American Chemical Society

ACS Chemistry for Life®

Graduate Education in the Chemical Sciences

Report of the ACS Presidential Commission

OXIDE Meeting

Arlington, VA

April 15, 2013

ACS Presidential Commission On Graduate Education In The Chemical Sciences

Charge
Conclusions
Recommendations

Commission Membership

Dr. William F. Banholzer, *CTO, Dow Chemical*
Dr. Jacqueline K. Barton, *Professor of Chemistry, Cal Tech*
Dr. Stacey F. Bent, *Professor of Chemical Engineering, Stanford University*
Dr. Ronald Breslow, *Professor of Chemistry, Columbia University, Former ACS President*
Dr. Gary Calabrese, *Vice President, Science & Technology, Corning Inc.*
Dr. Pat N. Confalone, *Vice President, Global R&D, DuPont, ACS Board of Directors*
Dr. Michael P. Doyle, *Professor of Chemistry, University of Maryland*
Dr. Larry R. Faulkner, *President Emeritus, University of Texas* **(Chair)**
Dr. Marye Anne Fox, *Chancellor, UC San Diego*
Dr. Joseph S. "Joe" Francisco, *Professor of Chemistry, Purdue University, Former ACS President*
Dr. Paul Houston, *Dean, College of Sciences, Georgia Inst. Of Tech.* **(Executive Director)**
Dr. Chad A. Mirkin, *Professor of Chemistry, Northwestern University*
Dr. Larry E. Overman, *Distinguished Professor of Chemistry, UC Irvine*
Dr. Hunter Ripley Rawlings III, *President, Association of American Universities*
Dr. Geraldine Richmond, *Professor of Chemistry, University of Oregon*
Dr. Richard H. Scheller, *Executive Vice President, Genentech Research & Early Development*
Dr. Joel I. Shulman, *Professor of Chemistry, University of Cincinnati - formerly at Procter & Gamble*
Dr. Peter J. Stang, *Distinguished Professor of Chemistry, The University of Utah, Editor of JACS*
Dr. Matthew Tirrell, *Pritzker Director, University of Chicago Institute for Molecular Engineering*
Dr. George M. Whitesides, *Woodford L. and Ann A. Flowers University Professor, Harvard University*
Dr. Mark S. Wrighton, *Chancellor and Professor of Chemistry, Washington University, St. Louis*
Dr. Mary Kirchhoff, *Director, ACS Education Division* **(Staff Liaison)**

Commission Membership

Working Group Members

Professor Hector Abruna, *Cornell University*
Dr. Richard Cavanagh, *NIST*
Professor Francis J. DiSalvo, *Cornell University*
Professor James J. Duderstadt, *University of Michigan*
Professor Jeff Evanseck, *Duquesne University*
Professor David F. Feldon, *University of Virginia*
Professor Carlos Gutierrez, *California State University, Los Angeles*
Professor Rigoberto Hernandez, *Georgia Institute of Technology*
Professor Anne Myers Kelley, *University of California, Merced*
Professor David Kliger, *University of California, Santa Cruz*
Dr. Shirley Malcom, *Education and Human Resources, AAAS*
Professor Anne McCoy, *Ohio State University*
Professor Diep Nguyen, *Illinois Institute of Technology*
Professor Susan Olesik, *Ohio State University*
Dr. Peppi Prasit, *Inception Sciences, Inc. San Diego, CA*
Professor Melanie Sanford, *University of Michigan*
Professor Ian Tebbett, *University of Florida*
Professor Charles M. Vest, *President, National Academy of Engineering, and President Emeritus, Massachusetts Institute of Technology*
Professor Isiah Warner, *Louisiana State*

Charge to the Commission

Answer two main questions:

- What are the purposes of graduate education in the chemical sciences?

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- What are the purposes of graduate education in the chemical sciences?
- What steps should be taken to ensure that graduate education addresses important societal issues as well as the needs and aspirations of graduate students?

Major Tasks in the Charge

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- Consider fundamental, comprehensive, and systemic changes suitable for graduate education in the chemical sciences.

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- Consider fundamental, comprehensive, and systemic changes suitable for graduate education in the chemical sciences.
- Suggest actionable approaches for enhancing the quality of graduate education at all institutions.

