Support research areas of national priority, including interdisciplinary programs
- Develop STEM workforce
- Broaden participation in STEM Fields
- Sponsor research and catalyze innovation in graduate education

Current NSF Portfolio http://www.nsf.gov/div/index.jsp?org=DGE

- NSF's current budget is over $7 Billion across seven Directorates. All Directorates support graduate education which constitutes about 1/7 of the total NSF budget.
- 41% of all federal support for STEM education programs comes from NSF (>$ 1 Billion annually).
- NSF funds about 40,000 graduate students per year. This includes traineeships (6-8%), fellowships (10-15%), and research assistantships (~80%).
- NSF has a Division of Graduate Education (DGE). It is one of four Divisions within the Education and Human Resources (EHR) Directorate.
- DGE administers the Graduate Research Fellowships Program (GRF), the GK-12 Fellows Program, and Integrative Research and Graduate Education Traineeships (IGERT).

Key Issues in Graduate Education

- **Summary of Key Issues and Priorities- May 2012 GradEdge** http://www.cgsnet.org/may-2012

  - **Investment**- *Graduate student support mechanisms and general financial concerns* effecting recruitment, retention, completion and learning outcomes
  - **Integrative** and **Interdisciplinary** Research, Education and Training- *Advancing professional development*
  - **Inclusiveness**- Broadening participation (women, minorities, international scholars) **Innovation** and **Impact**- Economic development and jobs- career tracking of graduates

- **CGS Pressing Issues Survey Summary- 2012** http://www.cgsnet.org/data-sources-results-2012-cgs-pressing-issues-survey-0
  - Recruitment/Admissions/Enrollment Management
  - *Graduate Student Support/Financial Issues*
  - General Administration
  - Evaluation and Assessment

- **CGS "The Path Forward' Report- 2010** http://www.fgereport.org/
  - Demographic Shifts
  - *Disruptions in Educational Pathways/Pipeline*
  - Growth in international education and overseas career opportunities
  - Attrition in graduate programs
  - Accumulated student debt
  - *Lack of career path transparency*

- **CGS "Pathways into Careers" Report- 2012** http://www.pathwaysreport.org/
  - *Track career outcomes*
  - *Development of professional skills*
  - Collaboration with Industry
  - Federal Role:
    - *"Professional Plus" program for RAs*
    - *COMPETES doctoral traineeship program*
    - IGERT-like program for the Humanities
    - Visa policies to retain international talent

- **NRC "Research Universities" Report- 2012**
  http://sites.nationalacademies.org/PGA/bhew/researchuniversities/index.htm
  - Improve capacity to attract talented students and address attrition rates and time-to-degree
  - *Align student career opportunities with national interests*
  - *Federal government should enhance support of graduate education through a balanced program of fellowships, traineeships and research assistantships, with funding sufficient to increase the number of federal S&E graduate fellowships and traineeships by 5,000 per year for five years.*
  - *Elevate STEM pathways for women, underrepresented minorities, and international scholars*

- **NIH Biomedical Workforce Report 2012** http://acd.od.nih.gov/bmw_report.pdf
  - NIH should create a program to *supplement training grants* through competitive review to allow institutions of higher education (IHEs) to *provide additional training and career development* such as project management and entrepreneurial skills.
  - NIH and IHEs should involve relevant employers in *designing training paths* for those students who seek employment in biotech and pharmaceutical firms.
  - IHEs should be encouraged to develop other degree programs, e.g. *master's degrees designed for specific science-oriented career outcomes such as industry or public policy*.
  - *NIH should cap the number of years a graduate student can be supported by NIH funds* for an average of 5 years and no more than 6 years, to encourage timely degree completion.
  - *NIH should increase the proportion of graduate students supported by training grants and fellowships* as compared to those on research project grants, without increasing the overall number of graduate student positions.
  - NIH should revise the peer review criteria for training grants to include consideration of outcomes of all students in PhD programs at those institutions.
  - *NIH Institutes and Centers should offer comparable training programs and fellowships* and their requirements should be harmonized.

