RENSSELAER POLYTECHNIC INSTITUTE

THE COLLEGE BOARD REVIEW, NO. 210, WINTER/SPRING 2007

Waking Up to the "Quiet Crisis" in the United States

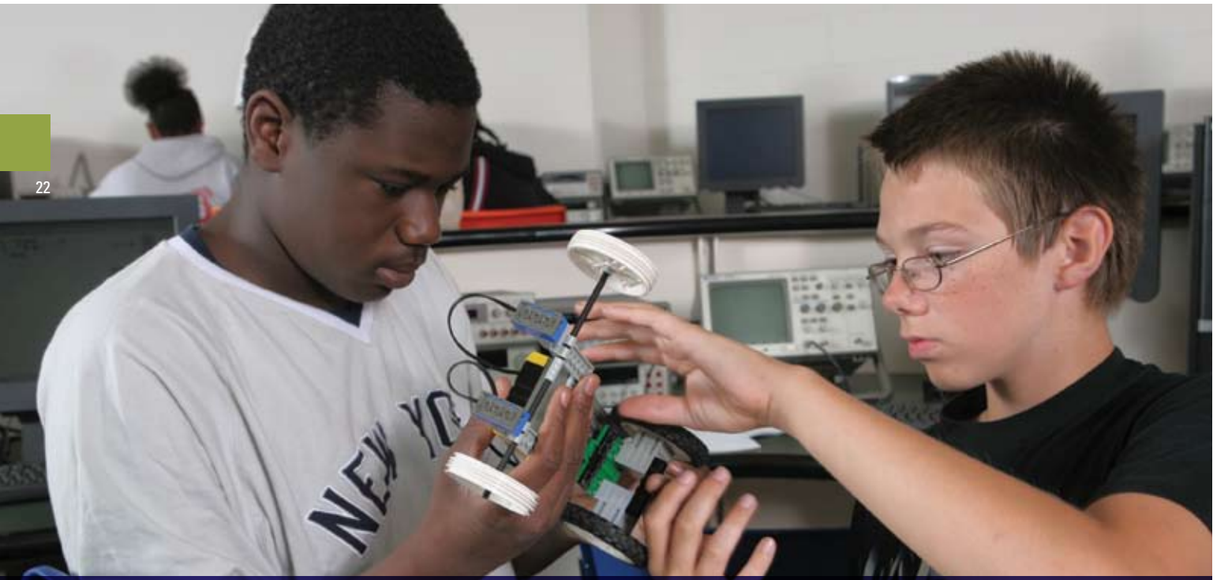
It's Time for a New Call to Action

By **Shirley Ann Jackson**

The launch of the Soviet satellite, *Sputnik,* in 1957, followed by the history-making flight of a cosmonaut in 1961, set in motion a space race that was transformational well beyond the success of the first steps taken by Neil Armstrong onto the surface of the moon at the end of the decade.

President John F. Kennedy issued a call to action in May 1961, urging that the United States rally its intellectual, industrial, and economic resources to put a man on the moon before the end of the decade. The Congress and the country responded. The wave of activity that followed included an intensive focus on identifying and providing the necessary science-and-math-focused educational supports for elementary, middle, and high school students—students like me—all across the country. These supports included teachers at the kindergarten to twelfth-grade levels receiving intensive training in science or math. New programs were created and resources provided to guide students who demonstrated talent and interest in math and science into and through college. Their study was made possible by federal support, and their laboratories were funded by research grants. Those who excelled were held in high regard by society for their interest and intellect.

Shirley Ann Jackson is president of the Rensselaer Polytechnic Institute. Before her appointment, she served as chairman of the U.S. Nuclear Regulatory Commission. Recently she received the 2007 Vannevar Bush Award for her achievements in scientific research and contributions to public policy.



Examples of Rensselaer Polytechnic Institute (RPI)'s outreach: Middle school students work on their robot entry for the FIRST LEGO League tournament, sponsored by General Electric and RPI's Center for Initiatives in Pre-College Education. RPI students are mentors in the competition.

