Testimony before the U.S.-China Economic and Security Review Commission
by
Ron Hira, Ph.D., P.E.
Associate Professor of Public Policy
Rochester Institute of Technology
Rochester, NY, USA
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Introduction

I want to thank the commission and chairmen Shea and Mulloy for inviting me to testify here today.

Offshoring is one the most important economic, technological, and national security issues this country faces. Yet we have had a muted and often misleading public discussion about its causes, impacts and the appropriate policy responses. I have been studying offshoring for the past decade and I believe that the U.S. is charting the wrong policy course that, if left unchanged, will significantly erode America's economic and technological performance. In this testimony, I will focus on the offshoring of innovation and research and development (R&D), areas where the U.S. is presumed to hold a commanding lead and are widely viewed as keys to our future success.

The dominant narrative given about offshoring is that as the US offshores particular jobs, industrial sectors, and tasks, it will be a win-win for both the US and the receiving country, say India or China. The argument goes that it is good for the US to offshore software programming to India, or offshore auto parts manufacturing to China, because these jobs and sectors will be replaced by better ones. The United States will simply specialize in high-tech sectors that create high-skill, high-wage innovation and creative jobs to replace those lost.

The narrative and its prescriptions rest on a division-of-labor hypothesis: the U.S. response to increased offshoring should be to "move up" the innovation and skill ladder. Policy responses aimed at "retaining" current jobs or industries is folly. The story acknowledges that low-skill, low-wage workers will face increased competition from workers abroad and some may lose their jobs, but it offers a solution for them too: they can be easily retrained for higher skill and higher wage jobs, and end up in a better job. Also remember that the narrative rests on the fundamental assumption that the economy is at full employment, a condition that few prognosticators have on their radar screen.

But what happens to the narrative if in reality the tasks and jobs moving to low-cost countries are in the very same high-skill innovation and high-tech sectors in which the United States is supposed to hold an advantage? What if the sectors that are lost are the "better" industries?

A variety of indicators show that some high-tech jobs and sectors have already moved to low-cost countries like India and China, and there is even more evidence that this migration will increase in scale and scope, and its growth could be substantial. Princeton economist Alan Blinder estimated the vulnerability to offshoring of all 838 Department of Labor job categories, and found absolutely no correlation with skill level. This means that many occupations requiring advanced skills are vulnerable to offshoring, including nearly all science and engineering job categories. Getting more education or advanced degrees does not make one immune from the negative effects, job and/or wage loss, from offshoring.

Further, large losses of U.S. manufacturing jobs and the worsening deterioration of the goods trade balance over the past decade are very troubling for those betting on innovation. According to the National Science Foundation manufacturing industries accounted for a whopping 70% of all business research and development (R&D) performed in the United States in 2007. Also, Department of Labor statistics show that more than 40% of engineers, the agents of technological innovation, work in the manufacturing sector. Recent discussions by some pundits that the U.S. should jettison manufacturing and will succeed by specializing in innovation defy reality. Innovation and manufacturing are inextricably linked and complementary activities. Now let me turn to some worrying indicators about the offshoring of innovation and R&D, which I have documented in more detail in some of my recent papers.

Advanced (High-Technology) Trade Balance

The United States is running large and growing trade deficits with China in the "advanced technology products" (ATP) category. Advanced technology products, defined by the Foreign Trade Statistics division of the Census Bureau, captures trade in goods (services are excluded) that require a high amount of R&D to produce. The ATP series was created in the late 1980s specifically to more easily identify the U.S. trade position in high-technology.

The United States began running a trade deficit in advanced technology products in 2002, and that deficit increased to $38 billion in 2006. Much of the deficit can be attributed to the rapidly declining trade position with China, dating to its accession to the World Trade Organization in 2001. Looking at exports and imports separately, China ranks number one for both exports and imports. The US exported more ATP, $24 billion, to China than any other country in 2006, up more than two-fold from $11 billion and 8th place in 2000. But the remarkable story is the massive five-fold increase in ATP imports from China between 2000-06 going from $12 billion and 7th place to $73 billion and a dominant 1st (Mexico is a distant second at $31 billion), accounting for one-quarter of all US ATP imports.

