

# Special Issue on Science and Technology Workforce

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Can America compete in science, technology, engineering, and mathematics (STEM)? This has become one of the nation's top debates among industrial leaders, governmental officials, and policy makers. In his State of the Union Address, the former President George W. Bush (2006) announced the American Competitiveness Initiative to encourage American innovation and strengthen the nation's ability to compete in the global economy. Bill Gates, Microsoft chairman, told the House Committee on Science and Technology that "our higher education system doesn't produce enough top scientists and engineers to meet the need of the U.S. economy" (quoted in Chee, 2008, p. 1). Economist and former Harvard professor Todd Buchholz has been giving lectures on "how to compete in a global economy."

Today key economic indicators of national competitiveness such as gross domestic product (GDP), productivity, and per capita income show that the U.S. economy continues to be a leading competitor among other major industrial countries. The United States holds the largest world market shares in three of the five high-technology manufacturing industries (aerospace, pharmaceuticals, and scientific instruments), whereas in the other two (communications equipment and office machinery, and computers), the European Union has the lead (National Science Board, 2008).

Yet the question of whether America will be able to maintain its competitive edge in STEM is not as straightforward. It is mostly because today's global environment is different from what it was in the 1980s. First, the United States has transformed from a manufacturing to a service-based economy. The service sector accounts for close to two thirds of GDP, and it has become a key driver of the U.S. economy. With the rise in income, demand for luxury goods has gone up, which, in turn, has increased the demand for service output. The United States has a leading position in the market-oriented knowledge-intensive service industries (business, financial, and communications) that are driving growth in the service sector (National Science Board, 2008). However, in the era of information technology (IT), any service that can be digitized can be performed anywhere in the world by anyone.

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Second, the United States has not been able to build STEM human capital at a pace consistent with the demands for these skills. Enrollment in higher education has been rising mostly because of increases in the U.S. college-age population and increased rates of college attendance (National Center for Education Statistics, 2007). The number of bachelor's degrees and master's degrees awarded in STEM fields has increased, but most of the growth in STEM is in life sciences, social sciences, and psychology (Babco, 2006). In the physical sciences and engineering, both undergraduate and graduate enrollments of U.S. citizens and permanent residents have declined, and the numbers of bachelor's and master's degrees have not yet attained the levels of the 1980s (National Science Board, 2008). The percentages of freshmen intending to major in engineering or computer science have dropped in recent years (Vegso, 2005). The demographic changes in college students—women are now the majority of students at the bachelor's and master's levels, and members of minority groups account for an increasing share of the U.S. college-aged population—have also presented challenges for the STEM fields in which participation of diverse students has been uneven (Bell, Di Fabio, & Frehill, 2006).

The number of STEM doctorates awarded by U.S. academic institutions has increased. However, much of the growth reflects higher numbers of STEM doctorates earned by foreign students, with substantial variations across the STEM fields. In 1966, U.S. citizens and permanent residents earned 84% of all doctoral degrees in the STEM fields. By 2004, however, despite a more than doubling in the number of STEM doctoral degrees, U.S. citizens and permanent residents earned just 60% of these degrees. Meanwhile, many countries in Europe, Australia, Canada, and Japan have expanded their enrollment of foreign STEM students. Most importantly, since the 1990s, many countries have expanded their higher education in STEM. In several countries, the proportion of first degrees in STEM fields, especially in engineering, is higher than the proportion in the United States (Organisation for Economic Co-operation and Development, 2007).

Third, U.S. organizations have been increasingly employing workers from foreign countries to fill their STEM workforce needs. Since the major 1965 immigration reform, the United States has given preference to professionals, scientists, and skilled workers in occupations for which labor is perceived to be in a short supply. However, the preference for foreign skilled workers has intensified since 1990. In 2003, of the 21.6 million scientists and engineers in the United States, 16% (3,352,000) were foreign born (Kannankutty & Burrelli, 2007). Advocates argue that migration of STEM workers helps the United States maintain its competitiveness in the global market, whereas critics argue that immigration displaces U.S.-born STEM workers. Regardless of which side of this debate one is on, it is clear that global competition for STEM workers has increased. A National Science Board (2008) task force found that “global competition for [STEM] talent is intensifying, such that the United States may not be able to rely on the international [STEM] labor market to fill unmet skill needs” (p. 3-48).

Fourth, developing countries are producing well-educated people who can fulfill some needs of the U.S. service-based economy at much lower cost. Since the 1990s,

U.S. technology companies have been increasingly offshoring their operations, claiming they need to do so to remain competitive. In addition to securing potential foreign markets for U.S. products and services, companies gain a competitive advantage by working around the clock. At the same time, outsourcing results in a loss of jobs, threatens U.S. national security, exerts downward pressure on high-skill wages, diminishes the U.S. tax base, and risks core competencies, in-house expertise, and future talent (Lieberman, 2004).

Finally, China and India are being seen as new global “powerhouses” or “superpowers.” They seem to be challenging the U.S. market position in high-technology industries and reducing the gap in technological innovation. China has rapidly risen to become a leading producer and exporter of high-technology manufactured goods, whereas India has established itself as a rising producer and exporter of IT. Traditional animosities between the two countries are being replaced with a closer economic relationship, which is viewed as changing world economics and politics in the next decade (Moller, 2003). Both countries, with more than 2 billion people, have experienced exponential growth in enrollment in higher education and degree production (Agarwal, 2007; Hsiung, Guttman, Meadows, & Yang, 2007). They are producing large numbers of STEM workers, which has led to growing uneasiness in the United States; can Americans compete with Chinese and Indian STEM workers?

