

254th American Chemical Society National Meeting
Division of Chemical Education

Advancing Graduate Education: Opportunities & Challenges

N. S. Goroff, Organizer

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Abstracts:

Bassam Z. Shakhashiri

Professor of Chemistry

UW-Madison

TITLE: Advancing graduate education: Prospects and expectations

Abstract: There is great capacity to adapt graduate education to the needs of society including satisfying personal curiosity and serving the common good. However, marshalling the will to act remains elusive. There are sparks here and there, but no major ignition yet. Synergy among academe, government, and the private sector is needed to bring about fundamental, comprehensive, and systemic changes in current practices in graduate education at all types of institutions. Clarity of purpose, intellectual leadership, institutional commitments, financial resources, and forceful expressions from graduate students and postdoctoral associates can drive much needed reform.

Jon R. Lorsch

Director, National Institute of General Medical Sciences

National Institutes of Health

TITLE: Catalyzing the modernization of graduate biomedical education

Abstract: Biomedical research has changed dramatically over the past three decades, yet the approaches we use to educate the next generation of researchers have changed little in the same time period. The National Institute of General Medical Sciences has embarked on an effort to catalyze the modernization of graduate biomedical education. Key facets of this modernization should include: a shift away from teaching “facts” in the didactic portions of graduate curricula to a focus on developing the range of skills (technical, operational and professional) needed to be a highly productive, creative, rigorous, and responsible scientist; use of evidence-based approaches to teaching and mentoring; and development of a culture of educational innovation,

experimentation, assessment and iterative improvement in order to meet the evolving needs of science, medicine, industry and society. I will discuss these efforts and, hopefully, provoke a useful dialog with attendees.

William J. Lewis

Deputy Director, Directorate for Education and Human Resources,
National Science Foundation

TITLE: Supporting graduate education in the future: Views from the National Science Foundation

Abstract: The National Science Foundation (NSF) supports fundamental research in all fields of science and engineering (S&E) and S&E education including approximately 24 percent of all federally supported fundamental research conducted by U.S. college and universities. The central role of graduate education as part of the agency's investment strategy was included in NSF's authorizing language, and has been reinforced over the past 65 years. NSF's direct investment in graduate education is large; the agency supports approximately 40,000 graduate students annually at a level of about \$1 billion. In 2016, the Foundation released its Strategic Framework for Investments in Graduate Education. In this session, we present an overview of this framework, provide updates on current activities at the agency, and describe our major investment strategies and research activities that support graduate education. We would also like to engage with the ACS community to gain input on our common goal of improving graduate education and graduate student preparedness for a range of careers in the workforce.

Alan I. Leshner

Chair, National Academies Committee on Revitalizing Graduate Education

TITLE: Key issues in transforming graduate STEM education for the 21st century

Abstract: The National Academy of Sciences has convened a committee to examine graduate education in science and recommend guidance for its evolution. The Committee is responding to the concern that greater than 60% of students do not pursue academic careers but they are being educated in the same way they have been for almost 100 years – for exactly that kind of career. The Committee has been studying career paths for graduate students as well as key issues needing attention. The presentation will focus on the key areas where the Committee is focusing and early thoughts about what it might discuss in the final report. All possibilities are being considered but the committee has agreed that under no circumstances should the core elements of what it means to be a graduate in science be diluted. The Committee is also opposed to tracking students too early in the process.

Keith Watson

Vice President, Corporate Research and Development
The Dow Chemical Company

TITLE: Fostering industrial and academic partnerships

Abstract: In 2011, The Dow Chemical Company greatly increased its investment in chemical-related research at several academic institutions across the United States as part of its University Partnership Initiative (UPI). The intent of this initiative is to strengthen research in traditional scientific fields such as chemical engineering, chemistry, and material science that are important to Dow, to industry, and to addressing some of the worlds most pressing challenges. In addition to expanding research in areas of immediate industrial relevance, the program also offers numerous other incentives, including the development of a pipeline of PhD researchers for future industrial careers and the enhancement of collaboration between Dow and Academia that will foster future innovation for years to come. Learnings from the first five years of UPI will be discussed. Specific focus will be placed on the methodologies that were used to foster a collaborative environment between Dow and Academia to meet the needs of both parties. Highlights of technical success, the positive effects that have been observed beyond technology, as well as the associated challenges will also be reviewed. Finally, Dow's vision for the future of industrial and academic partnerships and how the greater chemical community can ensure these type of partnerships continue to flourish will be addressed.

