Testimony to
the House Science and Technology Committee
Subcommittee on Research and Science Education

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Mr. Chairman and members of the subcommittee, thank you for inviting me today. I am honored to be speaking on behalf of the Aerospace Industries Association (AIA), the premier trade association representing the nation's major aerospace and defense manufacturers and their more than 631,000 high-wage, highly skilled employees; its Workforce Steering Committee, which I chair; and my employer—The Boeing Company. But I also come before the Committee with a background that spans more than a decade of engagement on education and science, technology, engineering, and math (or STEM initiatives). I have participated in shaping actions with the National Science Resource Center, National Association of Educators, the Business–Higher Education Forum, and the American Indian Science and Engineering Society. Additionally, I have engaged researchers and scientists in brain research on what motivates students and am a regular speaker on this topic. I say this not to boast but to describe what I believe is a background necessary to integrate a number of issues and actions that impact the topics you are addressing today—Undergraduate and Graduate STEM education, and, equally important, how to improve these areas and increase the number of students who choose STEM-related fields as majors and elect technology careers as their vocation.

Let me also provide a perspective that I believe is important to set a framework and context. In 1983, a blue-ribbon panel completed a seminal piece of work called "A Nation at Risk," which set the tone and framework for improving education in America. While it focused on primary and secondary education, I believe this work is directly related to today's topic. Today, nearly 27 years later, I contend that we are no longer a "Nation at Risk"; we are a "nation falling further behind"—this despite the fact that, as a nation, we spend more money on education at a total level and on a per-capita basis than any other country in the world. Hundreds of organizations are focused primarily on improving education in the United States and, more specifically, on STEM disciplines. These include the National Science Teachers Association, the Business–Higher Education Forum (BHEF), the Aerospace Industries Association (AIA), the American Institute of Aeronautics & Astronautics (AIAA), and the National Defense Industries Association (NDIA). In addition, every college and university is focused on increasing the number of graduates.

We are proud to be among those industries that have placed the United States in its leadership role in technology, innovation and the ability to solve highly complex problems. But as both the pace of innovation and the need for problem-solving accelerate globally, the United States faces a competitive gap that we can close only if more of our young people pursue careers in the growing fields of STEM disciplines.

In my industry, the *Aviation Week* 2009 Workforce Study (conducted in cooperation with the Aerospace Industries Association, American Institute of Aeronautics & Astronautics, and the National Defense Industries Association) indicates aerospace companies that are hiring need systems engineers, aerospace engineers, mechanical engineers, programming/software engineers and program managers. Today, across the aerospace industry, the average age of the workforce continues to increase, and expectations are that approximately 20 percent of our current technical talent will be eligible to retire within

the next three years. As a result, in the very near future, our companies and our nation's aerospace programs will need tens of thousands of engineers—in addition to those joining the workforce today.

These are becoming difficult jobs to fill not because there is a labor shortage but because there is a skills shortage: Our industry needs more innovative young scientists, technologists, engineers, and mathematicians to replace our disproportionately large (compared to the total U.S. workforce) population of Baby Boomers as they retire. At the same time that retirements are increasing, the number of American workers with STEM degrees is declining, as the National Science Board pointed out in 2008.

This skills shortage is a global concern across the board in all high-tech sectors—public as well as private.

But it is especially acute in the U.S. defense industry because many government programs carry security requirements that can be fulfilled only by workers who are U.S. citizens. According to the *Aviation Week* 2009 Workforce Study, of the positions open in the aerospace and defense industry in 2009, 66.5 percent required U.S. citizenship. Yet only 5 percent of U.S. bachelor's degrees are in engineering, compared with 20 percent in Asia, for example. Meanwhile, in 2007, foreign students received 4 percent of science and engineering bachelor's degrees, 24 percent of science and engineering master's degrees, and 33 percent of science and engineering doctoral degrees awarded in the United States, according to the National Science Board. And most foreign students who earn undergraduate and graduate degrees from U.S. institutions are not eligible for U.S. security clearances.

Clearly, the throughput of our U.S. STEM pipeline carries serious implications for our national security, our competitiveness as a nation, and our defense industrial base.

Three key actions are necessary to ensure that we have enough scientists and engineers to meet future needs: 1) Successfully graduate all (or at least a lot more of) those who enter colleges and universities; 2) Ensure colleges and universities produce enough qualified secondary teachers for science, math and technology; and 3) Motivate our youth to pursue STEM-related careers that provide great pay, deliver on the promise of challenging and fun work, and create the future.

About that third point, let's face it: If you ask children what they want to be when they grow up, how often do you hear "I want to be an engineer"? First of all, many of them think engineers run trains. And those who do know what engineers are think they are like the nerds on the TV show, "The Big Bang Theory." We can fund all the public service announcements we want, but the sad truth is: If kids just don't see scientists and engineers as something they can and want to be (and if parents reinforce that perception), they simply won't go down that path.

Let me discuss what I think we can do to implement the three actions.

