

BUILDING OUR COMPETITIVE FOUNDATION: SUPPORTING K-12 STEM EDUCATION

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 the “STEM” subjects of Science, Technology, Engineering, and Mathematics, increased national emphasis must be placed on these disciplines in general and in particular on Technology and Engineering (T&E). Increased emphasis on technology and engineering education will help to lay the foundation for a strong and vibrant supply of engineers to maintain America’s edge in the global competitive marketplace.

ISSUE BACKGROUND

The U.S. ranks well behind other countries in the percent of students earning their first university degree in engineering, as shown in Figure 1¹. 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 4% of all bachelor's degrees are in engineering. In Asia about 17% are in engineering, and in China about one-third are in engineering.

Though improving in recent years, overall the U.S. has also declined in the percentage of doctorate-level engineering degrees earned in the U.S. by U.S. citizens, from 47%–59% in 1995 to 34–53% in 2009. This is shown in Figure 2². In addition, the U.S. ranks behind the European Union and China in PhD degrees awarded in engineering, as shown in Figure 3³. The EU surpassed the U.S. in 1989, and China surpassed the U.S. in 2003.

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 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 seminal study of FIRST Robotics competition participants, shown in Figure 4⁴, 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.

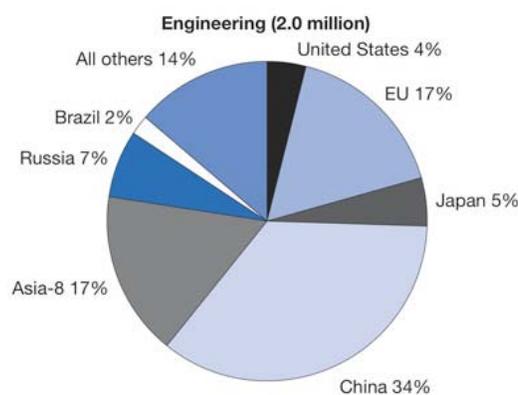


Figure 1: Percentage of 24-Year-Olds in Various Countries with First University Degrees in Engineering, Relative to all First University Degree Recipients

¹ NSF Science and Engineering Indicators 2012, http://www.nsf.gov/statistics/seind12/slides_tn.htm#g3

² NSF/Division of Science Resources Statistics, Survey of Earned Doctorates.

³ NSF Science and Engineering Indicators 2012, <http://www.nsf.gov/statistics/seind12/c2/c2h.htm>

⁴ <http://www.usfirst.org/who/content.aspx?id=46>

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, only 39% of U.S. 4th grade and 33% of U.S. 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. Similarly, only 33% of U.S. 4th graders and 30% of U.S. 8th graders performed at or above the proficient level in science. In addition, the U.S. ranked only 18 out of 33 OECD countries in a recent OECD study of mathematics proficiency of 15 year olds, and the U.S. ranked only 13 out of 33 OECD countries in science proficiency. Thus, the T&E part of STEM cannot be fully addressed without also improving general science and math education.⁵

Improving science education begins with implementing the Next Generation Science Standards to improve and strengthen the quality of science education throughout the nation. In a recent poll conducted in February 2012, 87% (+/- 3.5%) of voters surveyed supported these new standards⁶.

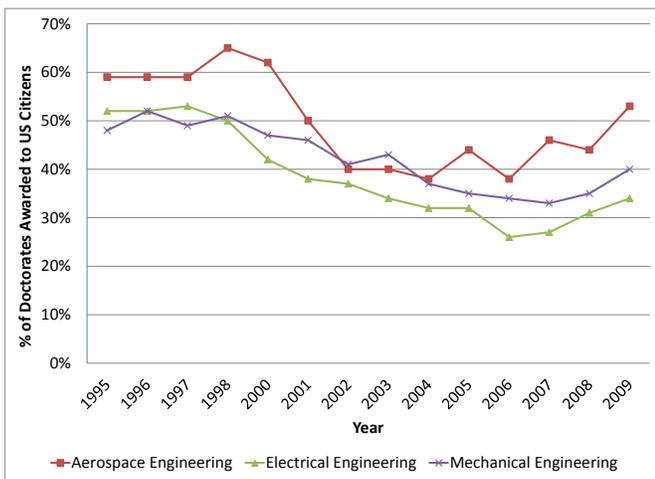


Figure 2: Number of doctorate-level engineering degrees earned in the U.S. by U.S. citizens

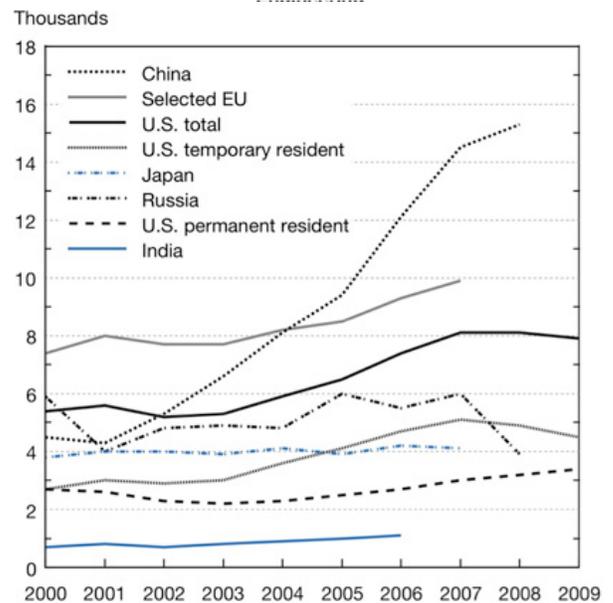


Figure 3: International Production of Science and Engineering Doctorates Compared with US Production

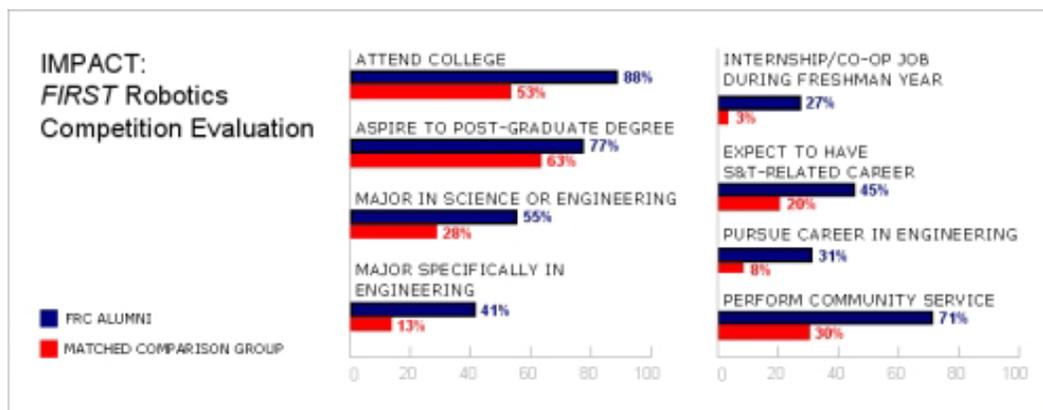


Figure 4: Impact of student participation in FIRST Robotics competitions

⁵ NSF Science and Engineering Indicators 2012, <http://www.nsf.gov/statistics/seind12/c1/c1h.htm>

⁶ On behalf of Achieve Inc., Public Opinion Strategies and Greenberg Quinlan Rosner Research conducted a national survey February 22-26, 2012 of N=800 registered voters.