Have We Hit A "Sputnik"Moment Again?

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Many (myself included) speak of October 4, 1957 as a day the world changed. Catching the world by surprise, the Soviet Union successfully launched an artificial "moon" into orbit around the Earth. This 84 kg metal basketball contained radio transmitters that sent signals received by millions of people around the world as it passed overhead.

More important (perhaps) than the pioneering achievement of the Soviet Union was that Sputnik highlighted the fact that the United States was apparently not the world leader it thought is was in STEM skills (Science, Technology, Engineering, and Mathematics). Since we saw the Soviets as a threat (and they saw us the same way), it became a matter of national importance to "do something" about our educational system to address the need for more scientists and engineers, and to do it quickly.

For example, a few weeks after Sputnik's launch, President Eisenhower gave a powerful speech that set forth, in no uncertain terms, the challenge we faced, and the need to do something about it. In a speech he gave on November 13, 1957, he said:

> "The Soviet Union now has – in the combined category of scientists and engineers – a greater number than the United States. And it is producing graduates in these fields at a much faster rate.
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> Recent studies of the educational standards of the Soviet Union show that this gain in quantity can no longer be considered offset by lack of quality.
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> This trend is disturbing. Indeed, according to my scientific advisers, this is for the American people the

most critical problem of all.

My scientific advisers place this problem above all other immediate tasks of producing missiles, of developing new techniques in the Armed Services. We need scientists in the ten years ahead. They say we need them by thousands more than we are now presently planning to have.

The Federal government can deal with only part of this difficulty, but it must and will do its part. The task is a cooperative one. Federal, state and local governments, and our entire citizenry must all do their share".

He issued a clear call to action. As a former president of Columbia University, he knew the importance of a well-educated populace in meeting the needs of modern society. Instead of "speechifying" about a topic and then doing nothing, the response to this clear challenge was strong and rapid.

In an article providing the history of one tremendously effective educational program (called PSSC, the *Physical Sciences Study Committee* formed in 1956 by MIT Professor Jerrold Zacharias), Arnold Strassenberg explores the role of federally funded research on educational methodologies that, once implemented, had a tremendous impact on students, both in terms of content and in developing and nurturing the kinds of long-term interest in the subjects that led to an increase in students seeking advanced degrees leading to careers in these fields (www.compadre.org/portal/pssc/docs/Strassenberg.pdf).

As he says in his paper:

"Most important, PSSC did what is essential to any quality curriculum reform project: It assembled a team of competent scientists who were willing to sacrifice their professional output for a few years in order to contribute to what they saw as a higher cause. Prior to PSSC, most high school science texts were written by people who had no deep education in or knowledge of science. Imagine what this change alone contributed to the accuracy and relevance of the PSSC materials!

A second feature that made the PSSC course different from most of its predecessors was its cohesiveness. A story line was created that spun together mechanics, electricity, optics, thermal physics, and modern physics into a seamless whole. Never before had it been so clearly exhibited that all topics in physics are linked through a small number of governing principles such as the Conservation of Energy.

Another aspect of how PSSC served as a great model for other projects was the scope of the materials that were produced. There was, of course, a textbook. Even more important, the PSSC leaders understood that the laboratory is where students begin to understand and appreciate the methods of science – not only how to make accurate measurements, but to recognize that the results of those measurements determine whether speculations about the way the natural world works are true or false. So lab manuals were key.

By no means did it end there. The PSSC leaders arranged for the production of many films. The quality of these films permitted a major leap forward for physics teachers. As a college physics professor, I used PSSC films often, preferring them to any other audiovisual materials then available. In my view, the use of PSSC films was the only was to help my students learn physics that was as effective as my lectures.

> Finally, the PSSC fathers stimulated the production of dozens of short, paperback books on science topics such as *The Restless Atom* and *Watching for the Wind*. This collection of books, known as the Science Study Series became – for many young students – more fun to read than science fiction or comic books.
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> One other characteristic of the way PSSC did business was worthy of emulation. Summer institutes were organized – supported by NSF – for the express purpose of helping high school teachers of physics to become familiar with the thinking behind the PSSC course and the panoply of materials available for its implementation. Once again, it was crucial to the success of this program that competent physicists agree to direct these summer programs."

The reason for this history lesson is to remind us of a time when we had the courage to change education in meaningful ways. As a beneficiary of the PSSC curriculum, I went on to become a scientist/engineer and, with similarly educated children of the October Sky, played a role in the invention of some core technologies we now take for granted.

Let me be clear. We have reached our second Sputnik moment, and we ignore it at our peril.

The fact is that we are facing a challenge today that is at least as powerful as the one we faced with the launch of Sputnik. While the US sharply increased the number (and quality) of graduates in the sciences and engineering fields after Sputnik, this number has declined in recent years. For example, after peaking at about 80,000 engineering graduates from US institutions in 1985, the number has dropped to about 65,000 degrees per year today.