(Note: Italicized sections above indicate common themes regarding graduate student support or professional development concerns)

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2. **Graduate Research Fellowship Program- GRFP (Muller-Parker)**

Updates

- GRFP is now cross-NSF with a GRFP Working Group involving various Directorates
- Growth is reaching steady-state, with ~ 7,000 Fellows and 232 institutions
- Budget: Cost of Education subsidy recently raised to $12,000; proposed increase in stipend from $30,000 to $32,000
- NORC program evaluation in progress
- Review of federal fellowship program policies in process
- Sixtieth Anniversary: Video contest and Fellow profiles to be announced soon
  Webpage: http://www.nsf.gov/news/special_reports/grfp_anniversary/index.jsp
- Video contest: http://www.nsfgrfp.org/grfp_video_contestProfessional development for Fellows to become a stronger focus:
    o International DCL coming soon, funding for international research collaborations
    o Engineering Innovation Fellows Program - a great example of a partnership with ENG
- Outreach: advice/ideas are solicited from the graduate deans on disseminating successful outreach/applicant preparation programs; how can we reach applicants at predominantly undergraduate institutions, HBCUs, MSIs?

Program Highlights

Initiated in 1952, the National Science Foundation (NSF) Graduate Research Fellowship Program (GRFP) is a highly competitive, federal fellowship program. The program goals are to select, recognize, and financially support individuals early in their careers with the demonstrated potential to be high achieving scientists and engineers, and to broaden participation in science and engineering of underrepresented groups, including women, minorities, and persons with disabilities. GRFP is a critical program in NSF's strategy in developing the globally-engaged workforce necessary to ensure the Nation's leadership in advancing science and engineering research and innovation.

- **5 Year Award**
- **3 Years Support**
- **$30,000/yr Stipend**
- **$12,000/yr COE**

By underwriting the training of graduate students with the demonstrated potential to be high-achieving scientists and engineers, the GRFP represents long-range investments for the future of society. For this reason, these Fellowships are distinct from grants designed to fund specific research or project development and do not require that special services be rendered by the recipient. Three years of support is provided by the program for graduate study that is in a field within NSF's mission and leads to a research-based master's or doctoral degree.

By The Numbers

- **45,773 GRFP** fellowships have been funded since 1952
- **6,438** Fellows enrolled in **230** institutions in the US and abroad
- **2,000** new awards in FY 2010, FY 2011 and FY 2012

Unique Features

- **Portability:** Fellows may enroll in <u>any</u> accredited institution in the US.

- **Flexibility**: Fellows may be on reserve for 1-2 years to engage in intensive research at national or international research facilities, to gain industry research experience, to gain teaching experience, or to participate in other career-enhancing opportunities during graduate school.

Program Impacts

- Results in higher PhD completion rates for Fellows compared to non-Fellows
- Responsive to national needs for a strong, diverse and globally engaged science and engineering workforce
- Leverages NSF resources to broaden the participation of underrepresented groups.

Fellow Successes

- **30** Nobel Laureates
- 440 Members of the National Academy of Sciences
- Famous authors (Steven Levitt, Freakonomics) **to** corporate founders (Sergey Brin, Google, Inc.)
- Achievements reported by 5,487 fellows in AY2011-12: 3,952 publications, 5,486 presentations, 187 patents and inventions, 2,011 awards and honors, 2,165 broader impacts activities, 2,149 international activities

http://www.nsf.gov/div/index.jsp?org=DGE email contact: grfp@nsf.gov   website: www.nsfgrfp.org

3. **Alliances for Graduate Education and the Professoriate- AGEP (DeAro)**

Updates

- The changes to the AGEP program were designed to align with the Directorate's overall direction toward ensuring that we learn from what we are doing through education and social science research and model building.
- AGEP can help your institution to catalyze changes in graduate education and postdoctoral training, including curriculum development and enhancement, research experience enhancement, faculty training and development, policy and procedure review and revisions, professional skills development, development of industry links and internships, new partnerships with other IHEs, industry, national labs and non-profit organizations such as professional societies, training opportunities for graduate students and postdoctoral trainees, and examination of new career pathways.
- AGEP projects can focus on one discipline area, an interdisciplinary area (such as clean energy and climate change), or all STEM disciplines. This will help AGEP to link to the other NSF Directorates and support the development of creative alliances that naturally have potential for sustainability because of the shared research interests.
- AGEP includes a social science and education research component which is part of an overall effort to invest in the "Science of Broadening Participation".

