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The Rising Chorus – Excerpts from Key Competitiveness Studies

In recent years a number of studies have begun to sound the alarm that America is at risk of losing its leadership in technology and innovation, with consequences for America's future economic prosperity and national security. As each study is released, the chorus becomes ever louder, urging policy makers to take significant steps to address this problem. This paper provides a two-page digest of the findings and recommendations of five studies:

- The National Academies' "The Gathering Storm" Report
- The President's Council of Advisors on Science and Technology's (PCAST's) "Sustaining Innovation Ecosystems" Report
- The National Innovation Initiative's "Innovate America" Report
- The Defense Science Board's "High Performance Microchip Supply" Report
- "Tapping America's Potential: The Education for Innovation Initiative"

Each of these studies contains a number of important findings and recommendations. The attached excerpts – 2 pages per study -- do not include all of these points, but rather are intended to provide a reasonable sampling of the recommendations in the reports' contents. Exact quotes are in *italics*.

The National Academies' "The Gathering Storm" Report

The National Academies was asked by Senators Lamar Alexander and Jeff Bingaman to list the top actions that federal policy-makers could take to enhance the science and technology enterprise so that the U.S. can compete, prosper, and be secure in the global community of the 21st Century. A 20 person committee was created chaired by Norman Augustine, retired chairman and CEO of Lockheed Martin Corp., and including current and former industry CEO's, university presidents, researchers (including three Nobel prize winners), and former presidential appointees. The report, "Rising Above The Gathering Storm: Energizing and Employing America for a Brighter Economic Future" was released in October 2005 and is available at: <http://www.nationalacademies.org/morenews/20051012.html>

Findings

The "Gathering Storm" report cites a number of worrisome indicators, including:

- *For the cost of one chemist or one engineer in the United States, a company can hire about five chemists in China or 11 engineers in India.*
- *The United States is today a net importer of high-technology products. Its share of global high technology exports has fallen in the last 2 decades from 30% to 17%, and its trade balance in high technology manufactured goods shifted from plus \$33 billion in 1990 to a negative \$24 billion in 2004.*
- *Chemical companies closed 70 facilities in the United States in 2004 and have tagged 40 more for shutdown. Of 120 chemical plants being built around the world with price tags of \$1 billion or more, one is in the United States and 50 in China.*
- *Fewer than one-third of US 4th grade and 8th grade students performed at or above a level called "proficient" in mathematics; "proficiency" was considered the ability to exhibit competence with challenging subject matter.*
- *In 2003, only three American companies ranked among the top 10 recipients of patents granted by the United States Patent and Trademark Office.*
- *In 2004, China graduated over 600,000 engineers, India 350,000, and America about 70,000.*

Although many people assume that United States will always be a world leader in science and technology, this may not continue to be the case inasmuch as great minds and ideas exist throughout the world. We fear the abruptness with which a lead in science and technology can be lost—and the difficulty of recovering a lead once lost, if indeed it can be regained at all.

“Gathering Storm” Recommendations

The committee reviewed hundreds of detailed suggestions and came forward with four recommendations, with 20 implementing steps.

1. *Increase America’s talent pool by vastly improving K–12 science and mathematics education.* Implementation steps include annually recruiting 10,000 science and mathematics teachers by awarding 4-year scholarships and thereby educating 10 million minds, and strengthen the skills of 250,000 teachers through training and education programs at summer institutes and other programs.
2. *Sustain and strengthen the nation’s traditional commitment to long-term basic research that has the potential to be transformational to maintain the flow of new ideas that fuel the economy, provide security, and enhance the quality of life.* Implementing actions include increasing the federal investment in long-term basic research by 10% a year over the next 7 years, with special attention to the physical sciences, engineering, mathematics, and information sciences and to Department of Defense basic-research funding. The report also proposed a new Department of Energy organization like the Defense Advanced Research Projects Agency (DARPA).
3. *Make the United States the most attractive setting in which to study and perform research so that we can develop, recruit, and retain the best and brightest students, scientists, and engineers from within the United States and throughout the world.* Implementing actions include a proposed 25,000 new Undergraduate Scholar Awards in Science, Technology, Engineering, and Mathematics (USA-STEM), 5,000 new graduate fellowships each year, and a new skills-based, preferential immigration option.
4. *Ensure that the United States is the premier place in the world to innovate; invest in downstream activities such as manufacturing and marketing; and create high-paying jobs that are based on innovation by modernizing the patent system, realigning tax policies to encourage innovation, and ensuring affordable broadband access.* Implementing actions include enhanced intellectual-property protection, a stronger research and development tax credit (roughly double the current amount), tax incentives such as incentives for the purchase of high-technology research and manufacturing equipment to promote U.S.-based innovation. *The Council of Economic Advisers and the Congressional Budget Office should conduct a comprehensive analysis to examine how the United States compares with other nations as a location for innovation and related activities with a view to ensuring that the United States is one of the most attractive places in the world for long-term innovation-related investment. From a tax standpoint, that is not now the case.*

