A Special Report

Launching the 21st Century American Aerospace Workforce

December 2008
The Aerospace Industries Association of America

The Aerospace Industries Association of America (AIA) was founded in 1919, only a few years after the birth of flight.

Today, nearly 300 major aerospace and defense companies and suppliers are members of the association, embodying every high-technology manufacturing segment of the U.S. aerospace and defense industry from commercial aviation and avionics, to manned and unmanned defense systems, to space technologies and satellite communications.

AIA represents the nation’s leading designers, manufacturers and providers of:

- Civil, military and business aircraft
- Helicopters
- Unmanned aerial vehicles
- Space systems
- Aircraft engines
- Missiles
- Materiel and related components
- Equipment
- Services
- Information technology
Launching the 21st Century American Aerospace Workforce

The long-term vitality of the U.S. aerospace workforce is a priority issue for the Aerospace Industries Association.

Our nation is not producing enough qualified workers to fill important jobs in U.S. aerospace companies, and the shortfall will increase as retirements grow in coming years. To maintain America's leadership in the global aerospace marketplace in the 21st century, we must cultivate a highly skilled workforce of scientists, engineers and other technical specialists critical to our national security, our economy and the strength of our industrial base.

This report is a starting point for the aerospace industry to collectively recommend and develop solutions to overcome the problem. And it is an invitation for government and like-minded stakeholders to partner with us in designing those solutions.

Together we can vigorously respond to today's pressing aerospace workforce challenge with the conviction and focus that led the nation to prevail in the Space Race and the Cold War.

Sincerely,

Marion C. Blakey
President and Chief Executive Officer
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Labishing the 21st Century American Aerospace Workforce

INTRODUCTION:
Replacing the Aerospace Talent that Won the Space Race and the Cold War

The United States has enjoyed preeminence in aerospace for more than one hundred years. The industry was invented here, and American achievements and technology continue to lead the world.

That supremacy is now in danger. The primary threat comes not from competitors’ actions but from our own demographics. The generation of aerospace talent that won the Space Race and the Cold War is reaching retirement age, and America is not producing the number and quality of engineers, designers and technicians needed to even begin replacing those who have served so well.

The 2005 National Academies report Rising Above the Gathering Storm (RAGS) presented the definitive statement of our nation’s problems and challenge in producing a workforce prepared for the global economy and jobs of the 21st century. This important document also provided a detailed roadmap of recommendations to address the issue across the workforce pipeline from K-12 to post-graduate education.

In response to the RAGS report, the Aerospace Industries Association in 2006 established an Industrial Base and Workforce Committee charged with advising the industry’s top executives on steps that should be taken to solve the workforce shortage. In particular, the committee was tasked with finding best practices in science, technology, engineering and mathematics (STEM) programs — those that should be expanded and brought to national scale. The committee was also asked to identify organizations with which AIA and its member companies might cooperate to address the issue at all levels and in all its aspects.

In August 2008 AIA published Launch into Aerospace, a white paper outlining the workforce crisis and steps the industry is committed to taking to turn the situation around. One stated goal is to make government a partner in achieving the future technical workforce.

Making government a partner is essential to filling the aerospace workforce pipeline by advancing an integrated, national strategy that addresses STEM education and training as a systemic issue that affects all high-technology industries. Through research and outreach we have learned that innumerable organizations, groups and individuals are doing good work in inspiring, educating and training young people to pursue high-tech careers. But to a large extent they are working on their own without the benefit of an overarching plan or the synergies that come from communication and cooperation with others pursuing a common purpose.

AIA, therefore, is striving to become a key participant in a grand “coalition of coalitions” dedicated to solving our national STEM workforce crisis. Aerospace companies intend to do their part among a coalition of stakeholders from government, business, academia, workforce development entities, education nonprofits and others.

The federal government must be engaged and take a leadership role given the magnitude and scope of the workforce challenge and its impact on our nation. But most of the work must be done and many of the decisions must be made at the state and local level where education and training actually take place. We believe that real progress will only come when dedicated parties work together at all levels to tackle the problems that exist in every phase of education and training.

This report spells out in greater detail the aerospace industry’s need for technical talent, showcases steps that individual aerospace companies are already taking (and that could be scaled up) and recommends ways in which government entities can help and partner with us. While the report is intended for senior government
policymakers, others in the education and workforce development community will also find it of interest.

The report has four goals and is structured accordingly:

- Emphasize why the STEM workforce shortage is a top issue for the nation.
- Explain why this is an especially serious problem for the aerospace industry.
- Share what the aerospace industry is already doing to address the problem.
- Indicate how we believe government can help.

Industry’s Role

We want to emphasize a distinction in the workforce discussion: This report uniquely represents the American aerospace industry’s perspective. We recognize and acknowledge the efforts of numerous private and government-sponsored organizations that have written reports and promulgated recommendations on the U.S. STEM workforce, many of which have helped form our conclusions.

Keep in mind that the scope of this report is carefully restricted to what the aerospace industry knows. While we identify STEM programs that industry has found to be constructive — in part to urge further support for them — we are keenly aware that the specifics of educational policy and practice are better left to those with more expertise in the field. Just as we would not ask an educational faculty to design a helicopter, we do not presume to prescribe specifically how to educate an engineer — although we do believe that business should play a role by identifying for educators our skill-set needs.

