On the Offense for Science and Technology Education*

Reinvesting in a New National Defense Education Act

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Lloyd Berkner, the eminent American physicist who would go on to develop the Distant Early Warning System that spread across North America's Arctic shoreline to detect incoming Soviet missiles, cleared his throat, clapped his hands for attention, and then asked for silence:

"I wish to make an announcement. I've just been informed by the *New York Times* that a Russian satellite is in orbit at an elevation of 900 kilometers. I wish to congratulate our Soviet colleagues on their achievement."

The night was October 4, 1957, a time remembered forever as "Sputnik Night." That night marked a crucial turning point in history, a milestone of collaboration between politics and science, setting the groundwork for the growth of the scientific industry to emerge into the powerful embodiment it is today. Less than a decade before, science was low in public perception. Then on October 4, 1957, the need for a reprioritization of science and technology rightfully and finally took center stage.

In many ways, "science fiction" has become simply "science" over the past 50 years. The need to recommit focus, resources, and community resolve in the same energetic manner that America showed when it reacted to Sputnik has never been more necessary. Having decisively won the space race, America now faces threats to its national security – including terrorism and chemical, biological, radiological, and nuclear attack – that are fluid and persistent in nature, demanding a flexible and evolving response that recognizes the critical nature of advanced science and technology graduates. A collective (and truly historic) about face on science and technology education funding is as necessary today as it was 53 years ago this month. But that's not enough. The reason: We face not just a science-funding crisis but also the absence of a holistic *technology*

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strategy that recognizes that advances in efficiency and effectiveness can double as advancement in our national security, alongside myriad problems that only long-term dedication to the advancement of scientific inquiry can tackle in the coming decades.

This was true as well half a century ago, which is why it's important to understand how we as a people and our government reacted to the Soviets' space gambit in October 1957. As you'll see, there are important lessons here that apply equally today.

From Panic to Resolve

The initial American response to Sputnik was panic. Sen. Lister Hill (D-AL) passionately described the perceived initial loss in the new "Space Race" represented by Sputnik as "a severe blow, some would say a disastrous blow, at America's self-confidence and at inner prestige in the world." Sputnik represented a symbol of Soviet technological superiority, but also a major psychological blow to the U.S. 'ego' as well as a terrifying military threat.

While literary journals spoke of America's loss of "intellectual prominence," the more widely circulated newspapers and magazines emphasized a more menacing issue: Sputnik was a symbol of a new and unprecedented military threat to the United States. The *Chicago Daily News* declared that if the Soviets "could deliver a 184-pound 'moon' into a predetermined pattern 560 miles out into space, the day is not far distant when they could deliver a death-dealing warhead onto a predetermined target almost anywhere on the earth's surface."

Newsweek magazine dolefully predicted that several dozen Sputniks equipped with nuclear bombs could "spew their lethal fallout over the U.S. and Europe." The launch of Sputnik II a month later, on November 3, 1957, ended any slim public perception of short-term American parity in the emerging Space Race. As the United States was still struggling to launch its so called International Geophysical Year scientific satellite, Vanguard, weighing 3.25 pounds, Sputnik II weighed 1,118 pounds and carried a live animal, a dog named Laika.

Correspondent Benjamin Fine reported in *Time* magazine that "the Soviet Union is far outstripping the United States in its emphasis on technical and scientific education." To counteract this gap, Congress passed the *National Defense Education Act* in 1958. NDEA appropriated $47.5 million in student loans for 1958 (valued at more than $352 million in 2009 dollars), with expenditures budgeted to exceed $100 million by 1962. Preference in loans was given to those studying science, engineering, or foreign languages.

Also, over the next four years nearly $300 million dollars (valued at $2.2 billion in 2009 dollars) went to fund the purchase of scientific equipment and the establishment of

National Defense Fellowships for graduate students. Considering other provisions, NDEA allocated approximately $1 billion in funds ($7.4 billion in 2009 dollars) to support research and education in the sciences over those four years. As a result of NDEA, federal support for science-related research and education increased by between 21 percent and 33 percent per year through 1964.

The enormous shock of Sputnik also spurred the establishment of the National Aeronautics and Space Administration in 1958 to conduct the United States' civilian space efforts. With NASA, the United States and the Soviet Union began a duel for control of the ether, the so-called Space Race that consumed both nations for the next 11 years, finally ending only when Neil Armstrong first stepped foot on the Moon on July 20, 1969.