PCAST's "Sustaining Innovation Ecosystems" Report

In January, 2004 the President's Council of Advisors on Science and Technology (PCAST) released *Sustaining the Nation's Innovation Ecosystems, Information Technology Manufacturing and Competitiveness*, which is available at: <http://www.ostp.gov/PCAST/FINALPCASTITManuf%20ReportPackage.pdf>

Findings

The report's findings were crystallized in a comment received during the course of the study from the leadership of the National Science Foundation:

Civilization is on the brink of a new industrial world order. The big winners in the increasingly fierce global scramble for supremacy will not be those who simply make commodities faster and cheaper than the competition. They will be those who develop talent, techniques and tools so advanced that there is no competition. That means securing unquestioned superiority in nanotechnology, biotechnology, and information science and engineering. And it means upgrading and protecting the investments that have given us our present national stature and unsurpassed standard of living.

The report noted that other nations not merely manufacturing commoditized products on an outsourced basis, but are catching up to the U.S. in the key areas needed for technological leadership:

1. A strong basic R&D investment;
2. A large body of skilled scientists and engineers;
3. A flexible and skilled work force;
4. Reliable utilities and other infrastructure;
5. Federal and state laws and regulations that encourage high tech manufacturers to locate facilities at home;
6. A competitive investor and tax environment; and
7. A level playing field, with enforcement of trade agreements and intellectual property (IP) rights.

The study also noted that design, product development, and process evolution all benefit from proximity to manufacturing, so that new ideas can be tested and discussed with those working "on the ground.". Locations that possess both strong R&D centers and manufacturing capabilities therefore have a competitive edge. *Indeed, several major manufacturers told the PCAST panel that they decided to locate new plants in the United States, despite cost benefits of offshore manufacturing, due to the proximity of leading university R&D capabilities.*

PCAST Recommendations

1. Strengthen the nation's R&D capacity by increasing funding for basic research in math, science and engineering in our universities, better coordination of R&D efforts with state governments, and consideration of a next generation "Bell Labs" model. With regard to the latter recommendation, the report noted that "*Over the course of the last two decades, the United States lost a significant R&D asset when the major industrial R&D centers, epitomized by Bell Labs, were shuttered or significantly contracted*" and suggested the need for a modern analogue to these activities, consistent with market conditions, citing nanotechnology as a possible opportunity.
2. Improve workforce/education by building on the foundation of the No Child Left Behind program and improving university and graduate education programs as well. Further workforce/education issues were explored in a separate PCAST report.
3. Enhance the U.S. entrepreneurial climate through lowered marginal rates, and reduced capital gains and dividends taxation, as had recently been proposed by President Bush and enacted. The importance of tort reform was also noted.
4. Maintain an aggressive schedule of infrastructure improvements, including broadband deployment (including supporting permanent extension of the Internet Tax Freedom Act) and highway programs.
5. Optimize our Federal tax system in light of foreign tax competition by enhancing and making permanent the R&D tax credit and appointing a task force to identify the tax competition we are confronting. The task force would identify foreign policies, such as offers of incentives for research and manufacturing investments that amount to the payment of zero corporate taxes, and explore ways to optimize our own federal tax policies to respond appropriately for the future.
6. Aggressively pursue free trade and, in recognition of the rapid technological obsolescence in high tech, work with the WTO to implement an expedited dispute resolution procedure to deal with Intellectual Property (IP) violations and denial of market access.
7. Better coordinate with state governments on plant location incentives. Specifically, PCAST recommended that the President also establish a review of foreign plant location incentive programs, including recommendations on how the federal and state governments can improve their coordination in these arenas, where appropriate.