This paper is an invitation for partnership in meeting the STEM workforce challenge by working together to identify, assess, improve and bring to national scale the most effective STEM curricula and activities.

SECTION 1

A TOP NATIONAL PRIORITY

"...Leadership is not an American birthright. ... Greatness has to be earned and continually re-earned." — Norm Augustine, Is America Falling Off the Flat Earth?

Economic growth is unattainable without a capable scientific and technological workforce. A skilled and talented workforce is a fundamental requirement to attract investment, foster wealth creation and spur innovation. This linkage is understood around the globe. According to China's President Hu Jintao, “The worldwide competition of overall national strength is actually a competition for talents, especially for innovative talent.”

In the 20th century the achievements of the Sputnik-generation workforce propelled the U.S. position as the world leader in the development of new technologies and products. Innovations that resulted from research and development during World War II, the Space Race, and afterwards — many that originated in the aerospace and defense industry — were critical to the prosperity of the nation in the second half of the 20th century. Those innovations, upon which virtually all aspects of current society now depend, were made possible because of the American men and women who led the world in science and technology.

Today, however, stark indicators suggest that the United States is losing its lead:
• **Aging Science and Engineering Workforce.** Retirements from the STEM labor force are likely to become more significant over the next decade. Twenty-six percent of all STEM degree holders in the labor force are age 50 or older. Among STEM doctorate holders in the labor force, 40 percent are age 50 or older.\(^4\)

According to the National Science Board’s Science and Engineering Indicators, by age 62 half of STEM bachelor’s degree holders had left full-time employment. Doctoral degree holders work slightly longer with half leaving full-time employment by age 66.

• **Declining “Homegrown” STEM Workforce.** At the same time that retirements are increasing, the number of American workers with STEM degrees is declining. In 2003, 25 percent of all U.S. college-educated workers in STEM occupations were foreign born as were 40 percent of doctorate holders in STEM occupations.\(^5\) In 2007, 60 percent of engineering Ph.D.s were awarded to foreign nationals.\(^6\)

According to a recent RAND Corporation report, the inflow of foreign workers has been critical in maintaining the U.S. STEM workforce and the major reason that the nation is currently not in a crisis-state. Due to the national security nature of our industry, however, this report focuses on the need for the United States to continue its efforts to cultivate homegrown talent.

• **Propensity toward a STEM Career.** For every new Ph.D. in engineering, America graduates one new Ph.D. in physical science, 18 new lawyers and 50 new MBAs.\(^7\) More than one-half of those holding bachelor of science degrees in engineering enter careers outside of engineering, including investment banking, law and business.

Recruiting domestic STEM talent depends heavily on student perceptions of the STEM careers that await them. Those perceptions can be solidified early in the educational process — before students graduate from high school. The desirability of a career in STEM is determined largely by the prospect of attractive employment opportunities in the field.

Some aspects of the graduate education and training process can also influence student decisions to enter STEM fields. The “pull factors” include time to degree, availability of fellowships, research assistantships or teaching assistantships and whether a long, post-doctoral appointment is required after completion of the Ph.D.\(^8\)

**The Need for Action**

Preparing the next-generation scientific and engineering workforce is critical to the future of the entire national economy. Although scientists and engineers today make up only 4 percent of U.S. employment, they contribute disproportionately to the creation of jobs for the other 96 percent of the nation’s workforce by generating knowledge, innovating and establishing new companies based on that knowledge and innovation.

Numerous reports, commissions and educational leaders have determined and argued the need for the United States to address and invest in our STEM capabilities — from training a highly qualified STEM-literate workforce to funding research projects and programs for these workers to take on. The Council on Competitiveness, the Business Roundtable, the Business-Higher Education Forum and others, with membership including some of the top CEOs from a variety of American industries, have expressed concern about the state of STEM education and research and the impact it will have on America’s ability to compete. The Department of Defense and our national laboratories have sounded similar alarms. Civil scientists and engineers are just as in demand as their private sector counterparts.

The issue came to the forefront for the aerospace industry in 2002 when the Commission on the Future of the U.S. Aerospace Industry declared workforce to be a priority.\(^9\)
SECTION 2:

INDUSTRY PERSPECTIVE

The Importance of U.S. Aerospace in America’s Economy

As the U.S. economy enters uncertain times, America’s aerospace industry remains a powerful, reliable engine of employment, innovation and export income. Aerospace contributed $97 billion in export sales to America’s economy in 2007. U.S. aerospace sales alone account for 1.5 percent of our country’s gross domestic product, and every aerospace dollar yields an extra $1.50 to $3 in further economic activity. While the industry directly employs over 600,000 workers, it enables 10 million high-quality American jobs.

In 2007 more than 600 million passengers relied on U.S. commercial air transportation, and more than 150 million people were transported on general aviation aircraft. More than 40 percent of the value of U.S. freight is transported by air. Aerospace capabilities have enabled e-commerce to flourish with overnight mail, parcel delivery and just-in-time manufacturing.

Other sectors of the economy depend on aerospace businesses and related disciplines for technical skills and technologies that are critical elements of our security infrastructure and that improve America’s position in the global marketplace. The diverse sectors of aerospace include commercial, civil and military aviation, space and defense projects. They encompass an array of talent and competencies not limited to researchers, engineers, technicians, mechanics, skilled machinists and precision production jobs.