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The young American students who responded in record numbers to Kennedy's appeal became the engineers, mathematicians, and scientists who have comprised the backbone of our innovative economy for the last 40 years. Their ingenuity, along with that of the students who came from abroad to study and work in the United States, strengthened our economic and national security for a generation. This generation of researchers, teachers, and inventors explored not only the outer reaches of space but also the inner workings of the human body, the far reaches of the earth, and the new horizons opened through information technologies. In so doing, they have made exponential advances in an extraordinary number of fields including health, communications, and transportation. The advances have changed how long we live, where we live, and the way we live.

THE SCALE OF THE PRESENT CRISIS

But now, these scientists and engineers are about to retire in record numbers. As I first warned in a 2002 report, *The Quiet Crisis: Falling Short in Producing American Scientific and Technical Talent,* a quarter of the current science and engineering workforce—whose research and innovation generated the economic boom in the 1990s—is more than 50 years old and will have left the workforce by 2010. There are not enough students being prepared in the education pipeline to replace them.[1]

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Leaders in a range of private industries are worried. The American Nuclear Society warned in June 2006: "By 2000, knowledge retention, education, and workforce planning evolved as major issues facing the nuclear industry.... by 2004, the average age of nuclear workers was 48, with 28% eligible to retire within five

A taste of things to come? Two eleventh-graders attend Design Your Future Day at RPI. The aim of the program is to give female high school students a feel for a college with science and engineering curricula.

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years." They and others have raised concerns about the potential of "severe shortages of qualified workers to maintain the safe and reliable operation of commercial and defense nuclear power plants."[2]

The looming trouble extends to the public sector at all levels. Officials in federal agencies with a stake in the science, technology, engineering, and mathematics (STEM) workforce, particularly the U.S. Departments of Education, Homeland Security, Commerce, Labor, Energy, and Defense have voiced their concerns. In August 2005, then Deputy Under Secretary of Defense Michael W. Wynne,[3] speaking at a Defense Advanced Research Projects Agency (DARPA) Systems and Technology Conference, noted that the U.S. Department of Defense, along with the vast defense industry, must fill vacant STEM positions with top secret "cleared" or "clearable" STEM professionals (restricted to U.S. citizens). He readily acknowledged the increasing difficulty of doing so. A November 2006 report from the Task Force on the Future of American Innovation notes that "Nearly one-third of the civilian scientific and technical workforce in the Department of Defense (DoD) is currently eligible to retire." The report also predicts that the percentage may rise to nearly 70 percent over the next seven years, and that at least 13,000 DoD laboratory scientists are likely to retire within the next decade, while more than one-quarter of the current aerospace workforce will be eligible to leave by next year.[4] As a June 2006 U.S. House of Representatives Science Committee overview documented, "More than 30 percent of NASA's employees are currently eligible for regular or early out retirement. NASA estimates that by 2011, 28 percent of its engineers and 45 percent of its