Program Highlights

AGEP goal: Increasing the numbers of African Americans, Hispanic Americans, American Indians, Alaska Natives, Native Hawaiians and other Pacific Islanders (URMs), including URMs with disabilities entering and completing graduate education and postdoctoral training to levels representative of the available pool of URMs.

To achieve this goal, the AGEP program will support the development, implementation, study, and dissemination of innovative models and standards of graduate education and postdoctoral training that are designed to improve URM participation, preparation, and success. Three types of awards will be supported in FY 2013

- **AGEP-Transformation** - Strategic alliances of institutions and organizations to develop, implement, and study innovative evidence-based models and standards for STEM graduate education, postdoctoral training, and academic STEM career preparation that eliminate or mitigate negative factors and promote positive practices for URMs.
    o 42 month projects up to $1.75 M total
    o May be eligible for up to five years of additional support after the initial project based on: the outcomes of a site visit; NSF review of evaluation and performance reports; and peer review of a proposal for continuation.
    o DUE: Oct. 30, 2012

- **AGEP-Knowledge Adoption and Translation (AGEP-KAT) –** Projects to expand the adoption (or adaptation) of research findings and evidence-based strategies and practices related to the participation and success of URMs in STEM graduate education, postdoctoral training, and academic STEM careers at all types of institutions of higher education.
    o 12 to 60 month projects ranging from $200K to $350K per year depending on scope
    o DUE: Oct. 30, 2012

- **AGEP-Broadening Participation Research in STEM Education (AGEP-BPR)** - Investigator initiated empirical research projects that seek to create and study new theory-driven models and innovations related to the participation and success of URMs in STEM graduate education, postdoctoral training, and academic STEM careers at all types of institutions of higher education.
    o 36 month projects up to $525,000 total
    o DUE: Oct. 30, 2012

AGEP Contact: AGEP@nsf.gov

AGEP Solicitation:

http://www.nsf.gov/pubs/2012/nsf12554/nsf12554.htm

AGEP Solicitation FAQ:
http://www.nsf.gov/pubs/2012/nsf12071/nsf12071.pdf

Examples of other NSF funding opportunities for social science and education research to build understanding of STEM graduate education and postdoctoral training to improve STEM learning and educational and training outcomes include:

- **Research and Evaluation on Education in Science and Engineering (REESE)**
  The program seeks to advance research on STEM learning and education, and to provide the foundational knowledge necessary to improve STEM learning and education in current and emerging learning contexts, both formal and informal, from childhood through adulthood, for all groups, and from before school through to graduate school and beyond into the workforce. (NSF 12-552)

  Proposals due: 7-17-2012 (future calls are anticipated), **Contact:** DRLREESE@nsf.gov

Type	Total	Length	Description
REESE synthesis	$300,000	2-yrs	Synthesis and/or meta analysis of existing knowledge or the diffusion of research-based knowledge
REESE small empirical	$500,000	3-yrs	Empirical research projects including the collection of new data or the use of existing databases
REESE medium empirical	$1,500,000	3-yrs	Empirical research projects including the collection of new data or the use of existing databases
REESE large empirical	$2,500,000	5-yrs	Empirical research projects including the collection of new data or the use of existing databases
REESE-FIRE	$400,000	2-yrs	Interdisciplinary collaborations to build education research capacity and innovative approaches

- **AGEP-Broadening Participation Research in STEM Education (AGEP-BPR):**
  The program seeks to advance understanding of the underlying issues affecting the participation and success of African Americans, Hispanic Americans, American Indians, Alaska Natives, Native Hawaiians and other Pacific Islanders (URMs), including URMs with disabilities, in STEM graduate education, postdoctoral training, and academic STEM careers. (NSF 12-554)

  Proposals due: 10-30-2012, **Total:** $525,000, **Length:** 3-yrs, **Contact:** AGEP@nsf.gov