In the case of India, America ran a slight surplus of $2.6 billion in 2006, up from $913 million in 2000. Exports to India increased from $1 billion and a rank of 28th in 2000 to $3 billion and a rank of 20th in 2006. Many predicted that India would become a large market for US ATP exports, as the offshoring of IT services increased. The prediction was that Indian workers would be buying "Dell computers" and telecommunications equipment from Americans. But it simply hasn't materialized. Information and communications ATP exports to India increased a mere $470 million between 2003 and 2007, from $650 million to $1.12 billion, while the Indian offshoring industry exploded. The claim that offshoring is a two-way street isn't supported by the facts.

Science & Engineering Articles

A significant output of research activities, especially academic research, is publishing articles. China's article output increased more than four-fold between 1995 and 2005 to 42 thousand, moving it from being ranked 14th to the 5th in just a decade. The 2005 Chinese output still significantly lags the US and EU, each in the low 200 thousand range, but it's now three-quarters the size of Japan's. India's output, which was nearly equal to China's in 1995, has increased at a much slower rate to 15 thousand. It began 1995 and ended 2005 as the 12th ranked country.

A potentially more significant figure is how China has focused its efforts on particular technical fields. The data above include social as well as natural and physical sciences. China appears to investing in the physical sciences, engineering and mathematics. In engineering and chemistry, China became the second leading publisher of articles, supplanting Japan. And in physics and mathematics it moved into third place behind Japan for physics and third place behind France for mathematics. In the leading edge field of nanotechnology, China is now ranked number two, behind the US, in number of nanotechnology papers.

Human Capital Measures
Chinese and Indians are responding to the increased opportunities in science, technology, engineering, and mathematics (STEM) occupations, from offshoring as well as overall growth. In India the response has been mostly in the private sector through a proliferation of private colleges and training academies. In China, the state has played a bigger role in expanding the talent pool at all levels with a dramatic difference especially at the doctorate level. According to the NSF, India's engineering doctorate production hardly budged from 1989 to 2003, but China's production increased nine-fold, surpassing Japan in 1999 and America by 2002 to move to first place.

U.S. Multinational Corporation R&D Activities in China & India
There is no comprehensive list of R&D investments by U.S. multinational corporations and they aren't required to disclose geographic segment activities of R&D in financial filings. Below are some of the R&D activities of leading U.S. firms that have been reported in the press or by the companies themselves. Two patterns emerge from the data: the R&D activities and investments in India and China are relatively new and they are growing. Figures in the parentheses show the firm's R&D spending ranking (for U.S.-based firms only) and its spending for fiscal year 2007.

General Motors (#1, $8.1bn)

India
The India Science Lab, one of eight General Motors research labs, is located in Bangalore and was established in 2003. More than 70% of its researchers hold a Ph.D. Also, GM has created collaborative research laboratories with two Indian universities to focus on specific R&D topics. GM has nine such labs with universities, and two of the three outside the U.S. are in India.

China
In October 2007 General Motors announced it would build a wholly-owned advanced research center in Shanghai to develop hybrid technology and other advanced designs. GM already has a 1,300-employee research center in Shanghai through a joint venture with Shanghai Automotive Industry Corporation.

Pfizer (#2, $8.1bn)

India
Pfizer has been outsourcing significant drug development services to India. 44 new drugs are under clinical trials involving 143 medical institutions and at least 1,800 patients. The company is now looking to expand into drug research in India through collaborations.

China

Pfizer has approximately 200 employees at its Shanghai R&D center, which supports global clinical development. It also uses a number contract research firms for some R&D there. It plans significant expansion of its R&D in China.

Microsoft (#5, $7.1bn)

India

It employs more than 4,000 workers in India. The Microsoft India Development Center (an R&D center) was established in 1998. It has grown to more than ten-fold since 2003 when it had 120 people. With 1,500+ workers now, it is the largest development center outside the U.S.