Monty Alger

Former Senior Vice President at Myriant Corp., Former Vice President and CTO, Air Products Institute for Natural Gas Research & Professor of Chemical Engineering, Penn State

TITLE: Building an integrated university/workplace education model

Abstract: In the 21st century, nearly every business has been disrupted by the application of technology. The combination of new business models with technology has transformed major industries, including transportation (Uber), hospitality (Airbnb), and retail (Amazon). Higher education is a massive market with structural weaknesses that make it an industry open to disruptive insurgents. In the next decade, the speed of learning and ability to deploy new information will become the primary competitive advantage for any educational organization. To adapt to these forces, universities must innovate and think "outside the box" to create new models that lower tuition costs; improve student experience; and reduce the time to knowledge, thus ensuring students have mastered skills for a worldwide marketplace that demands continuously updated capabilities. This presentation will discuss an integrated education model for the 21st century that addresses these needs.

Victoria McGovern

Senior Program Officer
Burroughs Wellcome Fund

TITLE: Addressing career preparation with foundation tools

Abstract: The Burroughs Wellcome Fund (BWF) has been broadly interested in the environment for science in the US and Canada since we became an independent foundation in the mid1990s. BWF is a independent private foundation whose mission is to advance the medical sciences by supporting research and other educational activities. Starting with internal

conversations about how to add value to the awardee experience of the relatively young researchers receiving our postdoctoral-faculty bridging awards, over time we have launched a number of trainee-focused initiatives ranging from producing books on career development topics to designing and running courses on how to manage the “small business” that is a laboratory while on the road to tenure. Since 2012, we have run four rounds of the Career Guidance for Trainees (CGT) program, a competitive grant initiative making small scale (~\$3050,000) awards that support academic institutions, professional societies, and other nonprofits to pilot innovative approaches to moving graduate students and postdocs toward their career destinations, whether in academe or further afield from their training. This talk will describe our current career development courses, including their agendas and outcomes, reflect on how our career development books have been used across the country, and summarize the handful of themes that have arisen over four rounds of the CGT program.

Nancy S. Goroff

Department of Chemistry
SUNY Stony Brook

TITLE: Balancing research training with professional skill building: Models for collaborative effort

Abstract: Are we educating too many STEM PhDs or too few? Recent studies suggest that this is the wrong question to ask. Instead, we need to make sure our PhD graduates have both the scientific and the professional skills needed for success. Yet chemistry faculty are often skeptical of programs that sound like professional training. We are educating scientists, not offering training for specific job tracks! How do we develop buy-in among faculty for professional development programs, so that they encourage their students to participate? This talk will describe some of the challenges of adding professional skills programming to STEM doctoral education, and approaches that schools have taken to overcome those hurdles. The talk will also cover resources from ACS that can help, including PFLAGs (Preparing for Life After Graduate School) workshops and ChemIDP.

Corrie Kuniyoshi, Jodi L. Wesemann, Joerg Schlatterer, Margaret E. Grow-Sadler

Education Division
American Chemical Society

TITLE: ACS development and implementation of career resources for graduate students and postdocs

Abstract: The availability of career development and planning resources for graduate students and postdoctoral researchers are critical to build a globally competitive U.S. workforce in the chemical sciences. The American Chemical Society Graduate Commission report has provided guidance in developing and enhancing ACS programs and tools that foster professional growth of graduate students and postdoctoral researchers. The ACS Graduate & Postdoctoral Scholars Office (GPSO) expanded career and professional development training opportunities including the *Preparing for Life After Graduate School* (PFLAGs) workshop and the *Academic*

Employment Initiative (AEI) and *Postdocs to Professor* (P3, P2F) workshops. The *Graduate & Postdoctoral Chemist* e-magazine features professional development information including articles about mentoring, communication, career tips, and national and international opportunities. A major addition to the GPSO offerings is the recently launched *Individual Development Plan* (IDP) web tool for chemical scientists (ChemIDP™). We will share how ChemIDP™ workshops are delivered and report on experiences of early users. Partnerships and approaches for incorporating ChemIDP™ into existing ACS career resources and graduate programs will be discussed.