First: Successfully graduate all (or at least a lot more of) those who enter colleges and universities

At Boeing, we cultivate close relationships with 150 colleges and universities in the U.S. and around the world. We see the best students and hire the best talent possible. Two years ago, Boeing initiated a unique project to correlate work performance scores of engineers to the higher-education institutions from which our top-performing employees graduated. We have assigned a Boeing executive to partner with each institution to help us understand (1) general characteristics of programs that produce high-performing STEM workers and (2) how we can work together to further improve their students' readiness to enter the STEM workforce.

Although we hire graduates from many other institutions, we focus our active recruiting on our company portfolio of these high-potential institutions—many of which have increased their retention rates of students who enter engineering programs from 50 percent to greater than 80 percent. All of their successful programs feature the same key ingredients: From the time a student steps on campus, he or she is pulled into a group of students; as part of this cohort has direct interaction with a professor who wants to see this team succeed; and performs hands-on work, starting as a freshman.

Let me give you some good examples of these successes:

- At Columbia University, engineering students must do a hands-on community-service project; they must design and implement something of value to the community—a wireless network, for example.
- At the University of Southern California, engineering students attend core classes with the same group of 50 peer students and are assigned to an energetic professor who can relate to them and help them get through their critical first year.
- Many institutions today—including New Mexico State University, Northwestern University, the University of Southern California, and the University of Washington—offer bridge programs to freshmen minority or disadvantaged students. These programs help the students make a smooth transition to college-level academics, establish stable study and homework groups, attend academic workshops, take remedial or prerequisite classes that may not have been offered at their high schools, learn about STEM professions, gain work-study experiences, identify learning resources, and engage with the academic community. All of these activities significantly help with retention. Unfortunately, some of these programs have lost private funding from companies that are not faring well during the economic downturn.
- Most aerospace companies offer both internships (in which students—typically college juniors but sometimes sophomores—work at a company for 12 to 14 weeks during the summer months) or cooperative education programs (in which students typically work three industrial periods prior to their graduation). These programs enable students to demonstrate their skills, stretch their capabilities beyond their current level, increase their knowledge of their chosen fields, and experience what it's like to work in a company. Companies, in turn, are able to

temporarily "hire" and evaluate talented students and later retain those with the right skills as full-time employees.

The U.S. has long been recognized as having many of the best colleges and universities in the world. By focusing on improving students' engagement in their freshman year with hands-on experiences and caring faculty, we can further improve even the best systems.

The second action: Ensure U.S. colleges and universities produce enough qualified secondary teachers for science, math, and technology

Our college and university system also prepares our teachers for primary and secondary education. But, by nearly every count, there are not enough qualified teachers to teach math and science in secondary schools. Many who teach STEM classes lack degrees in the fields they teach. According to the U.S. Department of Education, 58 percent of middle-school math teachers and 68 percent of middle-school science teachers are not proficient or certified in these subjects.

Math and science are hierarchical learning processes—meaning you have to learn them in stages, one step at a time, before you can move on successfully to the next step. When teachers anywhere along the way are neither proficient nor inspiring, too many of our young people miss foundational instruction, fall hopelessly behind and lose interest in science and math before they really have a chance to find out if they could be good at these subjects. What's more, the cost of remedial education (that is, trying to improve the skills of behind-the-curve students enough for them to grasp college-level STEM subjects) is very high compared to getting it right the first time.

Most colleges and universities that produce the lion's share of teachers have both education and engineering schools. The best higher-education institutions are finally beginning to focus on working together to ensure that teachers who graduate from college are in fact also wonderful scientists and engineers. "Rising Above the Gathering Storm," with its focus on 10,000 teachers and 10 million minds, did a great job laying out the actions needed to improve teacher quality and effectiveness at the primary and secondary school levels.

And finally, the third—and maybe most critical—action: Motivate our youth to pursue STEM-related careers

I know today's hearing focuses primarily on the undergraduate and graduate levels of STEM education. But if we cannot get enough students interested in going into the undergraduate STEM curriculums, we will fail in meeting the needs of business, government, and our economy. The underlying cause of the STEM-worker shortage starts way before college. What you learn <u>first</u> sticks with you; that is certainly true for how you think of math, engineering and science—and whether you're inclined to learn these subjects. Just as children whose parents read to them at a young age tend to do better as they progress through school and into adulthood, children whose imaginations are sparked by someone who reveals the possibilities of math or science tend to gravitate

toward STEM-related interests. How can we expect that to happen more when so many parents are intimidated by math and science?