China

The Microsoft China R&D Group is over ten years old and currently employs 1,500 workers. Activities are for both localization and global markets. The Microsoft China R&D Group focuses on the five areas of mobile and embedded technology, web technology products and service, digital entertainment, server and tools, and emerging markets. Microsoft broke ground on a new $280 million R&D campus in Beijing in May 2008. In November 2008 Microsoft announced it is significantly expanding its R&D operations in China by investing an additional $1 billion over the next three years making it the largest R&D center behind the U.S.

Intel (#6, $5.8bn)

India

Intel began with a sales office in 1988 and established an R&D center in 1998. It now has about 2,500 R&D workers in India and has invested approximately $1.7 billion in its Indian operations. In 2007, Intel's Bangalore Development center contributed about half the work towards its "teraflop research chip." In September 2008 Intel unveiled its first microprocessor designed entirely in India, and the first time that 45 nanometer technology was designed outside of the U.S. The Xeon 7400 microprocessor are used for high-end servers. In 2005 Intel announced a planned investment of $800 million in India to expand research operations and an additional $250 million to launch a venture capital fund targeted at Indian start-ups.

China

Intel is building a $2.5 billion 300 mm semiconductor fabrication facility in Dalian, China, its first fab in Asia. In April 2008 Intel announced a $500 million Intel Capital China Technology Fund II will be used for investments in wireless broadband, technology, media, telecommunications, and "clean tech." The first fund's size was $200 million. Examples of Intel's first China Fund company investments include Neusoft Group, Supcon Group, A8 Music, Chinacache International, Chipsbank Microelectronics, DAC, HiSoft Technology International, Kingsoft, Legend Silicon, Montage Technology, and Palm Commerce.

Why the Current Policy Response to High-Technology Offshoring is Insufficient

In response to the offshoring of high-tech jobs and tasks an additional narrative supporting status-quo globalization has been constructed. In this muddled tale, the rise of India and China is seen as both a challenge and a boon. In response to the challenge, American workers and companies and industries that cannot take advantage of offshoring must “run faster and jump higher” or “adjust” by moving to new functions or sectors. The proponents argue that innovation is the panacea, and that more public money should be directed to increase U.S. technological capacity. They offer a simple three-ingredient cocktail: increase R&D spending (and R&D tax breaks); produce more scientists and engineers; and improve K-12 science and math education.

Their primary focus is on increasing resource inputs into the innovation system. But this policy course is misguided because it is based on a misunderstanding of how R&D is connected to a company’s activities and the economy. First, the purpose of government subsidies for R&D is not to create research jobs, which number about 1 million in the U.S., or less than 0.7% of the workforce (less than the number of jobs lost in the past three months alone). The sector is simply too small to be a major job creator now or in the future. Instead the purpose of subsidizing R&D spending is the hope that the U.S. will capture the downstream benefits - the design, development and production jobs that complement and are complemented by those R&D activities. Second, a number of major structural shifts have occurred in the U.S. *national innovation system* (NIS), the term scholars use to describe the complex system that supports the innovation process. Our policies have not kept up with these significant structural and institutional changes affecting the U.S. NIS - its elements, institutions and the links between them. These changes include shifts in the employment relations and the rise of the globally integrated enterprise; the internationalization of U.S. universities; and, the uncertainty of the U.S. science and engineering labor market.

U.S. High-Technology Employment Relations & Rise of Globally Integrated Enterprises
During the past two decades there has been a significant shift in the employment relations between U.S. employers and their American scientists and engineers. Corporate decisions are increasingly being made with little regard to how it affects workers. IBM, a leading employer, shows how radically these practices have changed over the past 20 years. As recently as 1992 IBM never laid off an employee, but since 2002 it has policies in place that force its U.S. workers to train foreign replacements as a condition of severance and unemployment insurance. These practices have become quite widespread in the American technology sector. An American software engineer I know working at a major semiconductor company put it this way, “The basic plan where I worked was to hire H-1Bs [foreign workers in the United States on temporary work permits], train them, and use them as a way to outsource and transfer technology to China. I trained my replacement who was here on an H-1B visa from India.” When asked if he would tell his story publicly, he demurred saying, “The company I worked for required I sign a several page agreement stating I would not discuss company information. My human resources representative and manager both made it clear that the company has never lost any challenge and has gone out of its way to destroy the lives of the people who have caused issues. They tell everybody this, not just me. They would brag about cases.” At the same time that this American engineer was training his foreign replacement, the CEO of his company was publicly complaining to Washington policy makers about a shortage of U.S. engineers.