At the core of our industry’s success are the highly qualified men and women who work every day making history by blazing new technological trails. In order to continue providing our services to the nation, it is critical that we ensure the continued development of a robust, well-educated and well-trained workforce.

Our nation is not producing enough qualified workers to fill important jobs in America’s aerospace companies at present, and the shortfall will increase as retirements grow in coming years. To maintain America’s position in the global aerospace marketplace, we must immediately address how to cultivate a highly skilled workforce of U.S.-based scientists, engineers and other technical specialists who are eligible for security clearances.

Workforce Challenges

The aerospace and defense industry faces challenges similar to those of other high-technology industries, including an aging workforce and an impending shortage of skilled STEM workers. But the aerospace industry, along with closely associated defense companies, also faces unique workforce challenges: security clearances, recruitment and retention.

- Security Clearances. The United States produced 122,450 total engineering and science graduates in 2007, but less than two-thirds are eligible for high-level security clearances based on citizenship.

While other industrial sectors can outsource labor to foreign workers, security requirements dictate that most U.S. aerospace and defense systems be developed in this country by U.S. citizens. Thus, the need for home-grown, U.S.-developed technical talent is particularly acute for the aerospace industry. According to the Interagency Aerospace Revitalization Task Force, there are two major issues associated with security clearance requirements: clearable talent and clearance process portability.

Regarding the difficulty of finding clearable talent, the task force notes that American youth are often unaware of the necessity for and rigors of security screenings and clearances before employment in national security-related occupations. American youth need to be made aware of “disqualifying life events” — drug abuse, arrest and even activities presented on social networking sites, such as Facebook and MySpace, that
depict the candidate engaging in activities that could prohibit employment in national security-related occupations.

Every year tens of thousands of aerospace industry personnel are subjected to security clearance and renewal processes in order to perform many critical national security services. The current system is often backlogged for a year or longer and produces security clearances that are not portable among departments, agencies, from government to industry, industry to industry and so forth. As a result, industry and government suffer a myriad of problems in recruitment and from increased costs due to the unavailability of personnel.

**Recruitment.** AIA estimates that while the United States graduates approximately 70,000 engineers each year, only 44,000 are eligible for aerospace careers. The aerospace industry must compete with other industries, such as information technology and financial institutions, for the small pool of talent.

Adding to the challenge, the U.S. aerospace sector — once the employer of choice for the “best and brightest” technically trained workers — now holds a negative image for potential employees. Surveys indicate a feeling of disillusionment even among industry personnel, including production/technical workers, scientists and engineers. Eighty percent of nearly 500 responding to a survey, indicated that they would not recommend aerospace careers to their children.

Engineering students gave the aerospace industry low ratings for its physical work facilities, exciting and meaningful tasks, opportunities for professional development and growth, and supportive and encouraging management.

Questions about the future viability and stability of the defense and aerospace industry are also leading prospective science and engineering graduates toward other career paths. The perceived volatility and lack of career opportunities in defense and aerospace due to the large cutback and retrenchment of the industry in the early 1990s has contributed heavily to this lingering perception.

Recognizing an image problem, industry leaders serving on the 2008 Aviation Week Workforce Advisory Board identified the necessity to “develop — individually and as an industry — messages that share the technical achievements of this industry and what those achievements have meant to civilization/society.”

**Retention.** The aerospace industry has historically been cyclical and strongly driven by defense spending, with increases corresponding to national conflicts and budget fluctuations. Sales within the commercial sector of the industry also have been cyclical as has government spending on space science and exploration. Due to this dependency on external and, to some extent, uncontrollable events (for example, politics and the marketplace), aerospace jobs have an undeserved reputation for insecurity.

While the industrywide average attrition rate is 10 percent, younger workers with 0-5 years of experience had a higher rate at 14 percent. This has prompted many in the industry to place special emphasis on keeping their younger workers. The Workforce Advisory Board recognized this issue when it recommended: “Drive down the voluntary attrition level among young professionals.”

An Aviation Week article reports an increasingly common scene in the workplace: four generations of workers occupy the cubicles and factory floors of the aerospace/defense industry. Among them are individuals who benefited from Sputnik-era education benefits and used slide rules along with employees who use instant-messaging to resolve complex design issues.

The four generations — known as Matures, Boomers, Gen-Xers and Millenials— were educated differently with unlike tools and measures of capability. The newest generation’s requirements were captured in a study with the following findings: They want to learn and participate in decisionmaking, want mentors, are skeptical and value fairness and ethical behavior. They also expect customized career paths molded to the individual — creating a sense of control — and they value the newest and best technology and tools to do their jobs.
While it is difficult for more mature companies to change, some employers are already exploring ways to work with the incoming generation, such as mentoring programs, flex schedules and arranging the workspace in different ways, such as more open areas vs. cubicles.

On the topic of work environment, the advisory board saw the necessity for companies to “understand that the concept of work/life balance has evolved in the last five years and today we must encourage an integration of work and life versus a clear demarcation of where one begins and the other ends.” As one leader noted, “The need to shift modes between personal and professional occurs in real time and demands fluid transition on the part of the organization and the individual.”

Another retention issue identified by Aviation Week is more near-term: the gap in workers between ages 35 and 45 who continue to be problematic in hiring. This experience range is the most in demand among hiring managers, particularly in the areas of systems and network architecture engineering and program management.