The National Innovation Initiative's **"Innovate America" Report**

More than 400 leaders and scholars from universities, industry, professional societies, and government formed the National Innovation Initiative (NII) in October 2003 under the leadership of the Council on Competitiveness. The NII was chaired by IBM Chairman and CEO Samuel Palmisano and Georgia Institute of Technology President G. Wayne Clough, and issued its recommendations on December 2004. The report is available at: <http://innovateamerica.org/webscr/report.asp>

Findings

Noting that the U.S. remains near the top rank of countries measured by R&D as a percentage of GDP, is the world leader in venture capital, and possesses one of the most open economies for trade and investment, the NII concludes that *"America today is a clear No. 1 in productive innovation."* The report states *"We stand on a strong foundation. However that foundation can be shaken."*

"The bar for innovation is rising. And simply running in place will not be enough to sustain America's leadership in the 21st century." The shape of innovation is changing as technology diffuses at every increasing rates, innovation becomes increasingly multidisciplinary and collaborative, and advances come from centers of excellence around the world.

"We now face much more serious competitive challenges from new centers of innovation across an increasingly interconnected planet". China overtook the U.S. in 2003 as the top global recipient of foreign direct investment, only six of the world's top 25 Information Technology companies are based in the U.S. while 14 are based in Asia, and Asia now spends as much on nanotechnology as the U.S. While the rest of the world is picking up the pace, Federal funding of discovery research has been in long-term decline (exclusive of defense, homeland security and space, it is expected to decline in real terms over the next five years), and manufacturing has not been sufficiently linked to new sciences and technologies such as nanotechnology.

Environmentally friendly and plentiful sources of energy, new medical therapies, greater use of IT in health care, and the creation of new industries and better jobs are among the opportunities emerging from better policies to promote innovation.

An effective national innovation strategy requires an understanding of the way innovation actually occurs. *"Innovation is best seen not as a linear or mechanistic process, but as an ecosystem The National Innovation Ecosystem recognizes the influence of both innovation supply and demand on the rate of innovation productivity.... Public policies related to education and training, research funding, regulation, fiscal and monetary tools, intellectual property and market access demonstrably affect our ability to generate innovation inputs and respond to innovation demands."*

NII Recommendations

Talent

Build a National Innovation Education Strategy that includes tax-deductible private-sector scholarships for science and engineering undergrads, 5000 new portable graduate fellowships funded by federal R&D agencies, increased use of university-based Professional Science masters, immigration reform to attract the best and brightest science and engineering students from around the world.

Promote problem-based learning in K-12 and beyond to catalyze the next generation of American innovators.

Create tax exempt Lifelong Learning Accounts for employees and tax credits for employer contributions and accelerate portability of healthcare and pension benefits to empower workers to succeed in the global economy

Investment

Reallocate 3 percent of agency R&D budgets toward high-risk research, restore DoD's commitment to basic research by directing 20% of the S&T budget to long-term research, and complete the commitment to double the National Science Foundation.

Enact a permanent, restructured R&E tax credit and extend the credit to research conducted in university-industry consortia.

Recognize "services" science as a new academic discipline and allocate a higher percentage of research funding to multidisciplinary research.

Build 10 innovation Hot Spots over the next 5 years, designate a lead agency and an inter-agency council to coordinate federal economic development policies, and reinforce risk-taking and long term investment.

Infrastructure

An explicit national innovation strategy and agenda, led by the President and organized by a Cabinet-level interagency group or new mission for the National Economic Council, is needed. New metrics to track the health of the innovation ecosystem defined.

