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

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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

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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-based occupations in the United States --all of whom 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 my own experience as an engineer and three decades of involvement 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 the 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. 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 at non-profit research organizations. Most of the remaining ten percent are self-employed and work as consultants to businesses and government.

Globalization and the "Dis-Integration" 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. The 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 locational 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. 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 and partners all over the world. Major breakthroughs in cellular telephony are being made in China, advances in software development, information technology and pharmaceutical research are taking place in India and cutting edge improvements in automobile power trains and aircraft control systems are emerging in Brazil.

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

Lower labor costs in developing economies are undoubtedly a major contributing factor, but the new globalization of the engineering enterprise is also motivated by other factors including proximity to emerging markets, access to capable people as well as by cultural, social and regulatory environments that incentivize invention, innovation and entrepreneurship.

Impact on STEM Labor Markets and Professionals in the United States

Although there are no reliable figures on exactly how many jobs in STEM fields have moved offshore in recent years, the adverse impact of workforce globalization on high technology labor markets in the United States is becoming increasingly apparent. While unemployment rates for engineers and computer scientists – which reached historically high levels between 2001 and 2004 – fell back to less than 2 percent in 2005, statistics on recent employment and compensation trends across most science and engineering fields are troubling, to say the least.

According to a just-released report from unbiased analysts at the STEM Workforce Data Project – based on data compiled by the Bureau of Labor Statistics at the US Department of Labor - the decades long 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 salary growth for most STEM professionals has 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 upward growth in demand for health professionals in general) are the only notable exceptions to reported labor market conditions across STEM occupations].

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

If these trends continue – and knowledgeable observers think that they will – their impact on the health of America's high tech workforce could be devastating. The one/two punch of reduced demand (fewer job opportunities) and wage depression (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 and office space, 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 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 former Labor Secretary 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 technical and people systems integration as well as process and program management skills and experience will become 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, employers, family members and friends must emphasize the critical importance of making a life-long commitment to learning how to learn; and how to use technology including computer-based data collection, processing and storage devices to access, organize, evaluate and apply information 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. From the perspective of employers, in markets that reward firms that produce and deliver more, better, faster and cheaper, there are never enough good engineers. When it comes to workers, more is always better and cheaper is best.

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. Flexibility, adaptability, resourcefulness and determination are critical for continuing 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 the necessary 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. How has globalization changed the risks and rewards, costs and benefits of careers in STEM fields?

Globalization has significantly increased the risks and raised the potential returns/rewards for STEM professionals who are able to maintain/increase their employability.

8. What are countries doing to create and retain high wage/high value added jobs and to send clear signals to their 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 one that have been adopted by its principal competitors – to help American companies and citizens develop and maintain their technological competitiveness. 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.

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, let alone implement, in the midst of bitterly contested and extremely partisan Presidential and Congressional election campaigns. There are no easy answers or silver bullets, but there are some practical and immediate steps that can and should be taken:

- 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, should be established in the public and private sectors to enable 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 and identify best practices that STEM professionals can use to differentiate themselves from their foreign competitors.

- 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 (immigration) 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 reform the badly broken H-1B temporary work visa program.

- 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 take steps to address barriers to overseas employment by U.S. STEM professionals and better enable such individuals to find work 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 **Attachment C**

STEM WORKFORCE DATA PROJECT REPORTS

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