Broader Input

- Announced in C&EN, input welcomed
- Special advisors, 19 others included in working groups
  - Specific topical expertise
  - Diversity among participants
- Listening sessions in San Diego and Philadelphia
  - Graduate students
  - Recent graduates
- Participation in related meetings occurring in 2012

Effort by the Commission

- Three face-to-face meetings (January, June, November)
- Topical working groups:
  - Departmental Structure
  - Education for Employment
  - Student Support Mechanisms
  - Sources and Prior Preparation of Students
  - Institutional Expectations of Students
  - Postdoctoral Education
- Separate working group on the President's "big questions"
- Final Report by December 2012

Commission Report

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  - Intended for publication only in downloadable electronic form

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Both reports are available at

www.acs.org/gradcommission

Answers to the Big Questions

- Purposes of graduate education in the chemical sciences

  "The primary purpose of graduate education is education. The proper first focus is to educate students to solve problems in society, including the effective education of the succeeding generations."

  – 10 purposes transcending the individual

  – 6 purposes focused on the individual

- Addressing societal needs as well as the needs and aspirations of graduate students

  – 9 particular points

  The future of our society will be influenced by the quality of graduate education in the chemical sciences.

5 Conclusions, 32 Recommendations

- **The Educational Experience of Graduate Students**

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- Financial Support of Graduate Students

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- Financial Support of Graduate Students
- Safety as a Culture

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The Educational Experience of Graduate Students

ACS Chemistry for Life®

Conclusion 1:

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Commission reaffirms the anchoring concept that a doctoral program in the chemical sciences must manifest traditional depth and must maintain a focus on mastery.

But curricula need to be refreshed, and better-designed opportunities should exist for the development of critical professional skills.

The Educational Experience of Graduate Students

- **Greater departmental oversight** over the progress of their graduate students.
- Need for specific activities enhancing students' ability to:
  - **Communicate** complex topics to both technical and non-technical audiences and to effectively influence decisions,
  - **Learn new science** and technology outside prior academic training,
  - **Collaborate on global teams** and/or with global partners and clients,
  - **Effectively define, drive, and manage technical work** toward a practical, significant result, and
  - Clearly understand the **ethical conduct of research**.
- **Four years should be the target** for completion of the PhD, with the departmental median time less than five years.

The Financial Support of Graduate Students

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Conclusion 2:

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The system for the financial support of graduate students, as currently operated by private, institutional, state, and federal funds, is no longer optimal for national needs.

It rests too heavily on individual research grants and involves serious conflicts between the education of graduate students and the needs for productivity and accountability in grant-supported research.

The Financial Support of Graduate Students

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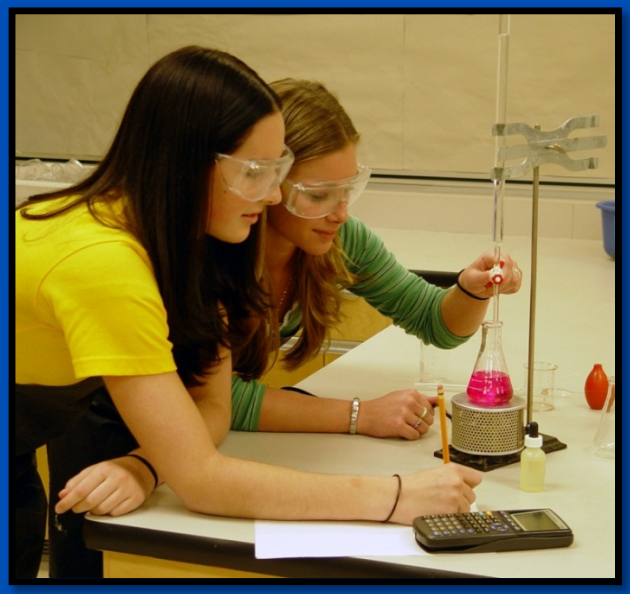
- Funders should take steps toward decoupling more student-support funds from specific research projects.
- On a ten- to fifteen-year horizon, decouple the preponderance of student support.
- In the near term, engage in trial projects designed to prove out new mechanisms.
- Commission recommends "graduate program grants" to support graduate students. Analogous to training grants, but packaged with greater support for innovation in the educational program.

Safety as a Culture

Conclusion 3:

Academic chemical laboratories must adopt best safety practices. Such practices have led to a remarkably good record of safety in the chemical industry and should be leveraged.