Adequately fund the Patent and Trademark office and establish post-grant patent review procedures so only meritorious patents are granted from among the 300,000 applications filed each year.

Utilize the health care industry as a test bed for innovative information technology applications – reduce the 30 minutes of paperwork that caregivers currently spend for every hour of patient care,

Defense Science Board's "High Performance Microchip Supply" Report

In February 2005, the Defense Science Board Task Force on High Performance Microchip Supply issued a report on U.S. semiconductor capabilities for national security needs. The report, available by clicking on "High Performance Microchip Supply" at <http://www.acq.osd.mil/dsb/reports.htm> , is a comprehensive review of industry trends, foreign dependency risks, DOD acquisition policies regarding trusted microelectronic components, usage of programmable parts, technology development policies, and export control policies.

Findings

The key competitiveness findings include:

"The microelectronics industry, supplier of hardware capability that underlies much of America's modern military leadership technology, is well into a profound restructuring.... One unintended result of this otherwise sound industry change is the relocation of critical microelectronics manufacturing capabilities from the United States Trustworthiness and supply assurance for components used in critical military and infrastructure applications are casualties of this migration." (p. 3)

"The shift from United States to foreign IC manufacture endangers the security of classified information embedded in chip designs; additionally, it opens the possibility that "Trojan horses" and other unauthorized design inclusions may appear in unclassified integrated circuits used in military applications.... As capacity moves to potential adversary countries, the United States is vulnerable to a governmental "reverse-ITAR" by which critical technologies are denied to the U.S. in international trade. A longer term risk lies in the historical fact that leading-edge R&D tends to follow production." (p. 4-5)

"DOD should advocate that a strongly competitive U.S. semiconductor industry is not only a DOD objective but also a national priority. Because the U.S. share of the world's leading-edge semiconductor manufacturing has declined, and because research and development is closely coupled to manufacturing leadership, the United States will soon start to lose its R&D skill base if its onshore manufacturing does not remain vital." (p.57)

DSB Recommendations:

Among the report's competitiveness recommendations are:

"...the secretary of defense, the USD(ATL) and the secretary of homeland security prepare a special briefing for the national security advisor and encourage him or her to take a key role in implementing the measures detailed in this recommendation to slow the migration of the microelectronics industry and enable it to strengthen its future in the United States." (p. 58)

"A coherent U.S. policy response is necessary to counter the extensive intervention by foreign governments to encourage local investment in the semiconductor industry. Such a response will require government policies that offset foreign incentives for manufacturing investment." (p. 58)

"To date, industry has provided the majority of the support of the [university Focus Center Research] program, with the DOD contributing additional funding and providing program management expertise through DARPA. DOD funding needs to keep pace with industry contributions." (p. 61)

"The NSF Authorization Act of 2000 authorized a doubling of NSF budgets over a six-year period. The act includes specific increases in nanotechnology and networking and information technology. Congress should appropriate the funds necessary to achieve the NSF Authorization Act's goals." (p. 60)

"Support for microelectronics at Air Force Office of Scientific Research (AFOSR), Office of Naval Research (ONR), and Army Research Office (ARO), however has dwindled over the past decade. These levels of funding should be increased commensurate with the increases planned for NSF." (p. 60)

"When it was established in 1994, the NIST Office of Microelectronics Programs was to start at \$12 million in annual funding and grow to \$25 million. This level was not achieved, but this task force considers this activity an important contribution to the national microelectronics supply issue." (p. 61)

The report also includes recommendations related to state incentive packages, a vigorous U.S. trade policy that vigorously supports compliance with World Trade Organization (WTO) rules, adequate funding for math, science, and engineering education at both the K-12 and university levels, encouraging foreign-born students who attain advanced technology degrees in U.S. universities to remain in the U.S.

