

Implementing the “5xME” Workshop Recommendations

“Scientists discover the world that exists; engineers create the world that never was.”

Theodore Von Karman

The National Science Foundation (NSF) sponsored a workshop, held May 2007, and entitled *The “5xME” 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 (ME) education. 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 challenge for engineering schools in the USA is how to educate a mechanical engineer that provides five times the value added when compared to the global competition, i.e., the “5xME.” The workshop report (see <http://umich.edu/~ulsoy/5XME.htm>) includes the following recommendations:

1. 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.
2. 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.
3. 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.
4. 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.
5. 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.
6. Lifelong learning programs in engineering, including executive education, need to be developed and delivered to engineers at all stages in their professional development.

A follow-up NSF-sponsored workshop, to be held in conjunction with the American Society of Mechanical Engineers (ASME) International Mechanical Engineering Congress and Exposition (IMECE) on November 13-14, 2009 in Orlando, Florida, focuses on *Implementing the “5xME” Workshop Recommendations*. Specifically developing the structures, or outlines, of various ME curricula that would embody some or all of these recommendations. The proposed ME curricula to be developed at this follow-up workshop will then be disseminated through special sessions at the ASME International Mechanical Engineering Education Conference (IMEEC) to be held in March 2010, and through the activities of the ASME Vision 2030 education committee. It is also expected that various institutions will pursue pilot programs to demonstrate and assess the proposed curricula, in part through proposals submitted to the NSF.

It has been well-established that graduates of our current ME programs follow many diverse career paths. Ten years after graduation ME graduates are not only practicing mechanical engineering, but a majority will actually be pursuing careers outside of mechanical engineering practice, such as business, medicine, law. Not all these graduates utilize all the knowledge they acquire during their degree program. However, some of the knowledge imparted is consistently used for all career paths, e.g., engineering principles, problem formulation and solution, design, and innovation. Recommendations 2 and 3 above, from the 5xME Workshop, are aimed at addressing this reality by calling for an engineering and technology focused liberal arts degree. Such a degree would provide a strong foundation for students who will practice mechanical engineering, typically after also completing a professional practice oriented masters degree. This new bachelors degree, focused on the discipline of engineering, would not only emphasize problem formulation/solution, design, innovation, entrepreneurship and creativity but would develop the breadth of the student's intellectual capacity by considering engineering and technology in its broader societal and environmental context. Furthermore, those graduates of this new bachelors degree who choose not to practice mechanical engineering will have a foundation in engineering that will serve them well in our increasing technologically sophisticated society.

Such a curriculum, focused on the discipline of engineering, by providing a flexible foundation for all types of students, will also address recruitment, diversity and retention issues that many mechanical engineering programs are currently faced with. Students have diverse talents and abilities that need to be nurtured, and allowed to develop. Such a curriculum can help to attract not only students who are fascinated by technology, but also students who are motivated by the positive societal impact that those technologies can have. Studies have shown that this is especially true with groups traditionally underrepresented in engineering, such as women and minorities. A bachelor's degree in engineering, which emphasizes innovation and creativity, collaboration, project-based education and the societal impact of technology also provides an excellent foundation for a professional masters degree in mechanical engineering. Such professional graduate schools in engineering, similar to those in medicine and law, can work closely with industry and elevate the prestige of engineering as a profession.

The transformation needed in mechanical engineering 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 must possess, e.g.:

1. Broad grounding in fundamentals, focusing on science, technology as well as its societal context, will enable students to provide leadership within their organizations in an increasingly technological world.
2. Flexibility and agility will lead to motivated learners who pursue topics based upon their interests and special abilities, attracting and retaining the best and brightest
3. Project-based mechanical engineering education will develop the creative aspects of engineering, including problem formulation/solution, design and innovation.
4. Post-baccalaureate professional schools of engineering, working closely with industry and emphasizing professional practice, will transform engineering into a true learned profession comparable in rigor, prestige and influence to medicine and law.

The implementation of such transformative changes to mechanical engineering education would provide value to both our students (i.e, create the 5xME) and contribute to the competitiveness and prosperity of the nation.