State of the Industry

**Current State.** The aerospace industry continues to show short-term growth, which bodes well for job seekers.

In 2008, for the fifth year in a row, U.S. aerospace sales increased in virtually every industry sector. Total sales are expected to reach $204.4 billion. The aerospace industry continues to be a major contributor to the nation’s trade balance with exports in 2007 reaching $97 billion and is expected to grow modestly to $99 billion in 2008.

The aerospace industry is expected to add 10,000 workers to its ranks in 2008, closing the year with 655,500 direct employees. Aerospace employment has risen steadily since 2004 with data up to the third quarter 2008 reflecting increased employment opportunities. Aircraft manufacturing makes up roughly one third of industry employment and has grown by 5,000 employees since 2007. Production workers, approximately half of the total workforce, will have taken home $29.58 per hour and logged 43.5 hours of work weekly in 2008.

Additionally, 43 percent of the aerospace and defense workforce is comprised of employees categorized as engineering, R&D/scientist, program management and information technology. Of the professional employees hired in 2008, 53 percent will require security clearances.

The 2008 Aviation Week Work Force Study reports that the industry’s current workforce is in a steady state but indicates signs of future concerns about staffing levels. While the average age of the workforce is 45 years, only 22 percent of the workforce is 35 years or younger, meaning a smaller pool inadequate to replace the 45 year olds as they retire. With 58 percent of the workforce over age 50, the majority of aerospace workers is heading to retirement. The rate of retirement for 2007 was 2 percent of workers eligible. This equates to the loss of 12,846 individuals. The number eligible for retirement is of more concern: 13 percent, which equals 83,499 individuals.

At present, female and minority workers represent about 25 percent of the aerospace workforce.

**Forecasted State.** AIA expects the industry to continue growing through 2009. Aerospace sales are projected to grow to nearly $214.3 billion in the coming year, an increase of 4.8 percent, as a result of robust backlogs and predictable defense spending occurring in 2008. Continued growth of the industry could likely result in the need for an even larger workforce.

**Forecasted Needs.** The U.S. Department of Labor’s Bureau of Labor Statistics provides projections concerning future job growth. In its Fastest Growing Occupations data, BLS reports that the most significant gain in jobs for 2006-2016 — 5.9 percent — will have been in scientific/technological jobs.
In 2007, BLS reported that 2.5 million STEM workers would be needed to fill vacancies occurring in the 10-year period 2004-2014 across all industry sectors, including:

- 15 percent job growth in science.
- 31 percent job growth in technology.
- 12 percent job growth in engineering.
- 10 percent job growth in mathematical sciences.

For aerospace engineers alone, the BLS reports a 10 percent growth in employment over the decade, which is about as fast as the average for all occupations.\(^{18}\)

Individual companies have shared retirement and need projections that suggest the dimensions of the demand:

- Lockheed Martin conservatively estimates it will need to hire 140,000 people in the next 10 years, but that figure could be as high as 190,000 (with half of that number being STEM professionals).\(^{19}\)
- In recent press reports both Northrop Grumman and Lockheed Martin reported that within the next five to 10 years roughly half of their workers will be eligible to retire.
- Responses to a recent survey conducted by AIA of its member companies revealed that the 30 companies that responded will need to hire 58,899 salaried scientists and engineers in the next five years. Including production/touch labor employees raises the combined requirement to more than 129,350 in five years.\(^{20}\)

In summary, broad, forward-looking indicators show that industry will have many positions to fill in coming years as it loses workers to retirement and more jobs are created as the industry grows.

**SECTION 3**

**TOP NEEDS FOR IMMEDIATE ACTION AND INDUSTRY’S RESPONSE**

Our industry recognizes that the workforce issue is an end-to-end challenge. Several studies, reports and commissions have documented problems at various stages in the STEM workforce pipeline from early childhood development through pre-college to undergraduate and graduate training and onwards. In this section, the most commonly discussed major problems are noted along with highlights on how the industry is responding to the issue.

**Pre-college Science and Mathematics Concerns**

**Top Need #1:** Today many school children are systematically discouraged from learning science and mathematics because their teachers lack professional preparation and, in some cases, confidence in teaching science and mathematics.

**Teacher Training and Qualification.** Research has established that the quality of a pre-college mathematics and science teacher's substantive training is one of the most important factors in improving student mathematics and science achievement.\(^{21}\)
Currently, there is such a shortage of highly qualified K-12 teachers that many of the nation’s 15,000 school districts have had to hire underqualified or even uncertified teachers.22

Studies have shown that STEM teachers at the middle school level are especially ill-prepared. According to a Department of Education study,23 approximately 68.5 percent of U.S. middle school students were taught by math educators who had neither a major nor certification in mathematics. For science, the proportion was 57.2 percent.