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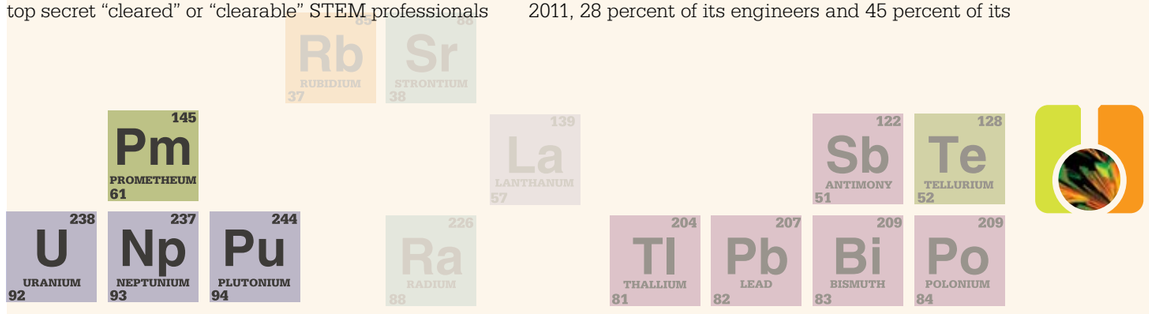
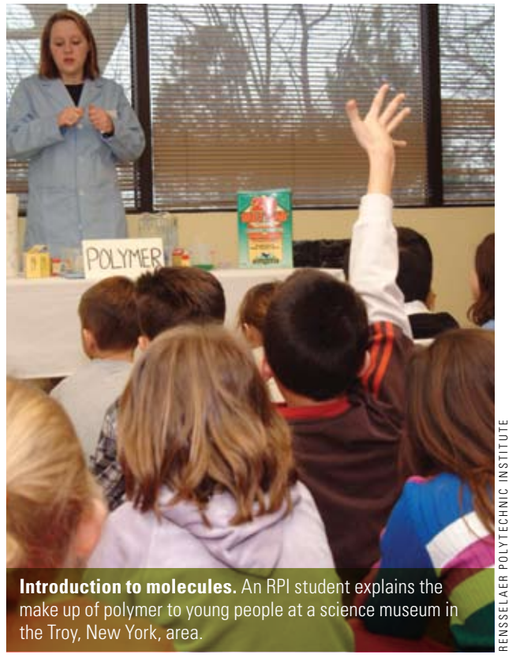


scientists will be eligible to retire. . . . less than 20 percent of NASA's overall workforce is under 40, and less than 10 percent of NASA's scientists are under 40."[5]

At the same time, fewer international students, scientists, and engineers are coming to study and to work in the United States as visa policies have shifted and, increasingly, as opportunities are opening to study and work abroad. At home, not enough young Americans are being excited and prepared to pursue science, technology, engineering, and mathematics (STEM) subjects.

I have described this looming science, engineering, and technology workforce gap as a "quiet crisis" because it is creeping up on us. The danger is in waiting to address the crisis until it is upon us, because then—due to the cumulative, decades-long nature of the education of a scientist or engineer—it will be too late. We must wake up to the crisis because the United States's capacity for innovation is inextricably interlinked with our economic and national security. Failure to act soon will undermine our national capacity for innovation, thereby threatening our economic well-being, safety, and global leadership.



Introduction to molecules. An RPI student explains the make up of polymer to young people at a science museum in the Troy, New York, area.

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ADDRESSING THE PROBLEM

In the public discussion on competitiveness and global leadership, every sector—universities, corporations, governments at all levels, nonprofit organizations, and professional organizations—are being asked to participate in fundamentally new, expanded, and collaborative ways.

Universities have the primary responsibility to educate the next generations of scientists and engineers, drawing students nationally and from abroad. Universities are also critically important in generating knowledge and in the exploitation of innovation—fostering ideas by moving discoveries from the lab to the marketplace; and creating new, globally competitive enterprises that are often linked to regional economic development. Sustaining and enhancing the role of universities as centers of innovation are contingent on three key factors.

The first is funding for basic research. While the United States still spends more money than any other nation on research and development, spending for basic research in physics, mathematics, computer sciences, and engineering has decreased steadily, as a percent of GDP, since 1970. Overall, U.S. research spending has been stagnant, while other nations are increasing their research capabilities. China, for instance, doubled its research spending from 1995 to 2005.[6] Despite broad bipartisan support for an agenda fostering innovation, not enough federal resources have been made available to fund the agenda. The president's proposed budget for FY 2008 does call for select increases in research funding, primarily in the physical sciences, but the overall federal investment in basic and applied research would fall 2 percent from the 2007 total because the select gains would be more than offset by cuts in other research funding. According to analysis by the American Association for the Advancement of Science, (AAAS), the federal research investment in real terms would fall for the fourth year in a row, after peaking in 2004.

