A Committee on Science Initiative:
STEM Education Pipeline to Innovation and Entrepreneurship

The Committee on Science (ComSci) at the American Chemical Society (ACS) has launched an initiative to explore various aspects of the STEM Education Pipeline and beyond. The goals are to determine what needs to be done to address the following:

• How best to inspire the younger generation to pursue STEM disciplines? The goal is to engage them.
• Are there new platforms that can be leveraged for STEM teaching and learning beyond the traditional seat time to retain students’ interests in STEM disciplines? These may include inquiry and discovery based multidisciplinary team approaches. What are the impediments to this new approach?
• What additional educational content beyond science needs to be delivered to students to help them pursue the 21st century STEM careers and not just the jobs? These may include intellectual property protection, technology commercialization, technology transfer or being entrepreneurs to commercialize their ideas.

The ultimate goal is to better prepare the next generation of STEM workforce with a steady pipeline for discovery, innovation and entrepreneurship to continue to impact the quality of life for the society at large.

As a first step on this initiative, at the Anaheim National Meeting of the American Chemical Society the Committee on Science organized a symposium on “STEM Education Pipeline to Innovation and Entrepreneurship” to initiate a dialogue. The focus of this symposium was to explore how best we can recruit students for the next generation of scientists and engineers, and what we may need to consider to better prepare our graduates for the 21st century careers. A distinguished group of speakers presented their perspectives on STEM education to Innovation and Entrepreneurship. Speakers from a National Research Laboratory and a large Biotech company highlighted their programs on what they are doing to recruit students, retain them and help support in graduating them. A Nobel Laureate in Chemistry illustrated examples of research that led to successful launch of start-up companies. A successful small business founder described their company’s role in outreach. A former National Science Foundation director shared his perspective on the need for additional skills in STEM education in the context of the global competitive market. A former director of Research & Development at a large corporation described the success factors for technology development and commercialization, and finally two speakers represented Venture Capital firms focusing on the need for business knowledge for STEM graduates to be successful. This symposium is the first step in our dialogue about the STEM initiative to explore challenges and opportunities in STEM education for breakthrough ideas for innovation in STEM teaching and learning. Below is a summary of the presentation focus by the speakers at this symposium in three distinct categories, outreach, education and business knowledge.
Outreach

John Knezovich, Director, Strategic University Relations, Lawrence Livermore National Laboratory:

The Lawrence Livermore National Laboratories (LLNL) focuses on anticipating problems of national priority, concentrates on innovation to deliver solutions. As it relates to the workforce needs, beyond disciplinary proficiency, the DOE is interested in excellent communication skills, technical leadership and the ability to work in multidisciplinary team environment to creatively solve problems. DOE is interested in supporting the STEM education pipeline and has implemented several programs targeted at middle school and Community College students to inspire them and motivate them to pursue STEM careers. They also engage science teachers to develop their skills and provide them hands-on experience through various programs, and LLNL also present a program to bring scientists via web to the classroom, and tour the laboratories in real time via web. It gives students an idea for what scientists do, where they work and what they are engaged in. All of these efforts are targeting to enhance the STEM education pipeline through inspiration and education about STEM career opportunities.

Jerry Murry, Vice President, Small Molecules Process and Product Development, Amgen Inc.:

This presentation shared the various programs that Amgen has in place to inspire and encourage the younger generation to pursue STEM careers. Amgen has several programs in place such as Summer Scholars for undergraduate students, and 80% of the alumni from this program have completed college degrees and are now pursuing advanced degrees in STEM fields. Amgen also has a program targeted for middle school students to learn through inquiry based Biotechnology research experience in classrooms. Amgen provides the curriculum, supplies and also loans research grade equipment for classrooms. To strengthen science teaching Amgen awards funding to recruit and support recent graduates to pursue science teaching careers, and Amgen encourages excellence in science education by recognizing and honoring extraordinary K-12 science teachers. The ultimate goal is to better prepare the next generation of STEM workforce with a steady pipeline for discovery, innovation and entrepreneurship to continue to impact the quality of life for the society at large.

