This report summarizes the outcomes of the Engineering Education in the 21st Century Workshop held in conjunction with The NSF CCMI Engineering Research and Innovation Conference in Honolulu, Hawaii on June 22, 2009.

Background

The workshop brought together several panelists with expertise related to different aspects of engineering education both at the undergraduate and graduate levels who shared their thoughts and made recommendations to the community and to the National Science Foundation. These recommendations are summarized below. The workshop was organized by a small steering committee of leading scholars. V. Narayananuriti of Harvard University and Adnan Akay of Bilkent and Carnegie Mellon University served as co-chairs and organizers.

The coverage of the workshop went beyond the many familiar topics that had already been addressed elsewhere in connection with engineering education to explore topics relevant to but yet unexplored.

Introduction

Engineering education has captured the attention of many over the last two decades. This continuing emphasis stems in part from the social and political fallout due to events related to higher education in general, including rising tuition and related costs and the effects of globalization. Engineering education in particular, however, attracted unsolicited recommendations and demands from industry for changes in the way we educate engineers.

The changes recommended by many in industry, academe, and government revolve around the perceived present and future needs of industry and society. Recommendations largely relate to the anticipated practice of engineering in the 21st Century. Describing them briefly, today an engineer must have effective interpersonal skills, must be conversant in new technologies, and must have the ability to anticipate the future needs of the workplace and prepare herself accordingly. In other words, we need renaissance engineers. We need to train engineers not only on how things work but how the world works.

Universities have the obligation to educate students and prepare them for the future. This obligation makes it essential to consider the perspectives of employers as well as the
directions the practice of engineering may go in the future. Universities also give consideration to the fact that there is an increasing demand for engineers in non-engineering sectors of the economy; engineering education is becoming a preferred preparation for many other professions. Finally, engineering methods and ways of thinking can be an important ingredient in the broader training of future leaders in the application of technology and public policy.

More recent efforts as epitomized in *Rising Above the Gathering Storm* also point to US falling behind in technological advances and providing evidence in terms of numbers of students enrolled and graduating in engineering fields.

Numerous efforts including workshops, conferences, and publications continue to address engineering education with specific goals of how to improve it, how to attract more students to study engineering, and more importantly how to broaden the student participation to take advantage of the diversity of population to increase the pool of students and future faculty. The recommendations that have come out of these have been taking root and yet much remains to be accomplished.

We have started to see bolder and more forward looking ideas to emerge by individuals both within engineering education and by those whose expertise are in fields related to cognition and learning from whom engineering educators can benefit. Similarly, time may have come to consider the engineering curricula under a different light, perhaps with a different definition of what engineering profession of the 21st Century should entail.

**Summary of Presentations and Recommendations**

In his keynote address, Jim Plummer, Dean of Engineering at Stanford, addressed the key ingredients of educating engineers for the 21st century. Among these he mentioned the importance of having students work on real engineering problems. If such problems are selected from among those that are part of grand challenges the world faces. He pointed to the NAE grand challenges as an example. In the same vain, Dean Plummer highlighted the significance of entrepreneurship as part of the education engineering students receive and the need to have the ability to “sell” ones ideas. He supported the notion put forth by Chuck Vest that the curriculum needs to be exciting and creative and yet rigorous.

In the first panel, Rick Miller, president of Olin College, presented his reflections of the ten years since Olin College was designed solely for engineering education and discussed their experience. After reviewing the basis for need to change engineering education, he described the foundation of how Olin College approaches innovation and enhance creativity. Role of design starting freshmen year and continuing throughout their education immerse students in design and innovation.

Sharad Malik of Princeton University presented the new Princeton initiative on Engineering and the Liberal Arts. He described the foundations of such an education and
the need to broaden the classical engineering education by also emphasizing societal issues. They aim to achieve their stated goal by also introducing significant flexibility in the program.

Richard Muller discussed his approach to teaching physics to non-science or engineering majors making a set of recommendations such as leaving out what is not important and not cover everything in lecture, the need to motivate and intrigue, teaching at multiple levels, and respecting students. His presentation gave a synopsis of his popular book *Physics for future Presidents*.

Tina Seelig of Stanford University discussed the importance of entrepreneurship and pointed out the new approach to education of “T-shaped” people; engineers with a broad education in entrepreneurship, creativity and innovation and depth in a technical area.

In the second panel, speakers contributed global perspectives.

Seeram Ramakrishna the Vice President for Research Strategy at the National University of Singapore described the role of a research university in addressing societal challenges. Presenting data for each of the global issues society faces, he described NUS’s approach to contribute to solutions through global collaborations.

Jackie Ying from the Institute of Bioengineering and Nanotechnology in Singapore elucidated the key areas in which engineering can make a difference: Sustainability, Health, Vulnerability, and Joy of Living and emphasized how engineering education needs to involve the NAE Grand Challenges for Engineering.

Ambuj Sagar from IIT Delhi discussed the view from India, pointing out that although the engineering education systems are different in the US and other countries, the challenges are similar.

As the final presentation of the workshop, Henry Yang, Chancellor of UC Santa Barbara made a plenary presentation on organizing engineering for an interdisciplinary future.

Summary of Recommendations

- The need for excitement, intrigue, challenge, and rigor in teaching
- Embedding topics and showing relevance to global issues society faces as a way of excitement and building interest of students (and professors).
- Bring in experiential learning; design and produce.
- “Don’t sweat the small stuff.” Know and teach what is important. Do not try and cover everything in a lecture.
Steering Committee

Adnan Akay, Bilkent and CMU (co-chair)
Rick Miller, Olin
V. Narayanamurti, Harvard (chair)
Henry Yang, UCSB

Participants

Besides the invited speakers and expert panelists the 81 participants were drawn from the attendees to the CMMI Grantees conference. There was lively discussion and the workshop presentations were made available on a website: http://www.engineeringedworkshop.seas.harvard.edu/
Pre-conference Workshop: Engineering Education in the 21st Century
in conjunction with the
NSF CMMI Research and Innovation Conference
June 22, 2009 from 8:00AM-3:00PM
Hawaii Convention Center
Honolulu, Hawaii

AGENDA

7:30AM-8:15AM: Registration and convening - Continental Breakfast

8:15AM-8:30AM: Welcome remarks, V. Narayanamurti and George Hazelrigg

8:30AM: Keynote Address:
Educating Engineers for the 21st Century – James D. Plummer (Stanford)

9:15AM-11:15AM: Session I (including panel discussion) – Adnan Akay, chair

From Concept to Reality: Designing an Independent College Devoted Solely to
Engineering Education—Reflections on the First Ten Years – Richard K. Miller (Olin)

Engineering Education and the Liberal Arts – Sharad Malik (Princeton)

Physics and Technology for Presidents – Richard Muller (Berkeley)

The Entrepreneurial Engineer – Tina Seelig (Stanford)

11:15AM-11:30AM: Coffee break

11:30AM-1:15PM: Session II (including panel discussion) – V. Narayanamurti, chair

Societal Challenges and the Global Research University– Seeram Ramakrishna (National
University of Singapore)

Grand Challenges for Engineering – Jackie Ying (Institute of Bioengineering and
Nanotechnology, Singapore)

Engineering Education and Research to Meet Developmental Challenges: A View from
India – Ambuj Sagar (Indian Institute of Technology Delhi)
1:30PM-2:45PM: Luncheon Address:

Organizing Engineering for an Interdisciplinary Future – Henry Yang (University of California at Santa Barbara)

2:45PM-3:00PM: Closing remarks – Adnan Akay