The U.S. STEM workforce accounts for only a small fraction (5%) of the total U.S. civilian labor force (Ellis, 2007). Yet the importance of the STEM workforce to society is enormous because these workers contribute to scientific knowledge, technological innovation, economic growth, and the training of future scientists and engineers. Furthermore, STEM occupations grew much faster than the U.S. workforce as a whole from 1950 to 2000. Although the total labor force grew 130% to 139 million during this period, the STEM workforce grew 669% to reach 6.9 million (Lowell & Regets, 2006). Richard Ellis, author of several STEM workforce reports, has noted that

it is widely accepted that the STEM workforce has a disproportionate impact on America's ability to compete in a global economy. If we are going to maintain and grow competitive advantage in the United States, it is critical that our policies reflect the full range of issues affecting STEM workers and employers. (Rochester Institute of Technology, 2007, p. 1)

The purpose of this special issue of *American Behavioral Scientist* is to address new challenges facing America in the area of STEM workforce. All but one of the authors in this special issue presented papers at a conference titled “Can We Compete? Trends in America's Scientific and Technical Workforce,” organized by the Commission on Professionals in Science and Technology in Washington, D.C., on November 2 and 3, 2007. The conference was part of the larger STEM Workforce Data Project, funded by the Alfred P. Sloan Foundation. These articles represent continued work by each of the authors on these papers following the conference. They provide

comprehensive examination of STEM education and occupations based on scholarly literature and empirical data rather than alarmist prognostications.

Ron Hira's article provides a critical examination of why we need to have a national policy related to STEM occupations and how that fits in the context of increasing global competition for creativity and innovation. He pushes us to move beyond rhetoric in which single variables are central and to consider the ways in which the STEM workforce constitutes a complex system. There is a need for more sophisticated measures of the supply and demand in the STEM workforce, with better feedback loops and an improved understanding of gender and race in supply and demand and how to increase the attractiveness of STEM jobs.

William Aspray examines one of the current issues facing STEM workers: offshoring of IT. A recent report by the National Academy of Engineering (2008) on the offshoring of engineering, for example, calls attention to this process as an inevitable one but one that differently affects industries and workers in those industries. Aspray discusses the context for offshoring, showing its impact on IT workers and responses from industrial leaders, labor unions, educational administrators, policy makers, and politicians. He provides some food for thought on the bigger picture of the offshoring by various industries and the global workforces.

Another article focuses on the particular context of STEM work in Canada. Paul Dufour provides a Canadian perspective on the several issues raised by Hira and Aspray. Dufour sketches the role of policy in boosting STEM activity in Canada but apparently facing structural problems insofar as the business environment is commodity oriented and, thus, does not draw on innovation as much as it could. How well then will the current policies mentioned in the article play out? Apparently, Canadians will need to think more strategically and "leverage all of their assets," which includes, among others, nontraditional organizations that support knowledge and talent and data agencies that compile and disseminate knowledge.

Mary Frank Fox and Cheryl B. Leggon focus attention on U.S. STEM faculties. Each of these articles calls attention to the problem of a persistently homogenous faculty (largely White male) that is responsible for educating the next generation of STEM workers, who are increasingly heterogeneous. Fox uses recent survey data on faculty at doctoral-granting departments to show that institutional policies and procedures can be key tools to increase equity among faculty members. Leggon argues that it is critical to disaggregate data by race/ethnicity and gender to finer levels of detail to better craft such policies to be most responsive to the needs of faculty from diverse backgrounds.

The final three articles provide important information about foreign-born workers' participation in STEM occupations. B. Lindsay Lowell provides a larger context in which to see the increasingly important role played by foreign-born workers in the U.S. STEM workforce. Lowell argues that all too often the debates about immigration are framed as a simple numbers game. His analyses suggest, however, that the *number* of immigrants admitted under the current system appears quite sufficient to any

objective assessment of demand as captured by trends in STEM employment and earnings. Policy makers and other stakeholders, therefore, should be looking for the policy fixes to the regulations that govern the *process* of immigration.

Jim McQuid, Laurel Smith-Doerr, and Daniel J. Monti drill down in their article to examine a particular segment of the STEM labor force in a specific geographical context. They use primary quantitative and qualitative data to specify the contours of the biotech industry in the northeast. Women and foreign-born STEM workers within larger firms often suffer similar issues related to the “glass ceiling”; therefore, starting a business is one way for members of such groups to experience greater economic mobility and fewer restrictions on their creativity.

Finally, Roli Varma further focuses attention on a particular foreign-born group: East Indians. Varma’s richly detailed article paints a portrait of the participation of Indian-born people in the U.S. STEM workforce, with an emphasis on four classes of workers in this field: entrepreneurs; scientists and engineers working in laboratories, academic institutions, and national laboratories; high-tech workers on temporary employment visas; and students. Although the migration of Indian-born STEM workers is often portrayed as a “brain drain” as the best and brightest leave India to build fortunes in the United States, the close connections that Indian expatriates maintain “allow expatriates and nationals to participate in a global economy.”

Despite the media sound bites, the diverse articles in this volume call our attention to the complexities of the STEM workforce. The variations in participation by members of various demographic groups have larger implications for social inequality in the United States in particular and for the global context more generally. The race for talent spans national borders as communications and transportation systems bring people across the globe closer together. Yet according to these articles, policies related to STEM implemented by governments need to do a better job of understanding that STEM represents a highly interconnected system that defies simple solutions or simple “numbers” restrictions. The articles in this volume represent the diverse scholarship currently in progress that will advance our knowledge of the STEM workforce and provide our leaders with firm scholarship on which to base sound policies.

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