Sharon Vercellotti, Founder and Owner, V-Labs Inc.:

This presentation focused on the role of a small business in supporting the outreach efforts to recruit students and inspire them to pursue STEM careers. Her business reaches out to various groups including Iota Sigma Pi, Girls Scouts, area museums, ACS and offer grants for outreach activities. High school and college students work in their laboratories under the supervision of Ph.D. scientists to conduct experiments and gain knowledge and confidence in science. The presentation also focused on the importance of creativity for science graduates, and the need for inserting Art in the science curriculum to instill creativity in science. The presentation also focused on sources of funding for entrepreneurship such as the Kaufman Foundation for commercialization, and also funding made available by the National Collegiate Inventors and Innovators’ Alliance for new course development for entrepreneurship, for
commercialization of ideas by Advanced Student Teams, Invention to Venture workshops, and conference sponsorship grants.

**Education**

**Bob Grubbs, Professor of Chemistry, Cal Tech Institute:**

Professor Grubbs shared examples of taking basic research through the commercialization path, from academic settings to the private sector. The presentation focused on three start-up companies that resulted from the basic research at Cal Tech. These include:

- **Ruthenium Based Olefin Metathesis Catalysts**
- **Materia, Inc.**
- **Light Adjustable Interocular Lens**
- **Calhoun Vision**
- **Battery Company**
- **Contour Energy Systems**

Prior to commercialization, there is always a consideration for protecting the intellectual property through patents; however, it needs to be balanced with the need to publish and also be part of a thesis for students which is also a form of publication. Often graduates and postdocs are involved in the start-up company after a proof of concept is in place; however, it does require external funding for commercialization. This can be accomplished through partnerships with small or large companies. Each option has their advantages and disadvantages. However, it is possible to achieve a balance and take academic research to a commercial product to help the society.

**Elsa Reichmanis, Professor of Chemistry, Georgia Tech, and Past ACS President:**

This presentation focused on translating ideas to products through examples of applications of polymers in electronics and photonics. Development of advanced technologies that address global concerns and societal challenges require multidisciplinary research and development, through collaboration between the sciences and engineering. The graduates need to develop effective communication skills and the ability for teamwork, knowledge of entrepreneurship and business leadership, and more importantly an understanding of relevant policy issues. We need to create opportunities at an early stage to engage students in hands-on research, educate them on the need of multidisciplinary approaches to solving problems.

**Luis Echegoyen, Professor of Chemistry, Texas Christian University, Former Director, NSF Chemistry Division:**

The presentation concentrated on the new reality that today the economy is global with opportunities in the global market place. It therefore requires Chemistry graduates to acquire skills beyond the technical proficiency. Among these additional skills one critical skill includes learning a foreign language and developing an understanding of other cultures. Developing a global scientific network for research and collaboration in STEM disciplines is critical to
participate in the global scientific enterprise. Students need to be engaged in research that reaches global boundaries to be better prepared for the 21st century careers. There is also a need to develop an understanding of business and management issues as it relates to science.

Business Knowledge

Cheryl Martin, Executive in Residence, Kleiner, Perkins, Caufield and Byers Venture Group:

The talk focused on educating STEM graduates about entrepreneurship. It is critical that science and engineering graduates understand how to commercialize their ideas. It can be part of the curriculum so that graduates are better prepared to only work for large corporations to create intellectual property, but also be able to launch their own start-up companies when it makes sense. The speaker encouraged partnerships between science and business programs in academic settings to accomplish this goal.

Judith Giordan, Managing Director, Venture Well:

The speaker emphasized the need for expanding the STEM education platform to include some entrepreneurship tools. STEM graduates are involved in creating intellectual property that upon appropriate legal protection and commercialization bring new products to the market place. These products improve the quality of life for the society. However, the commercialization path has several critical steps from idea to commercialization, both for the innovator and the innovation, that require due consideration. Assessing the market need for an idea is as important as the technical issues in research. The process of commercialization requires collaboration with other scientists, it needs the business expertise and also capital. The speaker shared the various funding opportunities by National Inventors and Innovators’ Alliance for students and also for faculty from entrepreneurship education to commercialization of ideas.