The prevalence of out-of-field math and science teachers is much greater in high-poverty areas and in schools where a high proportion of students are members of racial minority groups. In some states, the gap was glaring. In Maryland, 95 percent of elementary classes in affluent areas were staffed with highly qualified teachers, compared to only 66 percent in poorer schools.24

**Retention of Teachers.** Research has shown, moreover, that the problem of attracting highly qualified teaching candidates into mathematics and science fields is overshadowed by the ability to retain experienced teachers. Approximately half of all teachers leave within five years of entering the profession. The rate of attrition in poor schools is 50 percent higher that in wealthier ones.25

The National Science Foundation finds that science and mathematics teacher salaries continue to lag behind salaries for individuals working in comparable professions, and the gaps have widened substantially in recent years. In 2003 the median salary for full-time high school mathematics and science teachers was $43,000, significantly lower than the salaries of professionals with comparable educational backgrounds, such as computer systems analysts, engineers, accountants or financial specialists, and protective service workers ($50,000-$72,000.) The NSF reports that 53 percent of public middle school and high school mathematics and science teachers said that they were not satisfied with their salaries.26

Replacing a highly qualified STEM teacher is much more costly than retaining a current one and, furthermore, negatively affects student achievement.27

**Retirement of K-12 Educators.** The problem of recruiting and retaining science and math teachers is further compounded by chronic shortages in the overall teaching workforce. About two-thirds of the U.S. K-12 teachers are expected to retire or leave the profession over the coming decade, and so the nation’s schools will need to fill between 1.7 million and 2.7 million positions during that period — about 200,000 of them in secondary science and mathematics classrooms.28

**Industry Response to Teacher Development**

Many of our member companies are involved in programs that address challenges facing our educators, for example. One such program is the Business-Higher Education Forum (BHEF).

In response to America’s diminishing global advantage in science, technology and innovation, BHEF released the 2007 report, “An American Imperative: Transforming the Recruitment, Retention, and Renewal of our Nation’s Mathematics and Science Teaching Workforce,” which chronicled the necessity to transform teaching and improve student learning. Led by Warren J. Baker, president of California Polytechnic State University, and William Swanson, chairman and CEO of Raytheon, the report made several recommendations in the areas of recruitment, retention and renewal that address several of the previously discussed issues.

Another BHEF initiative — “Securing America’s Leadership in Science, Technology, Engineering and Mathematics (STEM)” — seeks to double the number of U.S. STEM college graduates by 2015 by strengthening the mathematics and science teaching workforce and pursuing promising strategies to bolster the education pipeline that leads to STEM careers.
Leaders from BAE Systems, Boeing, Lockheed Martin, Northrop Grumman, SAIC and other AIA member companies are also supporting BHEF efforts.

Examples of individual company efforts to support teacher development include (but are not limited to):

- The Boeing Company – SPACE CAMP® program. In partnership with the U.S. Space & Rocket Center, Boeing sponsors educators to its Space Camp facility in Huntsville, Alabama.
- GE Aviation – GE Foundation Developing Futures™ in Education. One of the core components is professional development for teachers via innovative strategies for the classroom.
- Harris – “Science Teacher of the Year” award. The winner is provided a stipend and inducted into the Harris Hall of Fame.
- Honeywell – “Creating the Next Generation of Scientists” program that supports development of math and science educators to teach space-based science.
- IBM – “Computer Science Curriculum” program. In partnership with the Computer Science Teachers Association, IBM provides computer science resources to high school teachers.
- Lockheed Martin – Supporting Project Lead The Way curriculum adoption in middle and high schools, including the embedded teacher and guidance counselor training.
- Northrop Grumman – “Weightless Flights of Discovery” program for middle school teachers.
- Rolls-Royce North America – “Building the Innovation Generation” program. This collaborative effort between industry/government/academia offers internships to faculty and students.

**Top Need #2:** Our youth are not performing well in math and science compared to students in other developed countries. Many students are not prepared either to pursue college or to go straight to work.

**Student Achievement.** Indicators of student achievement starkly highlight the severity of the decline of the U.S. STEM workforce and its capabilities.

The National Assessment of Education Progress test (NAEP), often referred to as the “nation’s report card,” is the only national test that assesses student performance. In 2007 for math, it was found that 62 percent of fourth graders scored below proficient. For the eighth grade, 69 percent were below proficient. In science, scores were 68 percent below proficient and 73 percent below in fourth and eighth grades, respectively, in 2005. “Below proficient” includes scorers in “basic and below basic,” and while the majority of students score below proficient, the National Center for Education Statistics, which runs the test, reports that scores at the basic level show improvement.

**International Comparisons.** The Program for International Student Assessment (PISA) measures performance of 15 year olds in reading, math and science literacy. In the most recent PISA science test, U.S. students ranked 21st out of 30 countries. In math, U.S. students ranked 25th out of 30. And in both cases for math and science, the U.S. score was below the average.

The Trends in International Mathematics and Science Study is another international assessment that measures and compares fourth- and eighth-grade students from around the globe. The latest data available for 2007 show U.S. fourth- and eighth-graders scoring in the middle of the pack, outpaced by their Asian and European peers. In math, fourth- and eighth-graders rank 11th and 9th, respectively. In science, fourth- and eighth-grade students ranked 8th and 11th, respectively.

Why U.S. student achievement declines in the upper grades is a common quandary. Some point to the quality of teaching, the curriculum (the need, for example, for more inquiry-based learning) and social and...
cultural factors, such as gender and what subjects boys versus girls are good at despite recent studies showing that young females and males perform equally when it comes to math.

Widening Achievement Gap. A recent study by Education Week reports that 1.23 million students will fail to graduate in 2008. Nationwide, about 71 percent of ninth-graders make it to graduation, but that figure drops to 58 percent for Hispanics, 55 percent for African-Americans and only 51 percent for Native Americans. That means that about 50 percent of Hispanics, African-Americans and Native Americans do not graduate high school. In some metropolitan areas with these peer groups, we see rates as high as 60 percent not graduating.