U.S. corporate leaders have been explicit about how they now manage their technology human resources. For example, in response to the discussion on offshoring and U.S. competitiveness, Craig Barrett, then CEO of Intel Corporation, said that his company can succeed without ever hiring another American. And in an article in *Foreign Affairs* magazine in 2006, IBM CEO Sam Palmisano gave the eulogy for the multinational corporation (MNC), and introduced us to the globally integrated enterprise (GIE). Palmisano said, "Many parties to the globalization debate mistakenly project into the future a picture of corporations that is unchanged from that of today or yesterday….But businesses are changing in fundamental ways—structurally, operationally, culturally—in response to the imperatives of globalization and new technology." The MNC model, where firms replicated their organization for each country where they sold, is now giving way to the GIE model, where firms geographically separate their production from the markets in which they sell. When discussing his firm's aggressive moves to shift its share of workers to low-cost countries, Ron Rittenmeyer, CEO of EDS, the largest U.S.-based IT services firm, said he "is agnostic specifically about where" EDS locates its workers, choosing the place that reaps the best economic efficiency. By 2008, EDS had 43% of its workforce in low-cost countries, up from virtually zero in 2002.

Firms are significant actors in the innovation process, and changes in their behavior will impact the U.S. NIS as well as the distribution of its benefits and costs. For example, advanced tools and technologies created or purchased by firms, will likely diffuse much more rapidly across borders (be geographically more leaky), giving domestic technology workers diminished preferred-access advantage. There will also be larger shares of technology workers in low-cost countries, and likely smaller workforces in the United States. This will affect new firm creation in the United States because engineers not only create new knowledge, but are also an important source of entrepreneurship and start-up firms. These new arrangements will also make innovations less geographically sticky, raising questions about whether promised payoffs to public investments in R&D will be realized. Global firms will have access to knowledge created in low-cost countries, if they aren't creating it themselves, and will be able to diffuse and exploit that new knowledge in their U.S. operations.

Low-Cost Countries Attract R&D Sites

Another new phenomenon is competition by low-cost countries for R&D site selection. Defying the product life-cycle pattern of technological investments proposed by development scholar Raymond Vernon in 1966, India and China have successfully attracted R&D and innovation facilities. Vernon argued that newly invented products were initially produced in developed countries and only after they matured did production move to developing countries. Any R&D done in developing countries would be limited to localization, customizing the product for the domestic market.

Recent surveys of corporate R&D managers indicate that India and China have become much more attractive as destinations for R&D investments. A survey by the U.N. Conference on Trade and Development of the top 300 worldwide R&D spenders found that China was the top destination for future R&D expansion, followed by the United States, India, Japan, the U.K., and Russia. A survey of 248 R&D managers of U.S. and European MNCs, conducted by Thursby and Thursby for the National Academies' Government University Industry Research Roundtable, found more firms had new or planned facilities, "central to overall R&D strategy," to be located in China than the United States, and a large number are slated for India. The study also found that the managers expected R&D employment growth in India and China, and more respondents expected U.S. R&D employment to decline than those that expected it to increase. In 2007 *The Economist* magazine surveyed 300 executives about R&D site selection. They asked them to name the best overall location for R&D, excluding their home country. India was the top choice, followed by the United States and China (Canada followed as a distant fourth). Eight of the top 10 R&D spending companies have R&D facilities in China or India, (Microsoft, Pfizer, DaimlerChrysler, General Motors, Siemens, Matsushita Electric, IBM, and Johnson & Johnson).

