



**The Implications of the Globalization of R&D and Innovation for
America's Science and Engineering Workforce**

Prepared Statement of Paul J. Kostek

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**The Institute of Electrical & Electronics Engineers –
United States of America**

To The

Subcommittee on Technology and Innovation

Committee on Science and Technology

United States House of Representatives

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I want to thank Subcommittee Chairman Wu and Ranking Member Gingery for inviting me to testify on the implications of the globalization of research, development and innovation for the people who work in science, technology, engineering and math (STEM) fields in the United States. They are important contributors to the nation's technological leadership, its economic prosperity and its military and homeland security.

Introductions

My name is Paul Kostek and I do hardware and software systems integration work on manned and unmanned aircraft for the Boeing Company in Seattle WA. Since earning my degree in 1979, I have worked for large, mid-sized and small manufacturing and engineering service firms as a full-time salaried employee, an independent contractor and a part-time consultant. I've also been a partner in a start-up company and an officer in a professional engineering union.

Today, I speak on behalf of the Institute of Electrical and Electronics Engineers - United States of America (IEEE-USA) where I am Vice President for Career Activities. My perspectives are based on three decades of experience as an engineer and continuing interaction with other engineers and scientists at work and in professional society activities at the local, state, regional and national levels.

The Institute of Electrical and Electronics Engineers (IEEE) is a transnational technical and professional society made up of more than 370,000 individual members in 150 countries. IEEE's purposes are to advance the theory and practice of electrical, electronics, computer and software engineering and to improve the ability of its members to innovate and create wealth that benefits countries in which they live and work. IEEE-USA promotes the professional careers and technology policy interests of IEEE's 215,000 US members.

Seventy percent of IEEE's U.S. members work in the private sector, primarily in the aerospace and defense, biomedical technology, computers and communications, electronics equipment and electric power industries. Of these, thirty percent work for firms with 500 or fewer employees. Ten percent are employed by Federal, state and local government agencies. Ten percent teach at U.S. engineering schools or work for non-profit research organizations. Most of the remaining ten percent are self-employed and work as consultants to businesses and government.

Globalization and the Redistribution of America's Engineering Enterprise (Cite 1)

Three decades ago, America's engineering enterprise was vertically integrated and hierarchically organized. Most research, design, development and even manufacturing functions were performed in the United States by American companies or at wholly owned subsidiaries in Canada, Japan and Western Europe. Engineering work being done in the rest of the world had little impact on the profitability of U.S. firms or the well-being of American workers.

Since then the integrated nature of engineering work has undergone profound organizational and geographic shifts. The hierarchical business model that once conferred unassailable competitive advantage on U.S. firms based in Massachusetts, California's Silicon Valley and the Pacific Northwest has been turned on its head. Many U.S. firms have become multi-national and are

racing to shift engineering research and design functions – not just routine development and production work - to subsidiaries, sub-contractors and partners all over the world. Chinese engineers are making major breakthroughs in cellular telephony. Indian companies are pressing ahead in software development, information technology and pharmaceutical research. And Brazilian firms are pressing the envelope in automobile power trains and aircraft control systems.

This disintegration and redistribution of engineering work within and between nations is the inevitable result of growing competition between firms and countries in an increasingly technology driven global economy. This transformation is driven by underlying market imperatives, including the need to increase shareholder value, improve productivity and efficiency and capitalize on the increasing mobility of capital and labor. And it is enabled by technologies that scientists and engineers help to create, adapt and improve.

Lower labor costs in developing economies are a major contributing factor, but the new globalization of science and engineering is also being driven by competitors needs for proximity to emerging markets and easier access to capable people. Cultural, social and regulatory environments that facilitate invention, innovation and entrepreneurship are also important.

Impact on STEM Labor Markets and Professionals in the United States

Although there are no reliable figures on how many jobs in STEM fields have moved offshore - or are likely to do so in the future - workforce globalization is exerting downward pressures on high technology labor markets in the United States. While unemployment rates for electrical engineers and computer scientists – which climbed to historically high levels between 2001 and 2004 – have fallen back to less than 2 percent in 2005 and 2006, employment and compensation trends in most STEM fields are moving in the wrong direction.