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Examples of potential research areas of interest are outlined in a Dear Colleague Letter (NSF 12-091) *DGE-REESE-AGEP-AISL Call for Research Proposals on STEM Graduate Education and Postdoctoral Training*:

- Effectiveness of interventions to broaden the participation of underrepresented groups (e.g., women, underrepresented minorities, and persons with disabilities).
- Studies of graduate education and postdoctoral training models
- Studies examining the effects of different funding models (e.g., teaching assistantship, fellowship, traineeship, research assistantship, work-for-pay, loans) on graduate student or postdoctoral fellow outcomes.
- Research that looks at evidence-based scalable constructs for graduate education or postdoctoral training to prepare a diverse 21st century workforce.

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4. Integrative Research and Graduate Education Traineeships- IGERT (Ramasubramanian)

Updates

The challenges facing the nation today demand the creative teamwork of people from multiple disciplines and multiple backgrounds. The IGERT program is positioned to produce the most innovative scientists and engineers of the future by jump-starting transformative interdisciplinary research and using it as the foundation for imaginative graduate education. Prepared for the careers of the 21st century, IGERT graduates enter the workforce ready to make America more competitive in our global economy. Through hands-on innovation and training, they also understand how to apply their research for practical societal benefits.

The IGERT program provides graduate students with exceptional training on transformative interdisciplinary themes, many in areas of national priority. About 1,500 graduate students are funded yearly, at $30K per year plus $10.5K for the cost of education. Beginning FY 2012, $200K is available per project for student activities related to innovation and $200K for international activities.

- Eighteen new awards to institutions were made for FY 2012.
- For the FY 2013 funding cycle, IGERT will grant approximately 16-19 new awards.
  - Each award is made for duration of five years.
  - Maximum funding per award is $3.5M

Program Highlights

Models/Methods/Tools

- **Traineeships:** Provide highly qualified graduate students in STEM disciplines with interdisciplinary training and professional development opportunities to prepare them to be leaders in their chosen fields.
- **Collaborations:** Each IGERT uses unique sets of collaborations across laboratories, disciplines, departments, colleges and institutions; regions, states, and countries; industry and non-profit organizations. Within the NSF, IGERT in DGE collaborates with other offices and directorates for the requisite expertise and perspectives for graduate education across disciplines.
- **Innovative Educational Methods:** IGERT projects have features such as collaborative mentoring, multi-disciplinary graduate student research teams, laboratory rotations across disciplines, student-led workshops and meetings, intensive summer projects and courses, experiences outside the university, exposure to innovation processes, new curricula (some designed by students), and new doctoral degree programs.

Success/Impacts

- Since the program's inception, 278 awards have been made and approximately 6,500 doctoral students have received funding. One-hundred and twenty three lead institutions in 45 states plus D.C. and Puerto Rico have hosted IGERT projects.
- Short-term successes include multiple student awards and prizes, thousands of student publications, and national recognition for interdisciplinary projects. As of FY 2010, several hundred IGERT students have graduated; success in obtaining excellent postdoctoral positions, faculty appointments, and positions in industry and government is reported.
  (See the summary of the IGERT graduate follow-up report by Abt Associates at: www.abtassociates.com/reports/Abt_1-page_report_summary_May_2010.pdf)

  Email: igert@nsf.gov   Program Information Website: http://www.igert.org

Summary of Discussion and Recommendations from Graduate Deans

The comments from deans emphasized issues and suggestions related to enhancing the professional development of graduate students. General points of emphasis included:

- There is a shared recognition of the importance of enhanced professional development for all graduate students.
- Professional development must not constitute another unfunded mandate in contrast to recent RCR requirements, and should not compromise funding for research programs.
- Institutions must explore effective mechanisms to allow sustainability of professional development activities for graduate students.
- There should be a functional partnership between faculty and institution-wide efforts coordinated through the graduate school to develop effective and sustainable practices.
- Through properly structuring the funding, exploring flexibility in policies regarding allowable grant expenditures, and adding a requirement for a mentoring plan for graduate students in every research grant, a hybrid approach can be developed as the foundation of a sustainable infrastructure for professional development.

