REPORT

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Benchmarking the Competitiveness of the United States in Mechanical Engineering Basic Research

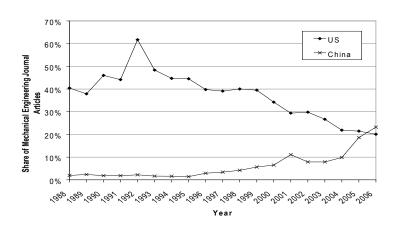
U.S. leadership in mechanical engineering basic research is strong overall and will continue to be strong. Contributions of U.S. mechanical engineers to journal articles will increase, but so will the contributions from other growing economies such as China and India. At the same time, the supply of U.S. mechanical engineers is in jeopardy, because of declines in the number of U.S. citizens obtaining advanced degrees and uncertain prospects for continuing to attract foreign students. U.S. funding of mechanical engineering basic research and infrastructure will remain level, with strong leadership in emerging areas.

Mechanical engineering is critical to the design, manufacture, and operation of small and large mechanical systems throughout the U.S. economy. It is often called upon to provide scientific and technological solutions for national problems, playing a key role in the transportation, power generation, advanced manufacturing, and aviation industries, to mention a few.

Much like many other science and engineering disciplines, the field of mechanical engineering is facing issues of identity and purpose as it continues to expand beyond its traditional core into biology, materials science, and nanotechnology. Concerns about educating students, future employment opportunities, and the fundamental health of the discipline and industry are regular topics of discussion in the mechanical engineering community. Before addressing questions of how mechanical engineering must shift to meet future needs, it is imperative to understand its current health and international standing.

This report highlights the main findings of a benchmarking exercise to rate the standing of U.S. mechanical engineering basic research relative to other regions or countries, key factors that influence U.S. performance in mechanical engineering research, and near- and longer-term projections of research leadership.

Figure 1. Comparison of U.S. and China's percentage share of contributions to overall mechanical engineering journal articles, 1988-2006.



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The United States is among the leaders in mechanical engineering basic research.

Evidence for current research leadership in mechanical engineering basic research comes from analysis of journal articles, most cited articles, and virtual congresses by the panel. Overall, the United States is among the leaders in mechanical engineering basic research. However, excellent mechanical engineers throughout the world provide stiff competition for the United States, especially in Asia and Europe. As shown in Figure 1, the United States contributed 40 percent of mechanical engineering articles in the world. That number declined dramatically in 2006 with the U.S. responsible for contributing only 20 percent of the articles.

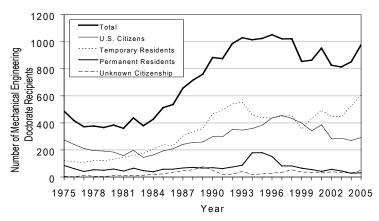


Figure 2. Earned doctoral degrees in mechanical engineering from U.S. institutions as a function of residency status for 1975-2005.

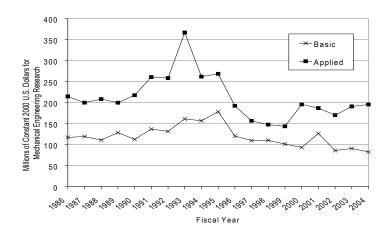


Figure 3. Federal obligations for applied versus basic research in mechanical engineering in constant 2000 U.S. Dollars, fiscal year 1986-2004.

A combination of factors is responsible for U.S. basic research leadership in mechanical engineering.

U.S. research leadership in mechanical engineering basic research is the result of a combination of key factors, including a national instinct to respond to external challenges and to compete for leadership. Over the years, the United States has been a leader in innovation as a result of cutting-edge facilities and centers, and a steady flow of mechanical engineers (Figure 2) and research funding (Figure 3). However, there have been significant declines in basic research funding since 1995.

Challenges lie ahead for the future position of mechanical engineering basic research.

The United States now holds a position among the leaders in most areas of mechanical engineering basic research, but because of the advance of mechanical engineering in other nations, competition is increasing and the U.S. lead will shrink. The United States is particularly strong in areas at the interface with other disciplines. In these areas, which include bioengineering, design, and mechanics of materials, the United States will maintain the leadership position in spite of growing competition. In some core areas where the U.S. position is currently not as strong, such as acoustics and dynamics, dynamics and controls, computational mechanics, and tribology, the U.S. position among the leaders may continue to fade.

This brief was prepared by the National Research Council based on a report by the Panel on Benchmarking the Research Competitiveness of the United States in Mechanical Engineering. The report was sponsored by the National Science Foundation. For more information, contact the Board on Chemical Sciences and Technology at (202) 334-2156 or visit http://dels.nas.edu/bcst. Copies of *Benchmarking the Competitiveness of the United States in Mechanical Engineering Basic Research* are available from the National Academies Press, 500 Fifth Street, NW, Washington, D.C. 20001; (800) 624-6242; www.nap.edu.