At this point, you might be expecting me to bring up competitive threats from other nations, especially China and India. In fact, these countries' achievements are not the reason we need to address the challenge – at least not by themselves. We need to develop all the talent we can independent of what other countries are doing. Just about every topic on our current hot list (health care, gas prices, global climate change, *etc*. requires a highly educated group of people to address – people we simply don't have.

For example, we are about to lose a significant number of engineers to retirement as the baby boomers finish up their active careers. As of 2008, 15% of Boeing's engineers are eligible for retirement. Similar numbers can be found in other industries. This does not even begin to address the talent needed for new or growing ventures, nor does it address the need for the general public to understand science well enough to help shape policy on topics like health care and global climate change. Compound this challenge with the fact that immigration policy is forcing many graduates from US colleges and universities to return to their home countries instead of helping build the economy and address the challenges of the nation where they were educated.

In short, as Eisenhower said, "We need scientists in the ten years ahead. They say we need

them by thousands more than we are now presently planning to have."

In raw numbers, the challenge exceeds that faced by Sputnik. After all, the US space program got on track pretty rapidly, and was able to achieve greatness with the talent we already had. The deeper issue had to do with meeting long-term needs. In this regard, we were successful: The personal computer, graphical user interface, Ethernet, Internet, laser printer, cell phone, and almost every other gadget you've got on your shelf or in your pocket was initially invented by a child of the October Sky. Unless we take our current challenge seriously, we risk facing a future even more difficult than the present. Many in the United States are fearful that this may be the first generation for which our children will not exceed the standard of living attained by their parents. *This is a sign of a nation in decline – and is a far greater problem than having some other country toss a tin can into space so it can send beeps to our short-wave radios.*

When Sputnik was launched we had the makings of a perfect storm:

1. A singular event captured the attention of the populace
2. A president gave a forceful speech and built a policy to address the issue
3. A powerful curriculum for high school education was already developed and ready to roll out

As for the third item on the list, there is a growing consensus that effective pedagogical models exist, and are ready to be put into the hands of educators once the schools are ready to meet the needs we currently face. These models are not a resurgence of the PSSC curriculum, but are built on the growing understanding the inquiry-driven project-based learning that is proven (according to the National Academy of Science *Rising Above the Gathering Storm* document) to have positive impact on the acquisition of STEM skills and the building of an appreciation for these skills that can lead to more students pursuing these fields in post-secondary education. In short, we have the tools we need to do an even better job than we did in the late 1950's.

For example, Chip Bruce has done a wonderful job with the Inquiry Page (inquiry.uiuc.edu) at the University of Illinois, and our own effort (www.tcse-k12.org) contributes to the cause, along with the efforts of numerous others. We don't need new theories, we just need to implement what we already know works with our children. And (most importantly) we need to stop doing things that don't work.

If we grant that we have powerful ways to address educational change, it remains to transform the country's mindset. It seems that rampant anti-intellectualism used to be the order of the day. The seeming distrust of "eggheads" is in stark contrast to the thinking we were shocked

into by the events of October, 1957.

Fortunately, those days are over. On April 27, 2009, President Obama gave a dynamic and far-reaching speech that will stand as this generation's call to action, mirroring the groundbreaking speech by Eisenhower over fifty years ago. In his speech, President Obama made his case in no uncertain terms:

> "A half century ago, this nation made a commitment to lead the world in scientific and technological innovation; to invest in education, in research, in engineering; to set a goal of reaching space and engaging every citizen in that historic mission. That was the high water mark of America's investment in research and development. And since then our investments have steadily declined as a share of our national income. As a result, other countries are now beginning to pull ahead in the pursuit of this generation's great discoveries.
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> I believe it is not in our character, the American character, to follow. It's our character to lead. And it is time for us to lead once again. So I'm here today to set this goal: We will devote more than 3 percent of our GDP to research and development. We will not just meet, but we will exceed the level achieved at the height of the space race, through policies that invest in basic and applied research, create new incentives for private innovation, promote breakthroughs in energy and medicine, and improve education in math and science.
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> This represents the largest commitment to scientific research and innovation in American history.
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> ...since we know that the progress and prosperity of future generations will depend on what we do now to educate the next generation, today I'm announcing a renewed commitment to education in mathematics and science. This is something I care deeply about. Through this commitment, American students will move from the middle of the top – from the middle to the top of the pack in science and math over the next decade – for we know that the nation that out-educates us today will out-compete us tomorrow. And I don't intend to have us out-educated."

There are dedicated educators and educational leaders throughout the country who do grasp the challenges confronting us. They deserve all the help they can get, and we are committed to helping them provide the talent that will invent our future. And, while this grass-roots effort is gaining adherents, we need to encourage our government to make the deep systemic changes that will provide all children with the kind of education they need to thrive in the coming years.

Our leadership is serious about this task. The development of an effective STEM education that reaches from elementary to high school and beyond forms the foundation of our work, and we encourage others to join in this critical cause.

Our future depends on it.