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Progress would afford better protection to students and other workers at all academic levels and would better prepare students to meet the natural expectations of their future colleagues and employers.

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- Faculty members in the chemical sciences can and should take the lead toward best practices, and should advocate for support at the highest institutional levels.
- Leadership from the top of an institution is essential. Safety culture must not vary across institutions, and mechanisms for managing the associated costs cannot be left to individual departments or research groups.

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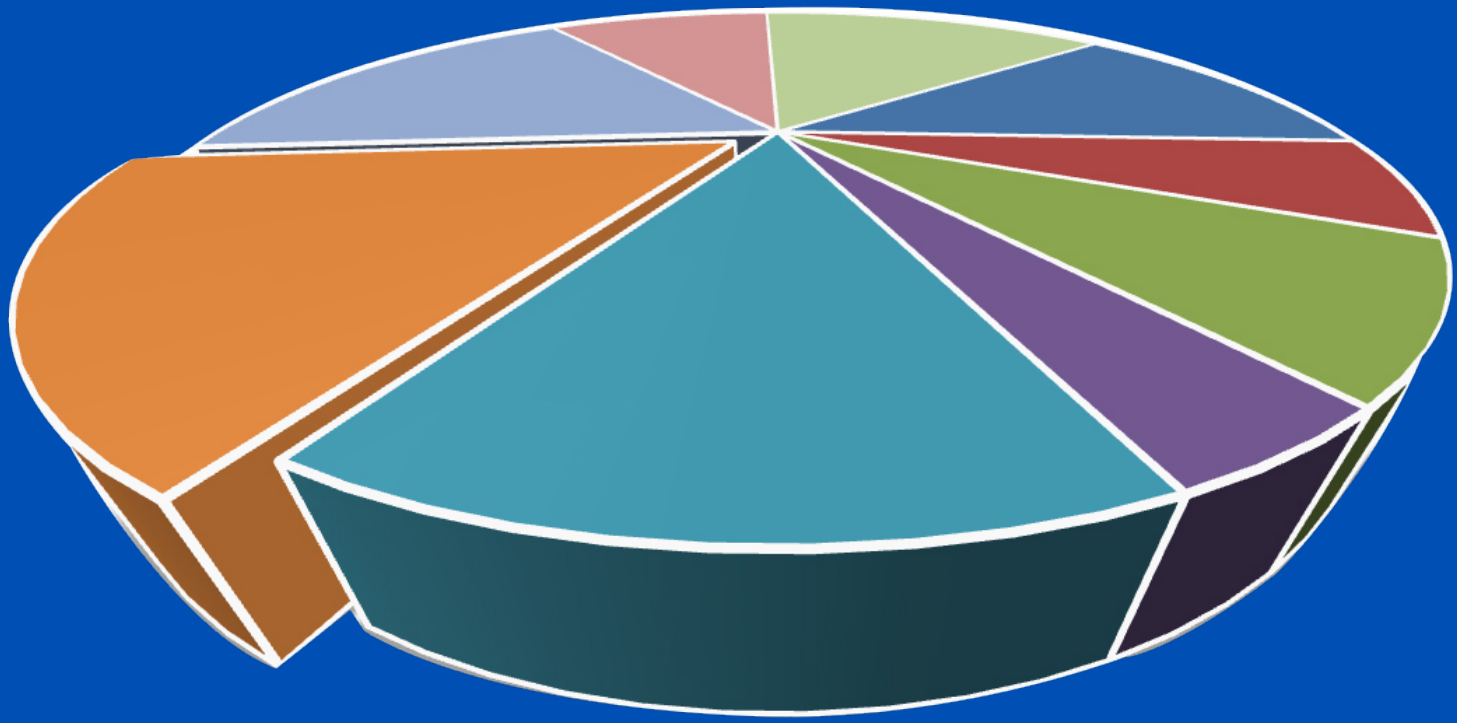
- Leaders in every graduate program are urged to reassess and to focus toward competitive advantages. **There is too much similarity among the nation's graduate programs.**
- To take advantage of the nation's whole talent pool, graduate programs must place an emphasis on attracting and empowering students from underrepresented groups.