An examination of the decades after Sputnik shows that investment in abstract science and technology education and overall research did yield tangible, valuable results. Technology developed in relation to this endeavor yielded immediate practical benefits. Within only one year after Sputnik's launch, the foundation was laid for technologies and communications that are considered matter-of-fact today. By the end of 1958 the first integrated chip was developed by Texas Instruments and Fairchild Semiconductor; the USS Nautilus passed under the North Pole; the first Boeing 707 transatlantic service was inaugurated by British Overseas Air Corp; and President Eisenhower's Christmas address was the first voice transmission from a satellite.

The next year continued to yield results. Motorola produced the first two-way fully transistorized radio. Project Mercury astronauts began training. COBOL, one of the first advanced programming languages, was developed. And computers moved beyond primary use for government projects into other applications such as oil refining and electricity generation. In 1960, computerized typesetting was introduced, the laser was developed by Theodore Maiman, and the Echo I communications satellite was launched.

Obviously, the legacy of the NDEA did not stop in the decade which ended in the moon walk. Technologies developed in that era continued to expand and exceed everyone's expectations. In many ways, "science fiction" has become simply "science" over the past 50 years. One case in point: Techniques originally designed to detect elementary particles are now applied to the collection of solar energy, resulting in a system much more efficient than previous designs. In another instance, work begun at the Fermi National Accelerator Laboratory has been appropriated by the medical industry in developing "neutron therapy" for cancer patients.

A final way in which the Sputnik-inspired NDEA philosophy toward science and technology funding left a tangible mark was in the training of capable scientists, engineers, technicians, and computer programmers who set the highest standards of excellence in higher education and industry. Many began in abstract science, but eventually defected to applied research or industry at a rate of over 60 percent. The result is that the pool of highly-trained scientists and technical specialists available to work on applied problems became much larger than it would have otherwise.

A New Resolve

Our nation needs another concerted push in this same direction today. But it should not have to begin because of another nation's "Sputnik." We need to spur a renewed interest in reestablishing the standard of excellence in science and technology in the United States for our economic and national security. Consider the following data on how America compares to the rest of the world in various scientific and educational rankings.

We are

- 39th in the world in percent of Gross Domestic Product spent on education—at 5.7 percent
- 12th among nations for the duration of compulsory education—at 12 years.
- 22nd among the 33 member nations of the Organisation for Economic Co-operation and Development (OECD) in test scores for 15-year-olds in International Assessment of Educational Progress Science examinations.
- 27th among member nations of the OECD in test scores for 15-year-olds in IAEP Math examinations

These are dismal sets of statistics on the state of our nation's science and technology education, and they are by no means exhaustive. Clearly more money is needed to turn the situation around—the Association of American Universities boasts a specific plan on their website to bring back the National Defense Education Act—but this is about more than money. Beginning immediately and with eyes firmly focused on the long haul, our nation needs to conduct a sweeping national dialogue about how we can reinvest energy and resources into science and technology education. And the result should be a true public-private partnership with a national goal in mind akin our sudden quest to "beat the Soviet Union," reprioritize science and technology learning, and focus on landing on the Moon a decade later.

The Moon, computers, telecommunications, and other 21st century technologies, of course, seem like easy targets today. So what should be our science and technology goals

50 years later? Expanding greater interest in science and technology among students; increasing percentage points in science and math scores; pouring more money into education would be helpful. The current national security environment does not provide a single technological target with the inspirational resonance of an orbiting Soviet satellite or a trip to the Moon. But the consequences of continued lethargy are perhaps more dire than in the 1950s. The United States must commit itself to developing the science and technological foundation necessary to meet the security threats posed not only by the terrorists and weapons of today but those of the next decade, as well. We must fight the “next” war while concurrently fighting the war we face “today.”

On the immediate horizon, for example, the Science & Technology Directorate of the U.S. Department of Homeland Security has identified several immediate and long-term goals necessary for our nation’s security. These include: technological solutions to improve border security, including a reliable and easily-portable means to inspect cargo for dangerous or contraband materials and real-time biometric scanners with identity verification capabilities. Secure internet protocols, cyber attack modeling, and threat detection modeling are necessary to improve cyber security and protect critical infrastructure and data. If our nation, for instance, was able to made significant improvements in both the content and the technology of our communications networks we would be able to more efficiently and effectively link first responders at the federal, local, and state first responders in the event of an attack.

Strengthening our national security by preventing terrorist attacks and increasing response capabilities does not present a single, finite goal – the challenge is constantly improving and enhancing our capabilities to be prepared to prevent or respond to an ever-changing threat matrix. What we can do now is recognize these needs and realize that the progress that science and technology has afforded us also comes at the price of defending both those advances and our way of life. We should be able to look back in, say, five years and remark, as college football coach Lou Holtz once did when reflecting on the progress of his team: “We’re not where we want to be. We’re not where we should be. But thank goodness we’re not where we used to be.”