The second factor is educational excellence. The university enterprise prepares, as it always has, the next generations to sustain and advance human society, to create knowledge, to propel discovery and innovation—to educate individuals who add value to society. To meet the demands of the flattening world in which competition for economic opportunity in the global marketplace is more equal across nations than ever before, universities must educate our young people along an innovation continuum, or what we at Rensselaer Polytechnic Institute call an entrepreneurial continuum—from grounding in basic concepts, to immersion in deep, open-ended problems in research and design, to the exploitation of new ideas through the incubation and venture funding of both new and existing enterprises. Our universities must educate students to become technologically and culturally sophisticated individuals who can understand and solve complex problems, individuals with multicultural understanding who can operate in a global context, and individuals with intellectual agility who can see connections between disciplines and among sectors across a broad intellectual milieu. We must also reach back into the K–12 system to assist in expanding the number of young people in the STEM pipeline. At Rensselaer and in higher education institutions across the country, there are excellent models that work to improve the quality of K–12 math and science teaching, and other programs targeted directly to students that inspire and assist in preparing these young people to study in the STEM fields at the collegiate level.

Fighting the "quiet crisis." Jackson has promoted RPI's involvement with area schools.

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The third factor is the need to tap the new majority of young women and ethnic minority groups, who are both underrepresented in the STEM professions. If we are going to succeed in filling the emerging gap in engineering and science talent, the United States cannot continue to ignore the 30 percent of the population represented by ethnic minorities in this country, and women who, together with minorities, comprise the underrepresented majority of the STEM workforce. We must begin to engage the complete talent pool.

FROM DISCUSSION TO ACTION

The first step in addressing the nation's quiet crisis was to wake people up to the problem. For the last several years, I and others in education, industry, and government have called for a national conversation to develop a national strategy to address the competitiveness challenge and commensurate workforce gap issues, and the national will to realize the strategy. The conversation on a national innovation agenda is now under way. A flurry of reports with which I have been involved over the last few years, by corporate, academic, and government entities, has warned of the consequences if we fail to act.

Through policy forums, issue papers, and annual conferences, the AAAS focused attention on the issue in Washington, D.C., and around the country during the two years of my tenure first as its president (2004) and then as chairman of the board (2005).

In 2004, the Council on Competitiveness issued a report from its National Innovation Initiative that declared, "innovation will be the single most important factor in determining America's success through the 21st century…", and that "…over the next quarter century, we must optimize our entire society for innovation…." Not mincing words, our call to action is subtitled *Innovate or Abdicate*.[7]

In the 2006 National Academies report *Rising Above the Gathering Storm,* we noted:

> The United States takes deserved pride in the vitality of its economy, which forms the foundation of our high quality of life, our national security, and our hope that our children and grandchildren will inherit ever-greater opportunities. That vitality is derived in large part from the productivity of well-trained people and the steady stream of scientific and technical innovations they produce. Without high-quality, knowledge-intensive jobs and the innovative enterprises that lead to discovery and new technology, our economy will suffer and our people will face a lower standard of living. Economic studies conducted even before the information-technology revolution have shown that as much as 85% of measured growth in U.S. income, per capita was due to technological change.[8]

A 2005 report by 15 of the nation's most prominent corporate chief executive officers—spearheaded by the Business Roundtable—also expressed deep concern about the United States's ability to sustain its scientific and technological superiority through this decade and beyond," and asked that the issue be a national priority, supported by national and state investments in research and innovation to strengthen U.S. competitiveness in the worldwide economy.[9]

I argue that the answer to sustaining our nation's capacity for innovation lies in responding to the global energy challenge. Addressing the world's energy needs is the central challenge of our time. Our nation's energy security is inextricably linked with our economic and national security. We must diversify energy sources. We must develop innovative global energy solutions. To do this we must unleash the human talent needed to achieve critical innovation. In other words, we must have the will, the way, and the workforce. I am concerned that, although the United States is certainly up to the challenge, this nation is not responding with the focused intensity and comprehensive long-term strategy that the issue demands.

