Graduate STEM Education for the 21st Century
The Issue

- Graduate STEM education is lagging behind the evolution of science and engineering, the nature of the workforce, and the career goals and paths of its students
The world of science has changed substantially over the last 50-100 years

• The science and engineering workforce is growing
  – Becoming much more diverse
• Over 60% of new Ph.D.’s do NOT go into academic research
  – But we train them the same way we always have
• The nature of science itself has changed
The nature of science has changed

• The cutting edge is multidisciplinary
  – More and more scientists work in teams
• Science has become global
• What makes a scientific career has changed
The sponsors

- National Science Foundation
- Institute of Education Sciences
  - US Department of Education
- Burroughs Wellcome Fund
- Spencer Foundation
The Committee’s task:

• A systems analysis of current state of graduate education and career paths
• Identify policies, programs and practices that could better meet the career needs of graduate students
• Identify strategies to improve the alignment of graduate education with the needs of prospective employers and students
• Identify possible changes to federal and state programs and funding priorities
• Identify how best to provide students and faculty with information about career paths
• Identify implications of the increasingly international nature of science
• Investigate the new models that are influencing graduate education
Committee Members
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What makes this report different?

• Proposes an ideal graduate education
• Recommends a systems approach to achieving ideal
  – Action steps for every stakeholder
• Urges the system to become more student-centric
  – And provide for an equitable and inclusive environment for a more diverse group of students
• Articulates core competencies at both master’s and Ph.D. levels
  – Plus additional career-relevant exploratory experiences
• Confronts the need for culture change
  – Increase emphasis on high quality teaching, advising and mentoring
  – Reduce stigma of non-academic careers
  – Realign academic incentive system
Some Elements of An Ideal Graduate Education

- Prospective students can select schools based on easy access to outcome data on alumni successes and careers
- Diverse student population can thrive in inclusive, equitable learning environments
- Students acquire core competencies
- Students can explore range of career options
- High quality, trained mentors and advisors
- Students learn to communicate to diverse audiences
Chapter 2: Data and Trends
(The Landscape)

• Enrollment, degrees and other general trends
  – Gender
  – Race and Ethnicity
  – Citizenship
  – Disability status

• Some disciplinary breakouts
Chapter 3: Cross-cutting themes

• Adjusting faculty rewards and incentives
• Increasing data collection, research, and transparency
• Enhancing diversity, equity and inclusion
• Responding to the dynamic nature of 21st century STEM
• Optimizing the graduate student experience
Chapter 4: Core Competencies for the STEM Master’s Degree

1. Disciplinary and interdisciplinary knowledge
2. Professional competencies
3. Foundational and transferrable skills
4. Research
Chapter 5: Core Competencies for the STEM Ph.D. Degree

1. Develop Scientific and Technological Literacy and How to Conduct Original Research
   a. Deep specialized expertise
   b. Acquire sufficient transdisciplinary knowledge
   c. Identify problems and articulate research questions
   d. Design a research strategy
   e. Evaluate outcomes and iterate as necessary
   f. Adopt rigorous standards of investigation and acquire mastery of skills needed in the field of study
   g. Learn and apply professional norms and practices of the scientific or engineering enterprise
Chapter 5: Core Competencies for the STEM Ph.D. Degree

2. **Develop Leadership, Communication, and Professional Competencies**
   
a. Develop ability to work in collaborative and team settings, including with individuals from diverse cultural and disciplinary
   
b. Acquire the capacity to communicate in many modes and to both STEM professionals and other audiences
   
c. Develop professional competencies needed to plan and implement research projects
Key Recommendations Relate to:

- Facilitating cultural and behavior change
- Promoting effective teaching and mentoring
- Collecting and sharing national and institutional data on students and alumni
- Ensuring diverse, equitable, and inclusive environments
- Providing for career exploration and preparation
- Ensuring graduate education stays current with relevant trends
- Evolving the structure of doctoral research activities
- Funding for research on graduate STEM education
- Improving the quality of the graduate student experience
How to Effect Change

• Need for cultural and behavioral changes throughout the system
  – Particularly the incentive system
  – Reduce stigma of non-academic careers

• Specific steps for each stakeholder
  – Summarized by stakeholders in Chapter 6
Actions for Federal and State Funding Agencies

• Re-align policies and award criteria... whether students supported by research or training grants
• Embed diversity and inclusion metrics in funding criteria
• Require institutions to collect and disseminate data on demographics, funding mechanisms and career outcomes
• Support research to better understand the graduate education system and outcomes of various interventions
Some other “big” recommendations

• Institutions should develop a uniform, scalable, and sustainable model for data collection.

• Institutions should develop and regularly evaluate strategies to accelerate increasing diversity and improving equity and inclusion.

• Departments should review and modify curricula, dissertation requirements, and capstone projects ... and to provide students with opportunities to work in teams.

• Institutions should integrate professional development opportunities into curricula.

• Industry, nonprofit and other employers should provide guidance and financial support for relevant course offerings at institutions and provide internships and other forms of professional experiences.