While General Electric spends less than many other firms on R&D it nevertheless provides an interesting case of a company with the majority of its R&D personnel in low-cost countries. Jack Welch, former CEO of GE, was an early and significant evangelizer of offshoring. The firm has four research locations worldwide, in New York, Shanghai, Munich, and Bangalore. Bangalore's Jack Welch R&D Center employs 3,000 workers, more than the other three locations combined. In fiscal year 2008, 47% of GE's revenues came from the United States and 84% from outside of Asia. So, clearly those R&D personnel are creating products for the global and high-cost country markets.

The emerging economies of India and China have leap-frogged certain stages of economic development by attracting private-sector R&D production. This may result in greater competition amongst regions for attracting R&D investments. An important rationale for public sector investments in R&D is that it helps to attract co-located private-sector R&D investments. These public-sector investments, often accompanied by tax and other subsidies, may become less effective at attracting those private investments.

Perhaps the most important effect will be felt on the downstream benefits accruing from public investments in R&D, which are often targeted at economic growth and job creation. The payoff from such investments is not the R&D jobs created by government spending or subsidies, but rather the expectation that the downstream spillover benefits, in the form of start-up firms and design and development and production facilities, will be geographically sticky. The fact that China and India are able to attract R&D indicates they have improved their absorptive capacity for the mid-skill technology jobs in the design, development and production stages.

U.S. Universities Begin to Internationalize

U.S. universities, long seen as providing a central role in the U.S. NIS, are beginning to internationalize in new ways. While these institutions have traditionally attracted large numbers of foreign students, particularly at the graduate level in science and engineering fields, they are beginning to take their education to foreign students by building campuses and offering STEM degree programs in other countries. Some, like Cornell, already identify themselves as *transnational universities*.

Offshoring is giving high-quality foreign students new job opportunities in their home countries making it less desirable to come to the U.S. to study. Those opportunities are increasingly with U.S.-based MNCs, creating new markets for universities. As a result prominent U.S. universities are expanding their global footprints, to tap a more geographically diffuse student pool, especially in India and China. While there are no definitive counts of foreign campuses and programs established by American universities, experts believe that more universities, particularly high-prestige ones, are venturing abroad. And the World Bank estimates that 150 of the 700 foreign degree programs operating in China are American. Cornell, which already operates a medical school in Qatar, sent its president to explore opportunities in India in 2007. And Cornell isn't alone—many other engineering-intensive colleges, such as Rice, Purdue, Georgia Tech, and Virginia Tech, have made similar exploratory visits. Various programs have already been initiated by major engineering colleges. Carnegie-Mellon offers its technology degrees in India in partnership with a small private college there. Students take most of the courses in India, because it is less expensive, and then they spend six months in Pittsburgh to complete the Carnegie-Mellon degree.

University internationalization is still in its early stages and is still small in scale, but reports indicate that high-prestige U.S. universities have serious plans in the works to ramp up their overseas operations.

Uncertainty for U.S. STEM Workers & Students

The emerging opportunities for GIEs to take advantage of high-skilled talent in low-cost countries have introduced career uncertainty for the U.S. STEM workforce. Many U.S. STEM workers worry about offshoring's impact on their career prospects. According to the Taulbee survey, conducted by the Computing Research Association, enrollments in bachelors programs in computer science dropped an astounding 50% from 2002 to 2007. Rising risks for job loss in information technology, caused in part by offshoring, was a major factor in students shying away from computer science degrees. Other factors, such as the bursting of the dot-com bubble and record unemployment levels for IT workers, were also important contributors. But even as those factors have been mitigated, enrollments have not come back.

Offshoring concerns have been mostly concentrated on IT occupations, but many other STEM occupations may be at risk. Blinder examined all 838 occupations as defined by the Bureau of Labor Statistics. He estimated that nearly all (35 of 39) STEM occupations are offshorable, many of which he describes as "highly vulnerable." By vulnerable, Blinder is not claiming that all, or even a large share, of jobs in those occupations will actually be lost overseas. Instead, he claims that those occupations have characteristics that mean they will face significant new wage competition from low-cost countries. Blinder finds that there is no correlation between vulnerability and education level; i.e., even occupations that require advanced education and skills are vulnerable.