ACS-Based Transparency Initiative

- **Collect and publish aggregated, privacy-protected data, organized by graduate program, on post-degree outcomes for all graduates.**



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- Provide prospective students with relevant information toward an informed decision in choosing a graduate school.
- Transparency should drive progress
  - In outcomes for students
  - In overall program quality and competitiveness

Postdoctoral Education

Conclusion 5.

Postdoctoral training and education is an extension of graduate education that is important for success in a variety of career paths, particularly for faculty appointments.

Postdoctoral associates should be treated as the professional scientists and engineers they are.

A postdoctoral appointment should be a period of accelerated professional growth that, by design, enhances scientific independence and future career opportunities.

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- Funding agencies become more receptive to requests for support of more senior research associates who are regular employees of research institutions.
- Foundations and other funding agencies re-explore programs for "teaching postdoctoral associates."

Issues Concerning Diversity in the Graduate Student Pool

Working Group of the Commission

- **Charge to Working Group**:
  - Is the current profile of our graduates the correct one, not only in terms of domestic vs. international, but in terms of diversity along other axes as well? Do they have the proper background for the type of graduate education we want them to attain?

- **Members:** Paul Houston (Chair), Geraldine Richmond (Co-Chair), Michael Doyle, Marye Anne Fox, Carlos Gutierrez, Shirley Malcom, Susan Olesik, Hunter Rawlings, Isiah Warner

- **Outline**
  - Background Information
    - Current Profile, Student Preparation, Attrition, International Students, the Size and Number of graduate programs
  - Recommendations

The Current Profile

	All PhDs	Males	Females
Total PhD	2,306	1433	863
Sex (%)			
Male	62.6		
Female	37.4		
Citizenship (%):			
US citizen or permanent resident	57.4	56.3	59.3
Temporary visa holder	36.8	38.7	33.5
Unknown	5.8	5.0	7.2

National Science Foundation. Science and Engineering Doctorates: 2010.

The Current Profile

	All PhDs	Males	Females
Total PhD	2,306	1433	863
Bachelor's in same field as doctorate (%)	71.8	71.4	72.3
Master's earned (%)	41.5	41.4	41.7
Age at doctorate (yrs)	29.4	29.6	29.0
Time to doctorate (yrs)			
From bachelor's	6.7	6.8	6.4
From graduate school start	5.9	6.0	5.7

National Science Foundation. Science and Engineering Doctorates: 2010.

The Current Profile
Underrepresented Minorities

Table 2. Underrepresented Minority Percentages

	AI	As	Black	Hisp	White	≥2	Other
Biochemistry	0.1	11.8	3.5	4.2	76.4	2.2	1.5
Chemistry	0.4	10.9	4.1	4.8	76.1	2.0	1.7
Chemical Engineering	0.0	9.2	1.4	5.0	79.4	2.1	2.8
Materials Science Eng.	0.0	16.6	5.1	6.4	67.7	2.2	1.9

AI = American Indian/Alaska Native, As = Asian, Hisp = Hispanic, ≥2 = two or more.
Source: National Science Foundation. Science and Engineering Doctorates: 2010.

Student Preparation

- There is great variability in undergraduate preparation
- Many graduate programs have done away with placement examinations for incoming students. In the past, these exams guided remediation, so that all students might strengthen and broaden their knowledge of chemistry.
- Most graduate students do not arrive with good preparation for teaching undergraduates. Much data suggest that those who are better teachers are also better at many other aspects of the doctoral program, e.g., research or communication.

Attrition from Graduate School

- Just 62% of entering PhD students have been awarded the degree after ten years [Sowell, R., Ed. *PhD Completion and Attrition: Analysis of Baseline Data; Council on Graduate Schools: Washington, DC, 2008*]

- There is little data available about how this varies with school, , sub-field, age, gender, ethnicity and other factors.

International Students

- The Commission fully recognizes and values the great contributions that have historically been made in our graduate programs and in our national technical enterprises by international citizens who were first attracted to the US as graduate students. However, the Commission also notes that the balance in graduate degree production has steadily shifted toward international students. A legitimate concern is whether the nation will continue to have a readily employable technical base large enough to sustain global leadership in innovation.