Specific recommendations from graduate deans are outlined below.

NSF (and federal agencies) should:

- Consider requiring graduate student mentorship plans for every graduate student on a project. IGERT proposals require this now (Educational and Training plan).
- Provide funding opportunities for grants to graduate schools to help develop the infrastructure to provide professional development for graduate students. .
- Consider mini grants or grant supplements to faculty and associated students to focus on professional development.
- Provide budget flexibility for PIs to fund some professional development on research grants. A possible short-term approach is to allow "other expenses" on research budgets to include funding for professional development activities, similar to allowing for materials, supplies, and travel to conferences. This should require an associated mentorship plan and provide a convenient means for faculty to include funds earmarked for training in their proposal budgets.
- Develop new funding opportunities for institutions to support the development and dissemination of effective professional development opportunities for graduate students; these should not be tied to specific funded projects.
- Not limit professional develop efforts to NSF-supported students, or target a subgroup of NSF-supported students.
- Encourage plans that address sustainability and dissemination of professional development activities and models, and optimally reach across multiple institutions.

Universities should:

- Involve university central administration offices, academic deans, graduate schools, and faculty advisors in the efforts to enhance professional development programs for graduate students. Although various offices offer some components of these activities across the campus, there is a common need for better integration and continuity.
- Assure graduate student input into the design and implementation of professional development opportunities and activities.
- Provide resources that engage and benefit faculty in assisting the professional development of both students and faculty. Support faculty so they do not need to repeatedly replicate the

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process or approach. Not all activities should be focused on students. The faculty may have deficits that need to be addressed (e.g. awareness of non-academic career pathways).
- Expand the infrastructure for graduate student professional skills development through the leadership of graduate schools. PIs on research grants should direct the students (and funds) to access professional development activities. Provide a central resource that includes the expertise needed to implement training.
- Include teaching assistants and unfunded graduate students in the training opportunities.
- Provide incentives to the department faculty and students to create some discipline-specific modules and training related to various professional development topics (mini-grants).

Models to consider in designing graduate student professional development program:
- Innovation through Institutional Integration (I 3) grants. http://nsf-i3.org/
  This prior NSF program promoted integration and utilization of NSF-supported training and other resources across campuses. Funding helped campuses to organize professional development activities at the graduate level (at Rutgers University, for example). Similarly, the University of Tennessee now has a central Office of Graduate Training which was developed in part by support through an NIH grant.
- Preparing Future Faculty Programs (PFF). http://www.cgsnet.org/preparing-future-faculty
  Preparing Future Faculty programs infuse professional development for academic careers, often through combined efforts of the graduate schools and academic units.
- Responsible Conduct of Research Programs (RCR). http://www.nsf.gov/bfa/dias/policy/rcr.jsp
  Coupling RCR infrastructure with broader professional development efforts is a possible means to leverage programs.
- IGERT Programs.   http://www.igert.org/
  IGERT has helped to establish traineeships as part of the institutional culture and has been involved in the traineeship activities. Professional development could be more broadly incorporated into future IGERTs.
- National Postdoctoral Association (NPA). http://www.nationalpostdoc.org/competencies
  NPA has a detailed articulation of core competencies and tools to assist post-doctoral students with development of professional skills.

Request for Additional Comments
In consideration of the above summary, please feel free to provide any comments or suggestions to the NSF panelists via e-mail to NSF-DIR-CGS@nsf.gov The NSF/CGS Dean in Residence will review the comments and share the additional information within NSF, as appropriate. (If you had sent any prior e-mails to DGE-DIR, please resend them to the above e-mail address.)

Of special interest are the following questions:

- General comments, questions or concerns about NSF's current support of graduate students?
- How can NSF elevate partnerships with graduate schools to promote the institutionalization of effective practices developed through NSF support (e. g. traineeship models, broadening participation, and interdisciplinary education)? What are the barriers to implementation and examples of successful institutional approaches to address them?
- Ideas for other priorities or strategies that NSF should consider for STEM graduate education, including professional development?
- Suggestions for future sessions at CGS meetings involving NSF participants?