

INCREASING EMPHASIS AND FUNDING FOR TECHNOLOGY AND ENGINEERING IN STEM: An AIAA Information Paper

ABSTRACT

The American Institute of Aeronautics and Astronautics (AIAA) – the world’s forum for aerospace leadership – is extremely concerned that the US 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 a vibrant supply of engineers to maintain America’s edge in the global competitive marketplace.

ISSUE

Science, Technology, Engineering, and Mathematics (STEM) education in our nation’s classrooms provides the critical foundation needed for our future national security and economic competitiveness. Inadequate emphasis and funding has been provided to the critical technology and engineering (T&E) components of STEM, thus eroding this foundation. This nation has been supporting science and math education for decades, yet enrollments and graduation rates in engineering have been dropping. Increased emphasis and funding must be directed to the T&E components of STEM if the nation is to fully reap the intended benefits of STEM education.

BACKGROUND

Enrollment rates in college engineering programs have been dropping. The US ranks well behind other countries in the percent of students earning their first university degree in engineering or science, as shown in Figure 1¹. 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 being minted annually by the U.S., some are also concerned about the relative acceleration of the production of engineers by China. One estimate is that in 2004, China graduated about 350,000 engineers, computer scientists, and information technologists with 4-year degrees, while the United States graduated about 140,000. China

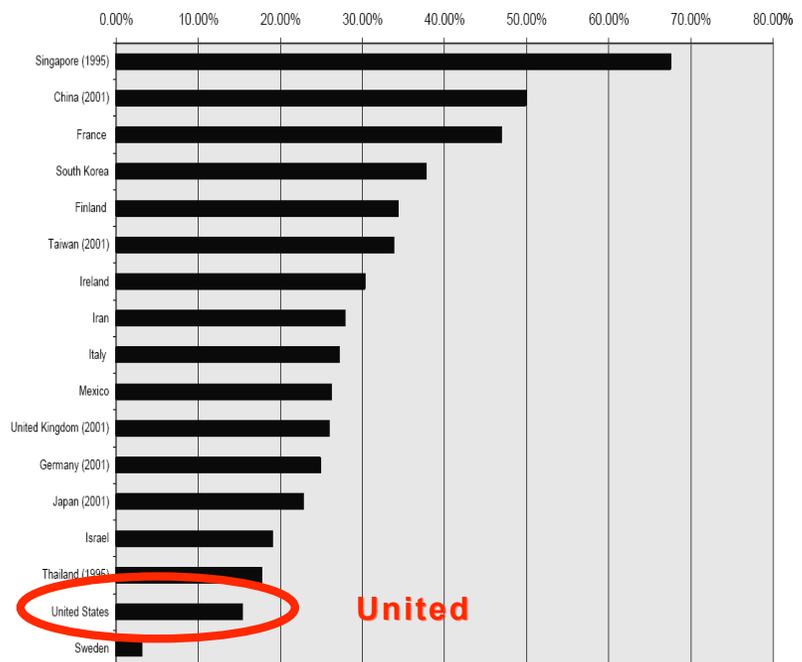


Figure 1: Percentage of 24-Year-Olds with First University Degrees in Engineering or the Natural Sciences, Relative to all First University Degree Recipients

¹ <http://www.nsf.gov/statistics/seind04/c3/c3h.htm>

also graduated about 290,000 with 3-year degrees in these same fields, while the US graduated about 85,000 with 2- or 3-year degrees. Over the past 3 years alone, both China and India have doubled their production of 3- and 4-year degrees in these fields, while the United States production of engineers is stagnant and the rate of production of computer scientists and information technologists doubled².

As shown in Figure 2³, the U.S. is also declining in the number of doctorate-level engineering degrees earned in the US by US citizens, from about 1300 per year in 1996 to just under 800 in 2004. Furthermore, the number of US citizens earning doctorates in engineering is declining. 34% percent of doctoral degrees in natural sciences and 56% of engineering PhDs in the United States are awarded to foreign-born students². In addition, the US ranks behind the European Union and China in PhD degrees awarded in science and engineering, as shown in Figure 3⁴. The EU surpassed the U.S. in 1989, and China will likely surpass the U.S. in 2010.

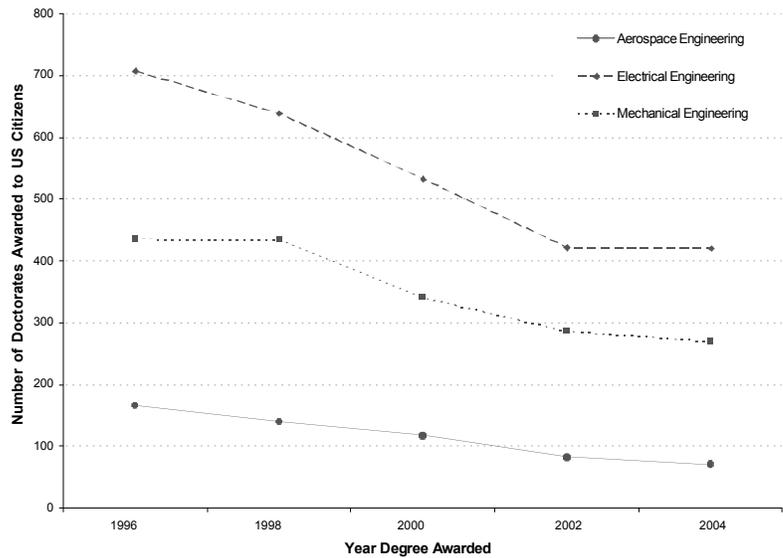


Figure 2: Number of doctorate-level engineering degrees earned in the U.S. by U.S. citizens

