INCREASING EMPHASIS AND FUNDING FOR TECHNOLOGY AND ENGINEERING IN STEM

An AIAA Information Paper

ABSTRACT: The American Institute of Aeronautics and Astronautics (AIAA) is extremely concerned that the U.S. increasingly is falling behind its own past record of attainment, as well as the records of other nations, in the production of engineering graduates. Since professional engineers rely on a firm academic foundation in Science, Technology, Engineering, and Mathematics (STEM), increased national emphasis must be placed on these disciplines in general and in particular on Technology and Engineering (T&E). AIAA provides this informational paper to raise awareness of the importance of increased emphasis on technology and engineering education, and how this lays the foundation for a strong and vibrant supply of engineers to maintain America's edge in the global competitive marketplace.

BACKGROUND: Enrollment rates in college engineering programs have been dropping. The U.S. ranks well behind other countries in the percent of students earning their first university degree in engineering or science, as shown in Figure 1[1]. In South Korea, 38% of all undergraduates receive their degrees in natural science or engineering. In France, the figure is 47%, in China, 50%, and in Singapore 67%. In the United States, the corresponding figure is 15%. In addition to the declining numbers of engineers graduating annually by the U.S., some are also concerned about the relative acceleration of the production of engineers by China[2]. In China, the number of first university degrees awarded in natural sciences and engineering has risen particularly sharply since 2002. In comparison, those awarded in the United States have remained relatively flat. In the United States, about 5% of all bachelor's degrees are in engineering. In Asia about 20% are in engineering, and in China about one-third are in engineering.[2]

As shown in Figure 2[3], the U.S. is also declining in the percentage of doctorate-level engineering degrees earned in the U.S. by U.S. citizens, from 52%–59% in 1996 to 27%–46% in 2007. In addition, the U.S. ranks behind the European Union and China in PhD degrees awarded in science and engineering, as shown in Figure 3[4]. The EU surpassed the U.S. in 1989, and China is believed to have surpassed the U.S. in 2010.

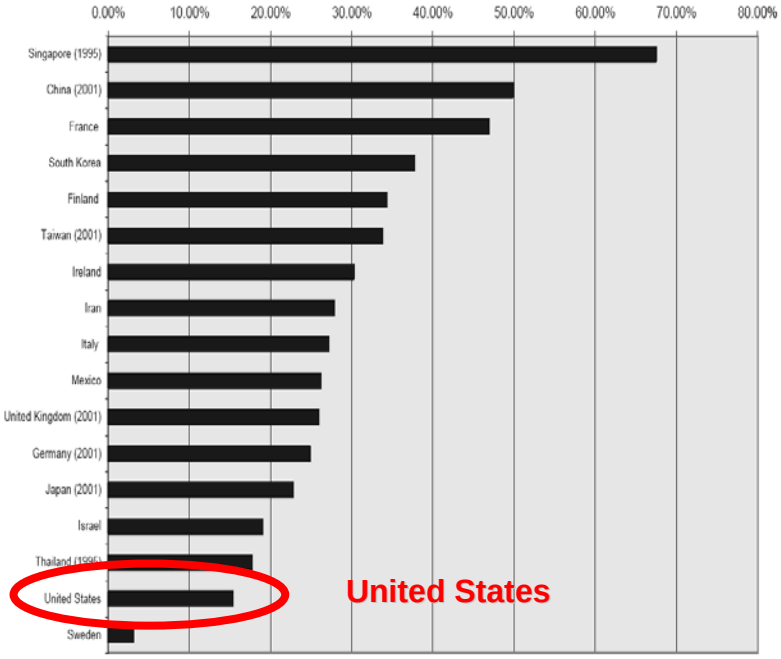

Figure 1: Percentage of 24-Year-Olds with First University Degrees in Engineering or the Natural Sciences, Relative to all First University Degree Recipients

Design is a core part of engineering and technology.
The design process is a method of discovery, exploration and problem solving. It teaches integrative knowledge

[1] http://www.nsf.gov/statistics/seind04/c3/c3h.htm
[2] http://www.nsf.gov/statistics/seind10/c2/c2h.htm
[3] NSF/Division of Science Resources Statistics, Survey of Earned Doctorates.
[4] R. B. Freeman. Does Globalization of the Scientific/ Engineering Workforce Threaten U.S. Economic Leadership? Working Paper 11457.Cambridge, MA: National Bureau of Economic Research, Jun. 2005.

skills, and sharpens teamwork and

communications skills. Data show that learning design motivates and excites students about choosing engineering as a career. Students that learn design achieve higher grades, have greater motivation, maintain better attendance, and exhibit less anti-social behavior. A recent study of FIRST Robotics competition participants, shown in Figure 4[5], demonstrates that hands-on experience in technology and engineering increase the likelihood that a high school student will major in engineering. Alumni of the FIRST Robotics competitions are nearly twice as likely to major in engineering or science, and more than three times as likely to pursue a career in engineering. Learning design and engineering skills and how they are applied in business fosters entrepreneurship, creativity, imagination, and innovation, all critical needs for global competitiveness.