In urging the Congress and the country to support his call to invest the necessary national resources to put a man on the moon before the end of the decade, in his May 25, 1961, Message to the Congress, President Kennedy said, "I believe we possess all the resources and talents necessary. But the facts of the matter are that we have never made the national decisions or marshaled the national resources required for such

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RPI students, here and above right, inspect the progress of robots for the FIRST LEGO tournament.

leadership. We have never specified long-range goals on an urgent time schedule, or managed our resources and our time so as to insure their fulfillment."[10]

JOINING A NEW RACE

Just as President Kennedy galvanized the nation around the space race then, so too could the president and the Congress rally around energy security now. We are in the midst of global competition and global geopolitics now, just as we were then. The clock is ticking now, just as it was then. We must marshal the nation's resources

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now, to focus on the challenges, the opportunities, and the agenda to accelerate energy security, and, in particular, energy innovation. We cannot just drill our way to energy security, we must innovate our way to energy security. True energy security will require innovation in the discovery, extraction, and transportation of fossil fuels; innovation in conservation; and innovation to develop alternative energy sources that are reliable, cost-effective, safe, and environmentally benign. Innovation, particularly on this scale, requires consistent investment in research and development, and consistent investment in human talent—i.e., in the "intellectual security" of a robust American science and engineering workforce.

In the 109th Congress, bipartisan coalitions in both the U.S. House of Representatives and the U.S. Senate introduced more than a dozen bills to improve America's ability to compete in the global economy. A range of energy initiatives were also proposed. The president outlined his American Competitiveness Initiative and introduced his Advanced Energy Initiative. The National Governors Association has designated innovation as its priority issue this year, and many governors are focusing on the energy challenge. The proposals encompass a broad spectrum of policies and approaches, from R&D tax credits, to increased funding for basic research in the physical sciences, to upgrading math and science teaching. They range from support for energy conservation and new energy exploration and extraction options, to the discovery of energy alternatives—all designed to expand our innovative capacity and address our energy needs.

As the 110th Congress convenes in 2007, it is time to move from proposals to action. All of the reports, which address the "quiet crisis" agree with the need for action, and they all point in the same direction—the prompt development and implementation of a national strategy to ensure our intellectual security, which is the root of our energy security, our national security, and ultimately, our global security.

Indeed, energy security is the space race of the twenty-first century. ■

ENDNOTES

1. *The Quiet Crisis: Falling Short in Producing American Scientific and Technical Talent,* by Shirley Ann Jackson, President, Rensselaer Polytechnic Institute, for *BEST (Building Engineering & Science Talent).* Page 2.
2. *Maintaining a Viable Nuclear Industry Workforce,* Position Statement of the American Nuclear Society, Revised June 2006. Page 1.
3. Remarks by Michael W. Wynne, Principal Deputy Under Secretary of Defense, Acquisition, Technology, and Logistics: "The Future of Ideas." DARPATech 2005, Anaheim, California. August 10, 2005. He had been nominated to be named Secretary of the Air Force, and subsequently was confirmed.
4. *Benchmarks of Our Innovation Future,* Report of the Task Force on the Future of American Innovation, November 2006. Page 21.
5. U.S. House of Representatives, Science Committee, Charter for Hearing, June 13, 2006.
6. *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future,* Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology and Committee on Science, Engineering and Public Policy, National Academy of Sciences, National Academy of Engineering, Institute of Medicine of the National Academies.
7. *Innovate America.* National Innovation Initiative Summit and Report. Council on Competitiveness, December 15, 2004.
8. *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future,* Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology and Committee on Science, Engineering and Public Policy, National Academy of Sciences, National Academy of Engineering, Institute of Medicine. Report of the National Academies, February 2006, Page ES-1.
9. *Tapping America's Potential: The Education for Innovation Initiative,* Business Roundtable, July 2005, Page. 2.
10. "Special Message to the Congress on Urgent National Needs," President John F. Kennedy, delivered in person before a joint session of the Congress, May 25, 1961.