Jyllian Kemsley

Senior Editor, Chemical & Engineering News
American Chemical Society

TITLE: From the safety beat: Incorporating lab safety into graduate training

Abstract: The 2012 ACS Presidential Commission report on Advancing Graduate Education in the Chemical Sciences included the recommendation that “academic chemical laboratories must adopt best safety practices.” C&EN Senior Editor Jyllian Kemsley will review common themes of academic laboratory incidents from the last several years. She will also discuss recommendations to improve lab safety in academic environments, responsibilities of personnel, and resources available to help improve safety culture.

Michael Ashby

Department of Chemistry & Biochemistry
University of Oklahoma

TITLE: Is the apprenticeship model in graduate education obsolete?

Abstract: The “apprenticeship model,” a general metaphor for a relationship in which a novice learns from an experienced person, is frequently used to describe the training of graduate students. The model is sometimes derogatorily described as the “cloning” of a professor. In fact, however, a graduate student is influenced by many people besides the Research Director, including other faculty who teach and serve on advisory committees, postdoctoral fellows, and student peers. Nonetheless, Research Directors presently serve as the primary mentors of their graduate students, and they are consequently most influential during a student’s graduate education, and oftentimes thereafter. Natural tensions exist between the apprenticeship model and the multifarious purposes of graduate school, as is, for example, articulated in the ACS study *Advancing Graduate Education in the Chemical Sciences**. The apprenticeship model has been criticized because it can inhibit creativity and innovation, it represents a significant power differential, and is inconsistently applied within doctoral training. In contrast, supporters of the apprenticeship model assert that learning by emulation is necessary if individual creativity is to follow. These antagonists may be both correct, provided the mentoring model evolves as a graduate student matures. National studies on the future of graduate education have produced some common themes around mentoring, individualized/broader instruction, and reducing the time to degree (TTD). However, the path towards achieving these recommendations is unclear. One reason for lack of clarity is there appears to be no consensus regarding the best practices in

graduate school. In contrast to undergraduate education, for example, ACS certified programs, graduate programs tend not to share pedagogy outside the departments in which it is taught. Facing impediments to tenure, young faculty tend to adopt the teaching practices of their senior colleague, and curricula within a department becomes entrenched. During this presentation, some of the efforts of our department to implement the recommendations of the ACS study* will be discussed, with an emphasis on broadcasting and amplifying best practices.

Andrew L. Feig

Department of Chemistry
Wayne State University

TITLE: Educating STEM doctoral students for success in a rapidly changing employment landscape

Abstract: Doctoral training at U.S. Universities has been a crown jewel in higher education, drawing students from around the world and preparing some of the most creative scientists and thinkers of our time. Graduates of our PhD programs have founded companies, expanded economic opportunities, and created knowledge that serves both the public good and private enterprises, not to mention the impact of the work they produced while earning their degrees. That said, doctoral education is in disequilibrium today having failed to react to economic forces that were visible to anyone who cared to look beyond their laboratory. Only about 24% of PhD recipients ever take tenure-track academic jobs, so the perception that the doctorate is primarily a pathway to the professoriate fails to recognize historical trends. Patterns of university hiring have changed significantly in recent years with the shift toward adjunct and part-time faculty. At the same time, industry-funded basic research has decreased dramatically, representing just 4% of such expenditures today as opposed to 17% in 2006 (*Research and Development: Essential Foundation for U.S. Competitiveness in a Global Economy* Arlington, VA (NSB 0803)). Universities and graduate programs must evolve if they wish to stay relevant. Successful navigation of these changes will require Departments, Graduate Schools and Universities to think more broadly about the products of doctoral education – both the knowledge created as a result of university research and the highly trained individuals who themselves need to have productive, satisfying careers after graduation. The discussion will look at the impact of concrete changes Wayne State University has made to its graduate programs including adopting individual development plans for all doctoral students to encourage students to think about their career trajectory, career exploration opportunities that reflect the multiple career pathways our students take after earning their degrees and career tracking of doctoral alumni to better understand their employment trends and to improve dialog between doctoral alumni and our current students as they think about transitioning from school to the workforce.

Ralph Stuart

Department of Environmental Health and Safety
Keene State College

Samuella B. Sigmann

Department of Chemistry

Appalachian State University

TITLE: Supporting improved safety practices in graduate chemistry education

Abstract: The 2012 ACS Presidential Commission's report on Advancing Graduate Education in the Chemical Sciences recommended that academic chemical laboratories adopt "best safety practices". An emerging strategy for moving this recommendation forward is to connect undergraduate and graduate chemical safety education efforts using a "virtuous cycle" based on spiral learning that supports continuous improvement of laboratory safety conditions and practices. Since the 2012 report was published, ACS committees (CCS, CPT and the CHED Safety Committee), technical divisions (CHAS, CHED and CINF) and other organizations have been exploring what improved safety practices, both technical and cultural, look like when implemented in academic research laboratories. This paper will review these resources and describe chemical safety education experiences that can be used to not only better prepare an undergraduate for graduate work, but facilitate continued improvement in best safety practices in graduate research. Specific examples of the added value of this strategy will be provided.