According to the U.S. Council on Competitiveness, boosting the participation of women and minorities in the science and engineering workforce presents the single greatest opportunity to expand the nation’s pool of technical talent. Current graduation rates for America’s minority population show that this is a major problem — and opportunity — that calls for great attention.

Preparation for Post Secondary. A 2008 report issued by the Strong American Schools organization found that more than one-third of American college students require remedial courses for basic academic skills. The group pointed to the failure of American high schools in preparing young people for post-secondary studies.

In a survey of young people who have recently entered the workforce, only 14 percent of high school graduate respondents reported that they are confident that they are generally able to do what is expected in the workplace. Forty-eight percent of those without a college degree say their high school teachers and classes should have done a lot more to prepare them for college or the workplace.

Industry Response to Student Achievement

The following are examples of joint efforts by AIA member companies.

Project Lead The Way. Project Lead The Way (PLTW) is a national, not-for-profit educational program that helps give middle and high school students a rigorous, ground-level education necessary to develop strong backgrounds in science and engineering. The curriculum is tied to national math and science standards. In the absence of a national standard for pre-engineering curriculum, PLTW is considered by many to be the de facto national standard.

The program offers a dynamic high school curriculum that provides students with real-world learning and hands-on experience to help them understand how the skills they are learning in the classroom can be applied in everyday life. This approach is called activities-based learning, project-based learning and problem-based learning — or APPB-learning.

Students in the PLTW program receive training in current technology using the latest computer software. They explore major career paths in STEM careers and participate in hands-on activity that utilizes team efforts. Students interested in engineering, biomechanics, aeronautics and other applied math and science arenas discover that PLTW is an exciting portal into these industries.

For the 2008-2009 school year, PLTW was active in 3,000 schools in 50 states and the District of Columbia and trained 7,000 teachers and 5,000 counselors. In 2006 AIA endorsed PLTW for its outstanding contribution to STEM education, and many AIA member companies are already working with local schools to implement PLTW. More than 60 percent of the college-bound graduates of PLTW programs major in engineering, and their retention rate through college is double the national average.

Team America Rocketry Challenge. The Team America Rocketry Challenge (TARC) is the world’s largest rocket contest, sponsored by AIA and the National Association of Rocketry (NAR). It was created in the fall of 2002 as a one-time celebration of the Centennial of Flight, but enthusiasm about the
event was so great that AIA and NAR were asked to hold the contest annually.

Approximately 7,000 students from across the nation compete annually in TARC. Teams design, build and fly model rockets that reach a specific altitude and flight duration. The contest is designed to encourage students to study math and science and pursue careers in aerospace.

Based on local qualification flights, the top 100 teams are invited to the Washington, D.C., area in May for the national finals. Prizes include $60,000 in cash and scholarships split among the top 10 finishers. NASA invites the top 25 teams to participate in its Student Launch Initiative, an advanced rocketry program. Some AIA member companies, such as Lockheed Martin and Raytheon, have sponsored additional prizes, including scholarships and a trip to an international air show.

In a recent survey of TARC participants, 61 percent reported increased interest in STEM because of their participation in TARC, and 54 percent of participating seniors plan on pursuing a STEM degree in college.

**FIRST Robotics.** FIRST (For Inspiration and Recognition of Science and Technology) Robotics was founded in 1989 to inspire young people’s interest and participation in science and technology. FIRST hosts extracurricular robotic competitions for high school students across the nation. It also has extracurricular programs for middle and elementary school students.

FIRST Robotics has had an impact on more than 159,000 students, 44,000 mentors and 28,000 event volunteers. In the 2008 competition, FIRST brought together 1,501 teams from 37,535 high schools from every U.S. state, plus Brazil, Canada, Chile, Israel, Mexico, the Netherlands and the United Kingdom.

A study conducted by Brandeis University found that FIRST provided a positive experience that gave participants an opportunity to be involved in a challenging team activity, build relationships, learn new skills and gain a new understanding of and interest in science and technology.

Eighty-nine percent indicated they had “real responsibilities.” Seventy-six percent believed they had a chance to play a leadership role, and 74 percent reported that students made the important decisions. Of those FIRST Robotics alumni reporting a college major, 41 percent had selected engineering. Based on national data from the U.S. Department of Education’s Beginning Post-secondary Student Study, FIRST alumni were nearly seven times as likely to become engineering majors as the average college student nationally (41 percent for FIRST Robotics competition alumni vs. a national average of 6 percent). FIRST alumni were also twice as likely to enroll as computer science majors (11 percent vs. 5 percent nationally).

Many AIA member companies are involved in FIRST Robotics, including major sponsorship and volunteer support nationwide.

**MATHCOUNTS.** MATHCOUNTS is a middle school program that heightens student interest in mathematics by making math achievement as challenging, exciting and prestigious as a school sport. But it is more than a competition. MATHCOUNTS involves students and teachers in year-long coaching sessions and helps students at all levels improve their problem-solving skills.

Corporations and individuals donate $1.5 to $1.7 million annually to the national program and more than $500,000 to the local and state programs. Business and industry partners have provided schools with coaches for students and assist in coordinating competitions. They also host local MATHCOUNTS activities, such as workshops and outreach programs to promote the importance of mathematics.