Unbiased analysts at the Washington-based STEM Workforce Data Project report that 50 years of steady growth in employment opportunities for scientists and engineers in the United States appears to have ended in 2001. (**Cite 2**). Even more troubling is the Project's finding that real salaries in most STEM fields have been flat or declining for at least 10 years.

Employment and salary growth for aerospace engineers (where increasing demand and improved financial incentives since the late 1990's) – and medical scientists (who are benefiting from strong nationwide demand for health professionals) appear to be only exceptions.

One very likely contributor to reduced rates of growth for domestic jobs in STEM fields – and flat or declining real wages for most STEM professionals – are continuing increases in the offshore outsourcing of engineering work.

If recent trends continue – and knowledgeable observers think they will – their impact on the strength of America's high tech workforce and economy could be devastating. The one/two punch of reduced demand (reflected in fewer job opportunities) and wage depression (as seen in flat or declining real wages) will encourage incumbent mid-career and older STEM workers to leave for better job opportunities in other fields and discourage talented students from pursuing science and engineering careers.

High Tech Specific Concerns, Issues and Questions

While most economists doubt that globalization will reduce the aggregate number of jobs in the U.S. economy, they all agree that the ongoing geographic redistribution of work – including engineering work – will alter the mix of jobs performed in the United States.

In order to maximize profits from the design, development, production, marketing and distribution of essential goods and services, employers must make the best possible use of all available factors of production.

1. What types of jobs will face increased competition from low-cost countries?

The transfer of high end engineering work, including increasingly sophisticated research, design and development jobs, from the United States, Western Europe and Japan to lower-cost locations in the former Soviet republics, China, India, the Middle East and South America is growing and will continue to grow in the foreseeable future. As the technical knowledge and skills base of workers in the developing world expands, the lure of lower costs – for labor, capital, plant, equipment and infrastructure – proximity to emerging markets and promises of relief from burdensome environmental, labor and tax policies are likely to make off-shoring even more important for the continuing competitiveness of US firms.

2. What kinds of jobs will go and what kinds are likely to stay?

The sophisticated “high tech” knowledge worker/transactional analyst jobs popularized by Robert Reich are and will continue to be fair game for geographic relocation. Stickier “high touch” jobs that require continuing face-to-face communications with clients or customers in the United States are less likely to be shipped to other countries

Problem-solving skills in such sectors as critical infrastructure protection; electric power generation, transmission and storage; cyber-security and environmentally friendly building and transportation systems will continue to be marketable here and overseas.

3. What kinds of knowledge and skills will be needed as the off-shoring of STEM jobs increases in scale and scope?

Softer interpersonal communications and team-building skills as well as process, project, program and enterprise management capabilities are becoming increasingly important in the United States and elsewhere as workers in other parts of the world master increasingly sophisticated technical skills.

4. How can we ensure that future generations of Americans get the knowledge and skills they will need to become and remain competitive in an increasingly technology-driven global economy?

Parents, teachers, guidance counselors, family members and friends must emphasize the critical importance of making a life-long commitment to learning how to learn; and how to apply fast-changing technologies to the solution of environmental, physical, social and political problems.

5. Is an inadequate supply of American STEM workers with specific skills causing companies to move offshore?

Although employers contend that an inadequate supply of appropriately skilled and properly motivated workers in the United States is forcing them to move jobs and facilities overseas, there is no credible economic evidence to support such claims.

6. What kinds of challenges is globalization creating for American STEM workers and what kinds of resources do they need to ensure that their careers are durable and resilient?

The successful application of new technologies can improve productivity by increasing efficiencies and/or reducing costs. Habits of mind including flexibility, adaptability, resourcefulness and determination will be critical for personal success in increasingly competitive global markets.

Individual engineers must be prepared to assume full responsibility for maintaining their employability. Employers and professional organizations can encourage and enable entry-level, mid-career and older engineers to develop cutting-edge knowledge, skills and capabilities.

