"The Traditional Engineer"

- Problem solver
- Excellent mastery of technical skills
- Understands technical context of work
- Is content doing all her/his work in one country
- Reports up the management chain to MBA

"The 5xME Engineer"

- Problem finder and solver
- Combines technical skills with soft skills
- Understands the market too
- Thrives on international relations and opportunities
- Hires MBAs

Nariman Farvardin
Dean, A. James Clark School of Engineering
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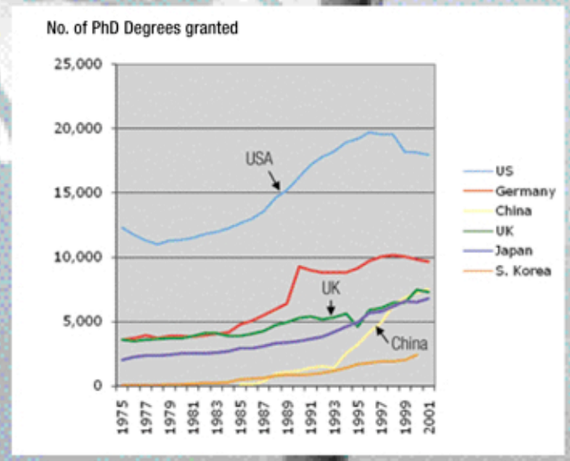
The 5xME Workshop

To maintain our preeminent position, American engineers must be more than excellent in their craft. To be leaders, we must also possess:

- A broad grounding in **Fundamentals**
- Intellectual **Flexibility** and **Agility**
- **Innovation** and **Creativity**
- A **Global Focus**
- Advanced **Teamwork** and **Leadership**
- Superior **Communication** Skills

The transformation needed in ME education must embrace societal priorities, and become an exciting and attractive leadership opportunity for a diverse pool of talent from all segments of our society. Such a transformation will require a new infrastructure, and new methods of educational delivery, that develop the specific abilities of diverse students, to achieve the attributes that graduates need.



The challenge for engineering schools in the USA is to educate a mechanical engineer that provides five times the value added when compared to the global competition, i.e.,

the "5xME."

The 5xME Workshop

Transforming Mechanical Engineering Education and Research in the USA

UNIVERSITY OF MICHIGAN

The 5xME Workshop

Transforming mechanical engineering education and research in the USA

Funded by the National Science Foundation (Grant # CMMI-0647197)

For more information and complete workshop report:

http://www.umich.edu/~ulsoy/5XME.htm

"Preparing the Nation's engineers to be leaders in the 21st century is vital to the Nation's future."

— **Arden Bement**, Director, National Science Foundation, Welcoming Address, 5xME Workshop, Arlington, VA, May 10-11, 2007

The National Science Foundation (NSF) sponsored a workshop, held May 10-11, 2007 in Arlington, VA, entitled "The '5X-ME' Workshop: Transforming Mechanical Engineering Education and Research in the USA". The ambitious goal of the workshop was to lay the foundation for transformative change in mechanical engineering education and research in the USA. The workshop was motivated by the fact that the science-based engineering education taught at our engineering schools has become a commodity, available to students all over the world, including low-wage markets. Global companies employ such world-class engineering talent, often at 20% of the cost in the USA, and are moving manufacturing, design and even research activities to such locations.

The workshop included plenary presentations by:
Arden L. Bement, Director, National Science Foundation
Richard O. Buckius, Assistant Director, Engineering Directorate, NSF
A. Galip Ulsoy, W.C. Ford Professor of Manufacturing, University of Michigan
Adnan Akay, Director, Division of Civil, Mechanical and Manufacturing Innovation, NSF

Ward O. Winer, E.C. Gwaltney, Jr. Chair of the Woodruff School of Mechanical Engineering and Regent's Professor, Georgia Institute of Technology
Nariman Farvardin, Dean and Professor of Electrical and Computer Engineering, University of Maryland.
James J. Duderstadt, President Emeritus and University Professor of Science and Engineering, University of Michigan

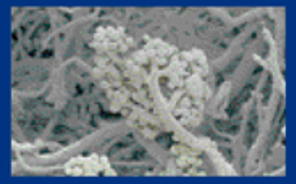
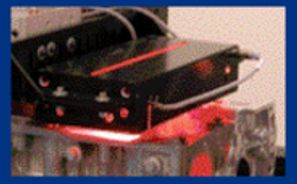
The workshop confirmed that:

In Education:

Engineers must be broadly educated, not simply to solve problems others have set for them, but to identify problems and issues and to provide the technological leadership needed to benefit society. We must fully develop the potential and all the skills of our students to develop the new renaissance engineer, and bring the successful research and project focus of graduate education to undergraduate students in engineering.