Workers need to know which jobs will be geographically sticky and which are likely to be offshored. But because offshoring of white-collar jobs is still an incipient phenomenon, there is a great deal of uncertainty about how globalization will affect the level and mix of domestic STEM labor demand. The response of some workers appears to be to play it safe and opt for occupations that are likely to stay. Longer-term impacts on the national innovation system are unknown but likely to be significant.

How Globally Integrated Enterprises Are Responding to Competition

We have an excellent case study for how these dynamics will play out in the near future. One of the most important high-technology stories of the past decade has been the remarkably swift rise of the Indian IT services industry, including firms such as Wipro, Infosys, TCS, and Satyam, as well as U.S.-based firms such as Cognizant and iGate that use the same business model. There is no need to speculate about whether the Indian firms will eventually take the lead in this sector; they already have become market leaders. By introducing an innovative, disruptive business model, the Indian firms have turned the whole industry upside down in the matter of four short years. U.S. IT services firms such as IBM, EDS, CSC, and ACS were caught flat-footed. Not a single one of those firms would have considered Infosys, Wipro, or TCS as direct competitors as recently as 2003, but now they are chasing them by moving as fast as possible to adopt the Indian business model, which is to move as much work as possible to low-cost countries. The speed and size of the shift is breathtaking.

The Indian IT outsourcing firms have extensive U.S. operations, but they prefer to hire temporary guest workers with H-1B or L-1 visas. The companies train these workers in the United States, then send them home where they can be hired to do the same work at a lower salary. These companies rarely sponsor their H-1B and L-1 workers for U.S. legal permanent residence.

The important lesson though is how the U.S. IT services firms have responded to the competitive challenge. Instead of investing in their U.S. workers with better tools and technologies, the firms chose to imitate the Indian model by outsourcing jobs to low-cost countries. IBM held a historic meeting with Wall Street analysts in Bangalore in June 2006, where the whole IBM executive team pitched their strategy to adopt the Indian offshore-outsourcing business model, including an additional $6-billion investment to expand its Indian operations. IBM's headcount in India has grown from 6,000 in 2003 to 73,000 in 2007 and is projected to be 110,000 by 2010, which will rival the current U.S. headcount of 115,000. And IBM is not alone. Accenture passed a historic milestone in August 2007, when its Indian headcount of 35,000, surpassed any of its other country headcounts, including the United States, where it had 30,000 workers. In a 2008 interview, EDS's Rittenmeyer extolled the profitability of shifting tens-of-thousands of the company's workers from the United States to low-cost countries such as India. He said outsourcing is "not just a passing fancy. It is a pretty major change that is going to continue. If you can find high-quality talent at a third of the price, it's not too hard to see why you'd do this." ACS, another IT services firm, recently told Wall Street analysts that it plans its largest increase in offshoring for 2009, when it will move many of its more complex and higher-wage jobs overseas so that nearly 35 percent of its workforce will be in low-cost countries.

What We Should Do

Most of the responses to offshoring will be done in the private sector, by firms and individuals, but governments can and should play a more significant role in ensuring that globalization works for the national interest. Given the speed by which offshoring is increasing in scale, scope and moving up the skill ladder, a number of immediate steps should be taken.

A. Establish a Dedicated Standalone FFRDC to Study the Globalization of Innovation

Princeton's Alan Blinder has likened the economic transformation caused by offshoring to be equivalent on scale to the industrial revolution. The stakes are simply too large for the country not to invest in a better understanding of the economic impacts and policy implications of offshoring. Existing institutions cannot provide objective and un-conflicted advice and analysis because they all have significant limitations. The scale of the problem, and its growth rate, requires a budget of at least $40 million per year for a new FFRDC dedicated to studying offshoring. Its agenda would be far ranging from advising the agencies on data collection to generating policy alternatives for creating geographically sticky jobs. The FFRDC should be created in a new organization, rather than an existing contractor to ensure that its functions and mission are focused and its resources are not poached by the parent organization.