The size and number of graduate programs

- On the institutional side, size and balance in a graduate program are only lightly influenced by opportunities and outcomes for students after they complete their degrees. Mainly, they are consequences of other considerations
  - The size of the faculty and their degree of engagement with research
  - The distribution of expertise and interests among the faculty
  - The service teaching load on the department
  - The available support for graduate students beyond teaching assistantships
  - The scale and balance of applications from students deemed qualified for admission, and mean time-to-degree.
- Given what seems to be a permanently restructured employment market for PhDs, the Commission perceives a risk that the number of career opportunities in the chemical science professions may be insufficient to accommodate those qualified for and desiring entry. Left unaddressed, an imbalance will likely be highly damaging to the talent level and traditional academic strength in the chemical sciences.

Recommendations

- Student Profile
  - To take advantage of the nation's whole talent pool, graduate programs must place an emphasis on attracting and empowering students from underrepresented groups.

- Student Preparation
  - The need for remedial courses has not disappeared with the disappearance of placement examinations; if exams are not used, other methods for evaluating the preparedness of all incoming students should be employed.
  - Proper teaching training of incoming graduate students, preferably in a program beginning in the summer before their first semester, is highly desirable.

Recommendations (continued)

- Attrition
  - There is a very definite need for more data, broken down by school, sub-field, age, gender, ethnicity
  - It is important for faculty in graduate programs to do a better job in earlier assessment of whether a student is truly well-suited to successful completion of a PhD.
    - Aspects of a sound early assessment process include building accurate expectations among undergraduate students bound for graduate school, better admissions processes, grades in early graduate courses, mentoring, and serious, early contact with a doctoral committee.
- International Students
  - Programs should build the domestic fraction of their graduate enrollments as a high priority. International students should not continue to substitute for the domestic share; instead, a mix richer in domestic students should be targeted.

Recommendations: Size and Number of Graduate Programs

- Departments should give thoughtful attention to maintaining a sustainable relationship between the availability of new graduates at all degree levels and genuine opportunities for them. Replication in excess is wasteful of resources and does injustice to the investment made by students and society.
- Departments should adjust program sizes in the light of truly attractive opportunities for graduates. This consideration should be paramount in determining the scale and balance of any program.
- A large undergraduate teaching need is not a sufficient justification for a large graduate program.
- Leaders in every graduate program are urged to reassess and to focus toward competitive advantages. There is too much similarity among the nation's graduate programs.

Diversity Initiatives at Georgia Tech College of Sciences

P. Houston at NDEW 2013 www.oxide.gatech.edu

College of Sciences Diversity Programs

In cooperation with ADVANCE

- Mentoring
  - Receptions and Lunches
  - Mentoring Awards (mentors, as nominated by mentees)
- Moving Forward Award (Chairs, for diversifying faculty)
- U. Michigan team presented diversity workshop
- CoS team (Snell, Li) visited each School
  - focus on chairs, hiring committees
  - Same team this year focused on RPT committees
- Help in placement of spouses, either in college, at Tech, elsewhere
- Support (day care) for faculty who need to take children with them to conferences
  - Need for more local day care
- Center diversity efforts, e.g.. COPE, CCE

College of Sciences Diversity Programs
In cooperation with ADVANCE

- Family Friendly Policies (tri-fold summary)
- Women in Chemistry Group – Deborah Ortiz
- NOBCChE Group – Keith Oden
  - Supported National conference
- Hispanic initiatives – Rig Hernandez
- Women in Science and Engineering Group
  - Helped support G. Richmond visit
- Women in mathematics group meets monthly
- Math: two course reductions during first two years after birth of child
- Reception for promoted women (ADVANCE)
- P&T Workshop (Harrell)
- Childcare survey and Exit Interviews (ADVANCE)

Successes

- Three women chairs in 2007
  - Psychology, EAS, Physics
- In Assistant Prof rank, nearly 1/3 are women, and very few leave at that rank
- CoS Diversity Administrator (Keith Oden) supported by contributions from all units
- 50% of faculty who received tenure in 2013 were women.

Major Efforts at Institute Level

- Provost Target of Opportunity Initiative
  - Provides new positions if candidate from under-represented group is not already the top candidate.
  - Encourages all units to have searches defined broadly enough so that those from under-represented groups apply
  - Makes possible multiple offers when for example there are two women candidates for positions in the same department, say Chemistry.
  - Occasionally helps with spousal hires
- Establishment of the position of Vice President for Institute Diversity
  - Coordinates all programs

Thank You

Discussion