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 recent study of FIRST Robotics competition participants, shown in Figure 4⁵, 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 3 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

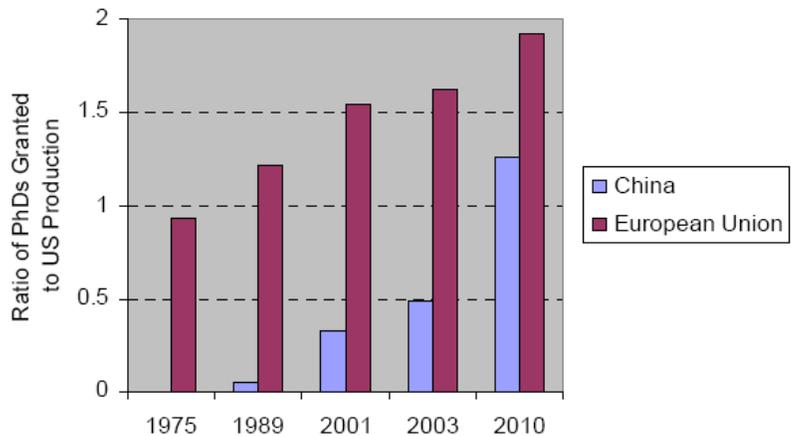


Figure 3: International Production of Science and Engineering Doctorates Compared with US Production

² "Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future," February 2006 Edition.

³ NSF/Division of Science Resources Statistics, Survey of Earned Doctorates.

⁴ R. B. Freeman. Does Globalization of the Scientific/ Engineering Workforce Threaten US Economic Leadership? Working Paper 11457. Cambridge, MA: National Bureau of Economic Research, Jun. 2005.

⁵ <http://www.usfirst.org/who/content.aspx?id=46>

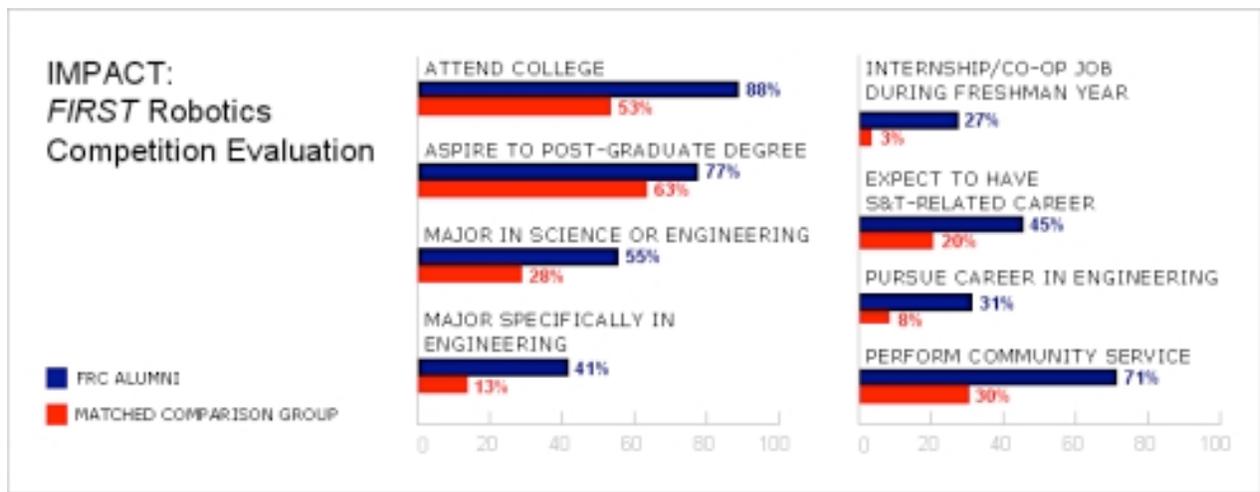


Figure 4: Impact of student participation in FIRST Robotics competitions

for global competitiveness.

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 US 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. Alarming, about one-third of the 4th graders and one-fifth of the 8th graders lacked the competence to perform even basic mathematical computations². In addition, the US 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.

RECOMMENDATIONS

To remain globally competitive, the U.S. must increase its emphasis and funding on the technology and engineering components of STEM education. Several policies and actions would make significant progress on this objective. First, Congress should explicitly include strong support for technology & engineering (T&E) education in STEM legislation at all levels from kindergarten through university. In addition, Congress should make federal agencies accountable for promoting STEM education, and in particular the T&E aspects, by evaluating the effectiveness of STEM education activities in OMB’s Program Assessment Rating Tool (PART). Second, the Administration should provide incentives for creating more in-service and pre-service hands-on training in T&E for K-6 educators, who are especially critical to laying the foundation for a student’s interest in engineering careers. Third, the Department of Education should promote the development and dissemination of a high school Advanced Placement Design Course and examination, emphasizing to secondary school students the importance of engineering. Fourth, the Federal Government should support university programs that partner NASA, DOT, DOD, and NOAA with academia to provide hands-on training experiences at the college and university level. Such experiences have been shown to have positive effects on retaining engineers in engineering-related industries.