More than 17,000 volunteers (teachers, engineers, other professionals, parents and alumni) participate annually to coach students and conduct competitions. Since the program began in 1983, more than 6 million students in 6,000 schools have participated in competitions annually from all 50 states, the District of Columbia, U.S. territories and State and Defense department schools worldwide. Each year, more than 250,000 students participate in MATHCOUNTS at the school level.
Many AIA member companies are involved in MATHCOUNTS as founding and major sponsors as well as by providing volunteer support nationwide.

For a sampling of individual company efforts, see Appendix A on page 22.

**Post-secondary Concerns**

**Top Need #3:** Many more undergraduates express an interest in science, technology, mathematics and engineering than eventually complete bachelor's degrees in those fields.

**Quantity of U.S. STEM Graduates.** Just over 122,000 American university graduates earned a degree in science and/or engineering in 2007.\(^40\)

According to the National Science Foundation, approximately one-third of U.S. bachelor's degrees are in science or engineering. The number pales next to Thailand's 69 percent, Japan's 63 percent, Singapore's 59 percent, Laos' 57 percent and China's 56 percent.\(^41\)

For advanced degrees, recent NSF data show that temporary residents earn more than half all U.S. doctorates in engineering, mathematics, computer sciences, physics and economics.\(^42\) Because advanced degrees are often required for R&D in science and engineering, this could adversely affect American innovation.

Since 1975, the United States has dropped from third to 13th in the world in terms of proportion of 24 year-olds who hold engineering degrees. Within the United States the number of aerospace engineering degrees awarded fell 47 percent from 1991 to 2000.\(^43\)

**Retention of Students in STEM Majors.** The undergraduate years have a profound influence on career direction and can provide a springboard for students who choose to major and then pursue graduate work in science, mathematics and engineering. Many more undergraduates, however, express an interest in science, mathematics and engineering than eventually complete bachelor's degrees in those fields.

In numerous surveys undergraduate students have indicated that “poor teaching” and “unsatisfactory learning experiences” were the primary reasons for switching majors and leaving the sciences.\(^44\)

Studies have found that hands-on research opportunities have boosted the retention of students in STEM fields. Students who have an in-depth understanding of engineering through a program like Project Lead The Way switch majors half as much as the national average. Students who participated in an undergraduate research experience generally reported a greater interest in STEM research, greater understanding of the research process and the strategies and tools that scientists use to solve problems and a broader sense of career options in the field.

**Attracting More Women and Minorities.** As minority groups grow as a percentage of the U.S. population, increasing their participation rate in science and engineering jobs is critical if we are to just maintain the overall participation rate among the U.S. population. Currently, the data show a disproportionate non-representation of women and minorities earning STEM degrees and in the STEM workforce.

In its latest Science and Engineering Indicators,\(^45\) the National Science Board reports that in terms of STEM degrees, males earned the majority of bachelor's degrees awarded in engineering (80 percent), computer sciences (78 percent) and physics (79 percent). According to the American Society for Engineering Education, only 18.1 percent of engineering bachelor's degrees went to women in 2007-2007. African-American and Hispanic student representation accounts for only 11 percent of engineering bachelor's degrees, despite comprising over 27 percent of the U.S. population.\(^46\)
Enrollment in Two-year Institutions. In addition to four-year institutions, those going into two-year and technical schools are just as important to our industry. “Vocational” aerospace education and training programs have experienced declining enrollments over the past 10 years even though 50 percent of the current aerospace workforce is made up of workers in installation, maintenance, repair and production. Most of these workers have completed stand-alone apprenticeship programs or intensive training programs that combine on-the-job training with classroom instruction leading to an associate’s degree from a community college.

While some major aerospace companies have apprenticeship programs to train production and technical personnel, few currently have apprentices in their programs due to the downturn in the economy. The need to replace retiring workers over the next two decades, however, points to the importance of starting to refill the “pipeline” of qualified workers now.

Analysis of the economic benefits of apprenticeship programs shows an impressive $50 return for every dollar of federal investment.

Industry Response to Post-secondary Concerns

At the post-secondary level, AIA member companies report that internships are the largest activity for this demographic.

Launch into Aerospace. Launch into Aerospace is an AIA Web site geared toward providing high school and undergraduate students with information about careers in aerospace. Students will find information about aerospace programs, internship opportunities and general information about working in the industry. Students will also find a link to “Ride the Leading Edge,” a video featuring three young engineers in the aerospace industry who discuss their experiences as young professionals.

Examples of some individual company efforts that support post-secondary education are:

- BAE Systems – “Introduction to Engineering Design.” BAE employees design projects and mentor first-year engineering students.
- Lockheed Martin – “SAE Collegiate Design Competition.” Lockheed Martin hosts collegiate student teams from across the nation for an airplane design competition.
- Textron – “Engineering Boot Camp.” Junior-level engineering students design a flight control system with the assistance of Bell Helicopter employees.

Industrywide STEM Education Statistics. In the Launch into Aerospace report, AIA members declared that the aerospace industry must and will take sweeping and coordinated action now to ensure the ongoing competitiveness and success of U.S. aerospace.

In an effort to get coordinated, AIA surveyed its members to seek input on their STEM education initiatives. The purpose of the survey is to form a broader picture of how industry as a whole is responding to STEM education challenges. Understanding where resources are being placed will help the industry to re-examine and strategically address the issue.