Tapping America's Potential: The Education for Innovation Initiative

In July 2005 fifteen prominent business organizations¹ joined together under the leadership of the Business Roundtable to express concern about the United States' ability to sustain its scientific and technological superiority through this decade and beyond, and to establish as a goal to double the number of science, technology, engineering and mathematics graduates with bachelor's degrees by 2015. The full report, "Tapping America's Potential: The Education for Innovation Initiative," is available at: <http://www.businessroundtable.org/pdf/20050803001TAPfinalnb.pdf>

Findings

By 2010, if current trends continue, more than 90 percent of all scientists and engineers in the world will be living in Asia.... South Korea, with one-sixth of our population, graduates as many engineers as the United States.... China not only graduates four times as many engineers as the United States, but it also offers lucrative tax breaks to attract companies to conduct ...R&D in the country.

More than 50 percent of all engineering doctoral degrees awarded by U.S. engineering colleges are to foreign nationals. However, security concerns in the United States are reducing the number of foreign students, while competition for this talent from other countries and the opportunity to return to their home countries to work is increasing.

The number of engineering degrees awarded in the United States is down 20 percent from the peak year of 1985. Out of the 1.1 million high school seniors in the United States who took a college entrance exam in 2002, just under 6 percent indicated plans to pursue a degree in engineering — nearly a 33 percent decrease in interest from the previous decade.

As the baby boom generation ages, more than 50 percent of the current science and engineering workforce is approaching retirement.

The current local, state and national focus that No Child Left Behind has brought to closing the achievement gap between majority and minority students was long overdue and is beginning to pay off.... However, education reform, while necessary, is insufficient to address the problem.

As World War II was drawing to a close, Congress approved the GI Bill, which provided billions of dollars in education and training benefits to nearly 10 million veterans.... The return to American taxpayers on that investment has been incalculable. This generation

¹ AeA, Business Roundtable, Business-Higher Education Forum, Computer Systems Policy Project, Council on Competitiveness, Information Technology, Association of America, Information Technology Industry, Council Minority Business RoundTable, National Association of Manufacturers, National Defense Industrial Association, Semiconductor Industry Association, Software & Information Industry Association, TechNet, Telecommunications Industry Association, and U.S. Chamber of Commerce.

now faces an entirely new challenge, both at home and abroad... What we are lacking at the moment is not so much the wherewithal to meet the challenge, but the will.

TAP Recommendations

- 1. *Build public support for making science, technology, engineering and math improvement a national priority.*** Implementing actions include launching a campaign to help parents, students, employees and community leaders understand why math and science are vital to individual success and national prosperity.
- 2. *Motivate U.S. students and adults to study and enter science, technology, engineering and mathematics (STEM) careers, with a special effort geared to those in currently underrepresented groups.*** Implementing actions include creating more scholarships and loan-forgiveness programs for students who pursue STEM degrees (including students who plan to teach math and science) by building on existing programs such as Defense Department's Science, Mathematics and Research for Transformation (SMART) and the NSF's Robert Noyce Scholarships. Increasing the retention rate of STEM undergraduates is also a key leverage area.
- 3. *Upgrade K–12 math and science teaching to foster higher student achievement.*** Implementing steps include promoting market- and performance-based compensation and incentive packages to attract and retain effective math and science teachers and launching a "Math Next" initiative as a logical next step to the U.S. Department of Education's focus on "Reading First."
- 4. *Reform visa and immigration policies to enable the United States to attract and retain the best and brightest science, technology, math and engineering students from around the world to study for advanced degrees and stay to work in the United States.*** Implementing steps include providing an expedited process to obtain permanent residence for foreign students who receive advanced degrees in STEM fields at U.S. universities and ensuring that foreign students who want to study STEM fields at U.S. universities can obtain the necessary visas by clearing Department of Homeland Security requirements in a timely manner.
- 5. *Boost and sustain funding for basic research, especially in the physical sciences and engineering.*** Reverse declines in the federal share of total R&D spending, particularly for basic research in the physical sciences and engineering at the NSF, National Institute of Standards and Technology (NIST), U.S. Department of Defense basic research programs [6.1 and 6.2 programs] and U.S. Department of Energy Office of Science, by adding a minimum of 7 percent per year to enable research to keep up with growth and inflation.

As a first step, all of the federal Cabinet secretaries with a stake in this issue — Defense, Education, Homeland Security, Commerce, Labor and Energy — should convene to map out how they can best mobilize to address the problem.