Governments can help by establishing tax incentives for lifelong learning and providing short-term transitional assistance for displaced manufacturing and service sector workers, including scientists and engineers.

7. What should we be doing to create and retain high wage/high value added jobs and to send clear signals to citizens about high demand job opportunities in today's increasingly competitive, technology driven global economy?

The United States needs a coordinated national strategy – like the ones being implemented its principal competitors – to help American communities, companies and citizens develop and maintain their economic and technological competitiveness.

With respect to signals, employers are understandably reluctant – for competitive and public relation reasons – to provide very much in the way of advance notice about their intentions to redistribute, consolidate or eliminate work at domestic and overseas locations.

8. How has globalization changed the risks and rewards and the costs and benefits of careers in engineering? What are the emerging challenges and opportunities?

Globalization and the attendant transfer of high wage / high value added jobs to lower cost overseas locations has significantly increased the risks associated with careers in STEM fields. At the same time it has also increased raised the potential returns for STEM professionals who are willing and able to maintain/increase their employability in a fast-changing world.

IEEE-USA Policy Recommendations

The economic and employment challenges associated with globalization of science and engineering work are complex and consensus policy responses extremely difficult to formulate.. There are no easy answers or silver bullets, but there are some practical and immediate steps that stakeholders can and should be taking.

- The federal government must collect and publish reliable statistics on the volume, nature and value of manufacturing, R&D and service sector jobs that are moving offshore and those being created in the United States by foreign direct investments.
- New and improved transitional assistance programs are needed to help displaced STEM professionals regain productive employment.
- Practical incentives, including targeted tax credits, paid internships and individualized instructional programs, must be provided to enable younger, mid-career and older STEM professionals to maintain their employability.
- Stakeholders from business, educational institutions, government agencies, labor organizations and professional societies should work together to develop strategies that will help U.S. STEM professionals to differentiate themselves from their competitors in other countries.
- Public and private sector employers must make post-graduate STEM education more affordable for US citizens and legal permanent residents by offering financially competitive scholarships, fellowships and assistantships in exchange for extended service commitments.
- Congress must enact balanced reforms in the nation's educational and employment-based admissions programs. Such reforms should increase permanent employment-based admissions, facilitate the transition of foreign students with advanced degrees from US schools to legal permanent resident status and reduce our growing national dependence on temporary work visa programs.
- Congress should take affirmative steps to ensure that the U.S. retains the human talent and production capabilities needed to develop and utilize technologies deemed critical to U.S. national defense and homeland security.
- Public and private sector stakeholders must work together to overcome barriers to the overseas employment of U.S. STEM professionals at foreign-owned companies, international agencies and non-governmental organizations.

Paul J. Kostek
IEEE-USA Vice President, Career Activities

Paul J. Kostek is a systems engineer with the Boeing Co., in Seattle and a senior member of the Institute of Electrical and Electronics Engineers (IEEE). He is a former IEEE-USA president and is currently the organization's vice president for career activities. He has been active in IEEE technical activities and U.S. engineering workforce issues for many years.

While chair of the IEEE-USA Career & Workforce Policy Committee in 2005-06, Kostek met with high-tech executives and engineers across the country to identify their concerns in today's job market. Under his leadership, IEEE-USA has offered career-management seminars throughout the United States, and he has counseled numerous engineers on optimal career paths.

Kostek was IEEE-USA president in 1999 and served on the IEEE Board of Directors. He was president of the IEEE Aerospace & Electronics Systems Society in 2000-01 and chair of the American Association of Engineering Societies in 2003. He also chairs the IEEE-USA Communications Committee and is a member of the IEEE's Member Benefits and Services Committee.

At Boeing, Kostek leads a hardware/software systems-integration team and oversees the design, modeling, installation and testing of computer systems on anti-submarine aircraft. He was previously assigned to a program-requirements management group that integrated controls and communications systems on unmanned military ground vehicles.