Unless and until we can show our young people that STEM specialties are important and fun—and pay well—the United States will continue to bleed human potential:

- According to the Department of Education: Of nearly 4 million children who start pre-school in the United States each year, only about 25 percent of them go on to complete basic Algebra in junior high, only about 20 percent are still interested in STEM subjects by the 8th grade, only 16 percent are still interested in STEM subjects by the 12th grade, only 9 percent declare a STEM major at the undergraduate level, only 4.5 percent actually graduate with a STEM-related degree, and only 1.7 percent graduate with an engineering degree. These figures are disproportionately worse for minority and female students. And, by the way—a topic for another day—1.2 million (or more than one-fourth) of those nearly 4 million children drop out of school altogether before they complete the 12th grade, though a majority of these eventually return to obtain diplomas or equivalents such as the GED. These trends are consistent year over year. *[See Attachment A]*

- Meanwhile, U.S. students ages 15 to 17 rank 19th in the world in STEM critical-thinking skills, as measured by the Programme for International Student Assessment test. The number of engineering degrees awarded in this country is down 20 percent from 1985; that year, the percentage of undergraduates earning degrees in engineering fields peaked at 7.83 percent. It has declined most years since then. The United States graduates approximately 70,000 engineers each year, with only 44,000 eligible for aerospace careers, according to the AIA.

To reverse these abysmal trends, we first have to get more American children interested in math and science; then we have to keep them interested. And it must start with their perception of technology careers.

Where do children get their view of science and technology? A Kaiser Family Foundation study released January 20, 2010, indicates that young people ages 8 to 18 are directly engaged with the media (TV, movies and computers), mobile devices, and video games an average of 7 hours and 38 minutes a day—in other words, more time than they typically spend in school. And there's a correlation between media use and grades: While the study did not seek to establish a cause-and-effect relationship, it reports that about half of heavy media users (the 21 percent of young people who consume more than 16 hours of media a day) reported getting lower grades (mostly Cs or lower), while only about a quarter of light users (the 17 percent of young people who consume less than 3 hours of media a day) reported getting lower grades.

Who has young people's attention? It's clear that media in all its various new forms has a huge impact on the perspectives, attitudes and behavior of our youth. Take a look at the video "2 million minutes," and you'll see what we are up against when it comes to

educating our children compared to other nations who want to be leaders in the marketplace.

In movies and on TV, 10 percent of characters are scientists and engineers. Unfortunately, of those, more than 70 percent kill others, are killed or are overcome by lay people. In the real world, however, scientists and engineers are the very people who create solutions for all that humans do in connecting people—whether by air, rail, car, or sea. They are the people who ensure that we have water, electricity, and gas. They are the people who create the devices that deliver the media that everyone clamors for. They are also the people who create artificial hearts and vaccines for H1N1. Scientists and engineers create the future. And they are real people. But if our media sends the wrong message, young people get the wrong view and don't want to be like most of the scientists and engineers they see on TV and in the movies.

In part to counter these misleading images, the Aerospace Industries Association has begun taking steps toward bringing together academia, government, industry, and media to strengthen the future workforce. Our Workforce Steering Committee, for example, is in the process of tackling one of the biggest barriers—the perception of the STEM disciplines. AIA and Boeing are collaborating with the Entertainment Industries Council (EIC), whose mission is to support accurate depictions of how engineers and scientists are portrayed in mainstream media. For the past 27 years, the EIC has played a critical role in shaping people's perspectives about smoking, seat belts (you remember the crash-dummy commercials) and mental illness, just to name a few. Boeing is providing scientific and technological expertise through a number of our engineers who are directly engaged with EIC to ensure that writers, directors and actors know what engineers and scientists do in real-world situations. These outstanding engineers have volunteered to help advance positive images of engineers and help develop creative storylines. Positive media influence will generate a huge impact on parents and children—and on those who would be our future teachers, scientists, and engineers.

Mr. Chairman and members of the subcommittee, I thank you for your attention to this important subject and appreciate your sense of urgency about it. If we in the United States hope to retain our nation's leadership in science, technology and innovation, we must immediately address the looming STEM skills gap.

At the recommendation of the Aerospace Industries Association and its members, please consider these actions to strengthen undergraduate and graduate education:

- First, encourage and expand scholarships and other forms of financial aid as well as retention programs for undergraduate STEM students.
- Second, encourage and incentivize the preparation of STEM-certified primary and secondary-school teachers.
- Third, help motivate our youth to pursue STEM-related careers by enhancing support for two- and four-year institutions that provide students with hands-on experience that is directly transferable to the workplace.
- And fourth, motivate the media, parents, and teachers to provide a positive view of STEM careers.

I want also to emphasize the importance of measuring the impact of our investments in STEM education. Right now the AIA is doing an inventory of our company programs to assess the impact of our investments by the first quarter of 2010. We are also working to coordinate this process with other industries through a STEM Coalition of Coalitions. We encourage the federal government to also considering measuring the impact of its investment in STEM education programs and scaling up those that show positive outcomes. The Business Higher Education Forum has developed a model that can help identify where we can strategically invest to make a difference to improve the STEM pipeline.

We must cultivate and diligently attract talented young people who will become the scientists, engineers, and technical professionals that keep the United States economically competitive, our aerospace industry innovative and our national security strong.

Mr. Chairman, Mr. Ehlers and members of the committee, thank you for the opportunity to testify before this important panel.

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