Barbara J. Natalizio

National Postdoctoral Association Board of Directors
Division of Graduate Education, National Science Foundation

TITLE: Conquer the challenge of change by communicating a shared vision of transformative graduate education

Abstract: Graduate education of the future needs to prepare students to be equal to the task of overcoming the ever-changing and dynamic demands of our society. Funding mechanisms such as the National Institutes of Health's (NIH) Broadening Experiences in Scientific Training (BEST) awards and the National Science Foundation (NSF) Research Traineeship (NRT) Program, specifically the Innovations in Graduate Education (IGE) track, invest in innovative programs that often pilot new models for graduate education. Postdoctoral scholars, who are a vital part of the research workforce, also benefit from many of these programs that focus not only on the discipline-specific conceptual knowledge, but also the soft skills such as communication, leadership, and management. Catalyzing successful cultural change at the institutional level will require new incentives and drastic changes to our current infrastructure. However, these events must take place for us to tackle the grand challenges of the 21st century. Lessons can be learned from programs, such as the AAAS Science and Technology Policy Fellowship Program, which strongly emphasize professional development in areas including policy, leadership, and communications. Given the global, and increasingly interdisciplinary nature of challenges that we face as a society, collaboration amongst universities, government, and the private sector will drive the advances in graduate education as we move forward. Persistence and perseverance exhibited by leaders who are committed to improving graduate education and postdoctoral training experiences will bring us closer to the implementation of graduate education paradigms that are effective and adopted. This presentation will explore innovative approaches to transforming graduate education and the applicability of those programs to support postdoctoral communities. There will also be a focus on stakeholder engagement, specifically generating excitement, energy, and commitment for advancing graduate education.

Jamie Curtis-Fisk

STEM Program Leader and R&D Scientist
The Dow Chemical Company

Ashley Bear

Program Officer
National Academies of Sciences, Engineering, and Medicine

TITLE: Fostering an inclusive graduate education environment: Promising practices for promoting gender equity

Abstract: While women remain underrepresented in science and engineering, this underrepresentation is not uniform across all disciplines. For example, women make up 53% percent in biology, but only 40% percent of doctoral recipients in chemistry and about 20% percent in fields like computer science and engineering. This raises questions about why women's representation varies between different scientific fields and which interventions are most effective in promoting the retention, recruitment, and advancement of women in STEM. What can chemistry graduate education programs learn about how to successfully recruit and retain women from fields like biology where women are at or near parity at the graduate level? What best practices exist amongst STEM graduate education programs that can be applied to chemistry graduate programs, and what successes in chemistry departments should be highlighted more broadly? This presentation will explore our current understanding of promising practices for promoting gender equity at the graduate level in STEM fields, and specific application of these to graduate education in the chemical sciences.

George Bodner

Department of Chemistry
Purdue University

TITLE: Can we accept the idea that the wheel might already have been invented?

Abstract: Conversations with a wide variety of members of the Society during my six-year term on the ACS Board of Directors have convinced me that the graduate programs at many of our top-ranked institutions might be described as ideal for educating individuals pursuing careers as research chemists in the 20th century; a time we are not likely to see again. Unfortunately, some of the people involved in discussions of improving graduate education in chemistry seem to forget that research in other disciplines also exists. This paper will start by noting that the call was issued, many years ago, for people to do the research that informs practice. It will therefore ask the question: What would happen if people thinking about changes in the way chemistry graduate students are educated were familiar with the results of work by individuals whose area of scholarship focuses on topics such as The Assessment of Doctoral Education: Emerging Criteria and New Models for Improving Outcomes? Which happens to be the title of a book by Maki and Borkowski; a book that contains a forward by the Director of Best Practices at the Council of Graduate Schools, which has published a wide variety of books devoted to the topic

of this symposium. It will argue that efforts to rethink graduate education in chemistry would benefit from building on the results of research that has already been done on the assessment of similar efforts in other fields and provide examples of that work.