Kostek also chairs the American Institute of Aeronautics and Astronautics' (AIAA) Career Enhancement Committee and is a member of the Project Management Institute's Aerospace and Defense Specific Interest Group Board. He was general chairman of the IEEE's Intelligent Transportation Systems Conference in 2004 and chairman of a joint AIAA/IEEE Digital Avionics Systems Conference in 2006. He is an associate fellow of the AIAA and a member of the International Council on Systems Engineering, the Society of Automotive Engineers and the Project Management Institute

Kostek received his bachelor's degree in electrical engineering technology from the University of Massachusetts, Dartmouth; completed graduate studies at the Polytechnic Institute of New York and Long Island University; and earned a certificate in project management from the University of Washington.

Paul and his wife, Leann, live in Seattle.

About IEEE-USA

IEEE-USA advances the public good and promotes the careers and public policy interests of more than 215,000 engineers, scientists and allied professionals who are U.S. members of the IEEE. With 370,000 members in 160 countries, the IEEE is the world's largest technical professional society. See <http://www.ieeeusa.org>.

Sources of Additional Information

Attachment B

1. Leonard Lynn and Hal Salzman, “The New Globalization of Engineering: How the Offshoring of Advanced Engineering Affects Competitiveness and Development,” (Paper presented at the 21st European Group for Organizational Studies (EGOS) Colloquium, Berlin, Germany - June 2005)
http://urbaninstitute.org/UploadedPDF/411226_new_globalization.pdf
2. STEM Workforce Report No. 8, “Is U.S. Science and Technology Adrift?” (Washington; Commission on Professionals in Science and Technology, October 2007)
https://www.cpst.org/STEM/STEM8_Report.pdf
3. B. Lindsay Lowell and Harold Salzman, “Into the Eye of the Storm: Assessing the Evidence on Science and Engineering Education, Quality and Workforce Demand” (Washington, The Urban Institute, October 2007)
http://www.urban.org/UploadedPDF/411562_Salzman_Science.pdf

Related IEEE-USA Policy Statements

1. U.S. Competitiveness and Innovation Policy – February 2006
<http://www.ieeeusa.org/policy/positions/competitiveness.html>
2. Offshore Outsourcing – March 2004
<http://www.ieeeusa.org/policy/positions/competitiveness.html>
3. Tax Incentives for Continuing Education – November 2004
<http://www.ieeeusa.org/policy/positions/continuingeducation.asp>
4. Ensuring a Strong High Tech Workforce Through Educational and Employment-Based Immigration Reform – June 2007
<http://www.ieeeusa.org/policy/positions/Immigration0607.pdf>

**Commission on Professionals in Science and Technology
STEM WORKFORCE DATA PROJECT REPORTS**

Attachment C

http://www.cpst.org/STEM_Report.cfm

1. Twenty Years of Scientific and Technical Employment
Report No. 1 (Jun 2004)
https://www.cpst.org/STEM/STEM1_Report.pdf

2. Women in Science and Technology: the Sisyphean Challenge of Change
Report No. 2 (Oct 2004)
https://www.cpst.org/STEM/STEM2_Report.pdf

3. Participation by Minorities in STEM Occupations
Report No. 3 (May 2005)
https://www.cpst.org/STEM/STEM3_Report.pdf

4. The Foreign Born in Science and Technology
Report No. 4 (Nov 2005)
https://www.cpst.org/STEM/STEM4_Report.pdf

5. Science and Technology Salaries: Trends and Details
Report No. 5 (Aug 2006)
https://www.cpst.org/STEM/STEM5_Report.pdf

6. Four Decades of STEM Degrees, 1966-2004: The Devil is in the Details
Report No.6 (Sep 2006)
https://www.cpst.org/STEM/STEM6_Report.pdf

7. STEM Employment Forecasts and Distributions Among Employment Sectors
Report No. 7 (Sep 2006)
https://www.cpst.org/STEM/STEM7_Report.pdf

8. Is U.S. Science and Technology Adrift?
Report No. 8 (Oct 2007)
https://www.cpst.org/STEM/STEM8_Report.pdf

9. Policy and the STEM Workforce System
Report No. 9 (Oct 2007)
https://www.cpst.org/STEM/STEM9_Report.pdf