Many academics, especially those in business schools, have set up research agendas studying ways that make offfshoring more efficient and effective, essentially speeding up the offshoring trend. This is understandable given the operating model of most universities. Faculty respond to incentives and to date there have been no incentives to study offshoring from a U.S. national interest perspective. The government is the only institution that can fill this breach.

B. <u>Create the Environment for Worker Representation in the Policy Process</u>

Imagine if a major trade association, such as the Semiconductor Industry Association, was excluded from having any representatives on a federal advisory committee making recommendations on trade and export control policy in the semiconductor industry? It would be unfathomable. But we have precisely this arrangement when it comes to making policies that directly affect the STEM workforce.

1. Government advisory boards, such as the National Science Board, should be required to have members that represent the interests of American STEM workers.
2. Organizations that fall under the FACA rules should ensure that STEM workers are represented on committees that make recommendations on policy issues that affect workers.

C. <u>Collect Additional, Better, and Timelier Data</u>

There is a consensus that poor data has severely limited analysis of, and policy as well as private responses to, the globalization of innovation and R&D. To remedy this situation, the National Science Foundation should work with the appropriate agencies (BEA, BLS, and Census) to begin collecting additional and timelier data on the globalization of innovation and R&D. The broad-based effort should include a number of new initiatives.

1. The NSF Statistical Research Service (SRS) should augment existing data on multinational R&D investments to include detailed STEM workforce data. This data will track the STEM workforce for multinational companies in the U.S. versus other countries. Details should include occupation, level of education, and experience. These data will be reported on an annual basis and in a timely manner such that the data are from the most recent fiscal year reported by the companies.
2. The NSF SRS should collect detailed information on how much and what types of R&D and innovation activities are being done overseas.
3. The NSF Social, Behavioral, and Economic Sciences (SBE) division will begin a research program identifying the characteristics of jobs that make them more or less vulnerable to offshoring. The program will include a study of estimating the numbers of jobs that have been lost to offshoring.
4. The NSF should make an assessment of the extent of U.S. university globalization. It should then track trends in university globalization.
5. NSF SBE will identify the impacts of university globalization on the U.S. STEM workforce and students. NSF SBE will begin a research program identifying and disseminating best practices in university globalization.
6. The NSF should conduct a study to identify the amount and types of U.S. government procurement that are being offshored.
7. The BEA should implement recommendations from prior studies, such as the 2006 study by MIT's Industrial Performance Center, to improve its collection of services data, especially trade in services data.

D. <u>Create Better Career Paths for STEM Workers</u>

STEM offshoring has created a pessimistic attitude about future career prospects for incumbent workers as well as students. New programs are needed to create better career paths for STEM workers including improved continuing education, a sturdier safety net for displaced workers, improving labor market signals and career information, expanding the pool of potential STEM workers by better utilizing workers without a college degree, and improving rates of successful re-entry into the STEM labor market after voluntary and involuntary absences. No American STEM worker should be forced to train his foreign replacement because of government designed loopholes in immigration policy.