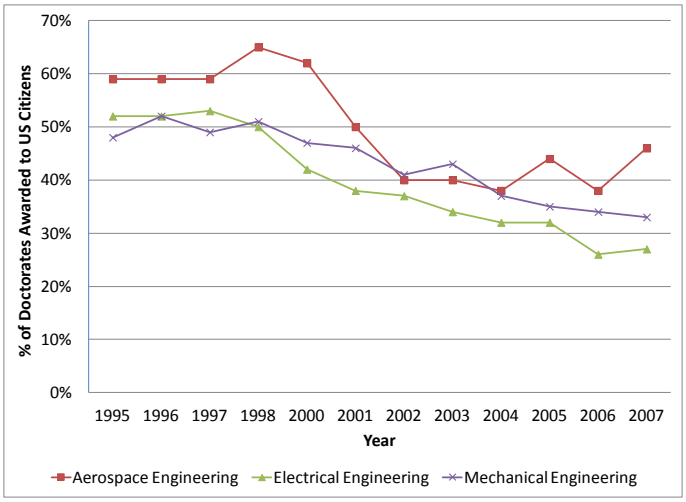

Figure 2: Number of doctorate-level engineering degrees earned in the U.S. by U.S. citizens

While the technology and engineering components of STEM particularly need emphasizing, the "T" and "E" parts of STEM need to build on a strong basic science and math foundation. Unfortunately, less than one-third of U.S. 4th grade and 8th grade students performed at or above a level called "proficient" in mathematics; "proficiency" was considered the ability to exhibit competence with challenging subject matter. Alarmingly, about one-third of the 4th graders and one-fifth of the 8th graders lacked the competence to perform even basic mathematical computations[6]. In addition, the U.S. ranked a lowly 36 out of 57 in a recent OECD study of science proficiency of 15 year olds. Thus, the T&E part of STEM cannot be fully addressed without also improving general science and math education.

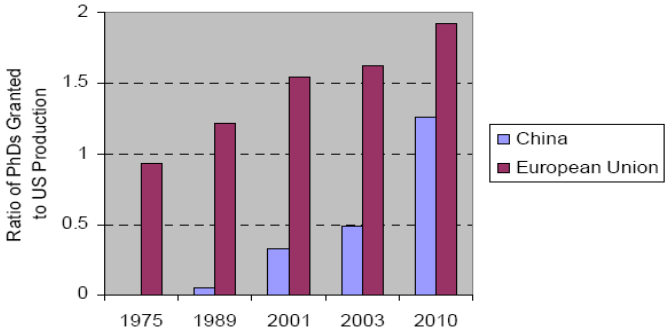

Figure 3: International Production of Science and Engineering Doctorates Compared with U.S. Production

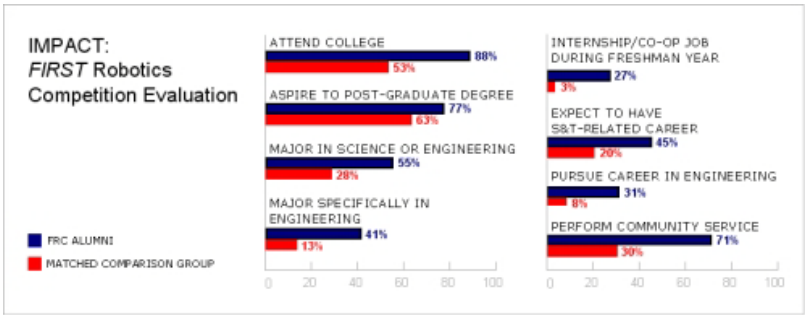

Figure 4: Impact of student participation in FIRST Robotics competitions

[5] http://www.usfirst.org/who/content.aspx?id=46
[6] "Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future," February 2006 Edition.