In Research:

Engineers must practice concurrent discovery and innovation to fuel the economy, and benefit society, in a time of accelerating technological change. Emerging areas, such as macro systems (e.g., innovation, energy, environment, enterprises, service industries, health care, complex systems), micro/nano systems, bioengineering, information technology and cognitive engineering present new opportunities.


The 5xME Workshop Recommendations

Key Observations. Consistent with other recent studies on engineering education, major changes were recommended in all stages of engineering education:

- In today's global knowledge economy, mechanical engineers educated in the USA must be able to add significantly more value than their counterparts abroad, through the breadth of their intellectual capacity, their ability to innovate, and their leadership in addressing major societal challenges.
- Transformative changes are needed at each of the five major stages of the education of an engineer. These stages include: (1) primary and secondary education, (2) bachelors, (3) masters, (4) doctoral, and (5) lifelong learning. Discussions during the workshop focused only on stages (2) through (5).
- The bachelors degree should introduce engineering as a discipline, and should be viewed as an extension of the traditional liberal arts degree where education in natural sciences, social sciences and humanities is supplemented by education in the discipline of engineering for an increasingly technological world.
- This bachelors degree in the discipline of engineering can be viewed as the foundational stem upon which several extensions can be grafted: (1) continued professional depth through a professional masters degree in engineering, and (2) transition to non-engineering career paths such as medicine, law, and business administration.
- The masters degree should introduce engineering as a profession, and become the requirement for professional practice. This is where educational institutions and professional societies can build an awareness of the profession, as opposed to producing graduates who view themselves merely as employees.
- Doctoral education in engineering is essential to national prosperity, and global competition is rapidly increasing. The doctoral degree in engineering, while indisputably the best in the world, needs to be enhanced and strengthened with an emphasis on breadth as well as depth, linking discovery and innovation, and improved leadership and teaching skills.
- Lifelong learning programs in engineering, including executive education, need to be developed and delivered to engineers at all stages in their professional development.

Proposed Studies. Although many studies have been done on various aspects of this topic in recent years, it was felt the following studies would be valuable for moving ahead with the recommended changes:

- There is a need for a national market study for engineers. What are the various career opportunities for engineering graduates, and what are the various programs that best prepare the students for different markets (e.g., corporate employment, entrepreneurial companies, academic positions). This can help shape the content for the proposed bachelors, masters and doctoral degree programs.
- A study to benchmark engineering education in the USA vis a vis the rest of the world. This would complement the recent NRC study of mechanical engineering research in the USA compared to the rest of the world.
- A study of the doctoral engineering degree pipeline, including its economics, sources of students, and placement of students, is needed. Such a study will be important to ensure that this degree remains in a leadership position worldwide.
- A compilation and assessment of existing engineering programs that currently implement some aspects of the recommendations in 1 above, e.g., a liberal arts engineering bachelors degree, a 5-year professional masters degree, teaching of innovation, etc.

Proposed Pilot Programs. The changes recommended are transformative, thus, difficult to implement. To move forward, identifying and/or establishing pilot programs, and using assessment to benfit from those experiences, was recommended, e.g.:

- Programs that focus on societal relevance in engineering to attract a diverse student body.
- Development of courses and curricula in engineering for teaching innovation.
- An understanding of incentives that support the transformations outlined above.
- A collaborative effort among organizations, such as ASME, NAE, ASEE, etc. to move forward on some of these recommendations.
- A collaborative effort with medical, business and law schools to establish a common cause among professional schools.

A follow up to the workshop will be held at the Mechanical Engineering Education Conference sponsored by ASME International in
Galveston, Texas
April 4-8, 2008

See: http://www.asmeconferences.org/meed2008/