1. The government should encourage the adoption and use of low-cost asynchronous on-line education targeted at incumbent STEM workers. The program would coordinate with the appropriate scientific and engineering professional societies. The pilot program will assess the current penetration rates of on-line education for STEM workers and identify barriers to widespread adoption.
2. Using H-1B fees, the U.S. Department of Labor should work with the appropriate scientific and engineering professional societies to create a pilot program for continuous education of STEM workers and to re-train displaced mid-career STEM workers. Unlike prior training programs, these ones should be targeted at jobs that require at least a bachelors degree.
3. The NSF SRS should issue a report on improving the dissemination of STEM labor market signals, and begin reporting these data on a monthly basis. The report will assess the current state of labor market signals, and ways in which they may be distorted. The focus of the report is how workers and students receive information on the current and future prospects for specific STEM careers. The report will identify the appropriate data from the Department of Labor including data series such as JOLTS, DWS, and BED.
4. The National Academies should form a study panel to identify on-ramps to STEM careers for students who do not go to college. This study will identify how many workers enter STEM careers without formal college degrees. And it will identify the barriers for additional workers, without college, to enter STEM careers and ways to overcome those barriers.
5. The National Academies should identify effective strategies for STEM workers to more easily re-enter the STEM workforce. STEM workers are more likely to leave the workforce, voluntarily and involuntarily, for extended periods of time.
6. Extend TAA to services workers since many STEM workers work in the services sectors.
7. Fix the broken high-skill immigration system by encouraging the best and brightest from abroad to stay permanently and reducing our reliance on guestworkers. First, fix permanent residency pathways by increasing the overall quota for high-skill permanent residents. We should move towards a two channel approach in permanent residence, with a new merit point system quota coupled with a reduced reliance on employer based sponsorship. Second, the loopholes in the H-1B and L-1 visa guestworker programs should be closed. These loopholes enable employers to pay below-market wages and exploit vulnerable guestworkers, harming American and foreign workers alike. These H-1B and L-1 reforms should ensure that employers look for American workers first, pay market wages, and not displace American workers. As part of the broader immigration reform policies, place the ability to set immigration quotas in the hands of an independent body that monitors the labor market. This allows the board to adjust the new flow of immigrants to real needs by the US economy. Former Secretary of Labor Ray Marshall has developed proposals on how such a board could be operated.

E. <u>Improve the Competitiveness of the Next Generation of STEM Workers</u>

As universities globalize and multinational firms take the latest tools and technologies to STEM workers in low-cost countries, American STEM workers must find new ways to compete. They can compete by finding new opportunities and niches in the types of jobs and tasks that will remain geographically sticky to the United States. Those opportunities and niches for American STEM workers need to be identified. Entrepreneurship and innovation training have been identified as a comparative advantage, for American STEM workers, have yet to be fully exploited.

1. The National Academies will form a study panel to identify the types of curricula reform that are needed, if any, in response to globalization. The aim is to ensure that US STEM students graduate with the best skills to compete in the world.
2. The National Academies will form a study panel to examine best practices in teaching innovation, creativity and entrepreneurship specifically target to STEM students.
3. The National Science Foundation will encourage study abroad programs for STEM students to improve their ability to work in global teams.

F. Public Procurement Should Favor American Workers

Government procurement has been one of the primary areas of outsourcing policy debate, since about forty states have legislation either pending or passed that restricts offshore outsourcing to some degree. Tennessee was the first state to pass this kind of legislation, but it is likely to pass in many more states. An outright ban does not make sense, but instead we should take a pragmatic approach to what should and should not be outsourced overseas. A simple one-size-fits-all approach just does not work. American taxpayers have a right to know that government expenditures at any level are being used appropriately to boost innovation and help U.S. workers. The public sector—federal, state, and local government—is 19 percent of the economy and is an important mechanism that should be used by policymakers. There is a long, strong, and positive link between government procurement and technological innovation. The federal government funded not only most of the early research in computers and the Internet but also was a major customer for those technological revolutions. Also, our billions in defense expenditures have helped to fund technological innovations, such as the Internet, that have commercial applications.

The first step is to do an accounting of the extent of public procurement that is being offshored. Then the government should modify regulations to favor STEM intensive work staying in America.

G. Establish Tax & Trade Policies That Put U.S. On Equal Footing In Attracting High-Wage STEM Jobs

U.S. tax and trade policies currently discourage investments by companies in high-wage STEM jobs. Changes should be made to tax and trade policies to improve America's ability to recruit and retain R&D and innovation facilities.

1. Investigate "unfair" trade practices such as linking market access to a country with technology transfer, undervalued currencies, and theft of intellectual property.
2. Fix the perverse loopholes that provide firms a tax advantage for keeping profits overseas.
3. Explore more fundamental tax reform where corporate tax rates are scaled by the kinds of jobs they have in the US. It would offer lower rates for companies with high-wage jobs and higher rates for low-wage jobs.