Based on response to the AIA member survey:

- Member companies on average support 26 STEM educational programs.
- Seven out of 10 member companies provide employee/volunteer support to STEM education programs.
- Ninety percent of member companies encourage their employees to volunteer or mentor students.
• STEM education programs most frequently address high school students (75 percent of respondents).

Forty-four percent of member companies have STEM education programs geared toward women and 47 percent have programs geared toward minorities.

• Ninety-one percent of member companies offer or support some kind of STEM education programs.

And based on our respondents, we found that AIA member companies on average invest about $8 million per year on STEM education initiatives. Companies with more than 100,000 employees spent on average $10 million.

This report highlights the activities of several AIA member companies on the STEM education front. Some have been ongoing for decades, and many involve collaboration with local communities through teachers or principals, nonprofit organizers, local government and other community leaders.

Through these private-public partnerships, aerospace businesses have shown time and again their commitment to improving the lifelong career prospects of students, and educators have responded positively to industry's interest and support. But industry can't do it alone. In the next section of this report, we provide recommendations to our government partners.

SECTION 4

RECOMMENDATIONS TO GOVERNMENT PARTNERS

AIA member companies know the importance of making a difference on the community level, but the aerospace industry also realizes that the STEM workforce issue now requires a national systemic approach. Given the current state of our economy and the looming shortage of qualified workers for high-technology industries, addressing the problem on the grassroots level remains necessary but is not enough. State and national leaders must also play a part in solving the problem nationwide.

Our research, experience and interaction with a variety of stakeholders have led AIA’s Industrial Base & Workforce Committee to the following recommendations (in no particular order). They are global in scope and address many of the top needed actions for our STEM workforce pipeline mentioned in the previous section. They are also intended to show how government and industry can partner in solving the national workforce crisis.

RECOMMENDATION 1: ESTABLISH, FUND AND IMPLEMENT A STRONG INNOVATION AND ECONOMIC COMPETITIVENESS AGENDA.

The national agenda should prioritize the development of a robust, homegrown, scientific and engineering workforce, should include the recommendations of this report and should be made in consultation with education and business leaders.

The aerospace workforce challenge is an intrinsic part of a much larger issue of economic competitiveness and growth. In order to truly make an impact, national leaders must make a public commitment to solve the U.S. education and workforce issue in the context of a strong innovation and economic plan agreed to by the executive branch, Congress and other stakeholders.

U.S. policy toward domestic aerospace employment must reaffirm the goal of stabilizing and increasing the number of good and well-paying jobs in the industry. Doing so will not only promote creation of new jobs...
here in United States but also will foster development of an American workforce prepared to lead the nation in the 21st century.

We urge the Obama Administration and the 111th Congress to make American competitiveness and the preparation of a robust, highly capable and technically skilled workforce a top priority. Many potential aspects of this agenda are embodied in the America COMPETES (Creating Opportunities to Meaningfully Promote Excellence in Technology, Education and Science) Act, passed in 2007 but never fully funded.

**RECOMMENDATION 2: CREATE A CABINET-LEVEL EXECUTIVE BRANCH STEM EDUCATION COUNCIL.**

*In consultation with education and business leaders, this STEM council should work across federal departments to identify, align and coordinate government efforts on STEM education toward achieving common strategic goals.*

Our industry leadership has undertaken an initiative in which member companies will inventory and assess the STEM programs they already support. The next step is for them to align their programs in an effective, strategic manner that will produce significant results in developing the next-generation aerospace workforce.

In a similar vein, we believe that the federal government should create a high-level official body in the executive branch to identify, assess, strategically align and oversee government investments in STEM education programs.

We applaud the first steps taken by the Academic Competitiveness Council in inventorying federal programs that found that more than $3 billion dollars had been spent by the government on STEM programs in fiscal 2006. Common sense suggests that the next step is to determine how better to measure and coordinate all these programs to ensure meaningful results.

Additionally, this federal council should work with state governments as well as private nonprofit and for-profit entities to identify common goals. Only by such cooperation, coordination, partnerships and alignment can we activate a systemic approach that will produce real solutions.

One possible model for the federal workforce council is the Interagency Aerospace Revitalization Task Force led by the Department of Labor with members from the U.S. Departments of Commerce, Defense, Education, Energy, Homeland Security and Transportation’s Federal Aviation Administration; the National Aeronautics and Space Administration; the National Science Foundation; the President’s Council of Economic Advisors; the President’s Office of Science and Technology Policy; and with broad advisory participation from the aerospace industry and educators. We believe that a similar body should be created to address the overall national STEM workforce issue.

**RECOMMENDATION 3: EACH STATE SHOULD CREATE ITS OWN EXECUTIVE BRANCH STEM COUNCIL.**

*State councils, in consultation with education and business leaders, should work across state government departments to identify, assess, align and strategically coordinate statewide efforts on STEM education toward common goals.*

Ultimately, education is a state and local endeavor, and so coordination and collaboration at this level is at least as important as at the federal level.

AIA has come across many instances of regional collaboration where public-private partnerships have developed among businesses, local government and educational institutions. We’ve seen some examples of
very mature regional partnerships with burgeoning programs and are amazed at the results these groups have achieved.

For example, we’ve been informed about cases where business leaders interfaced with their local community colleges for workforce development programs. Doing so created win-win-win situations for all players: the community college is able to attract more students because students know there is a job waiting for them once they finish the program; the business wins by getting workers with the skill-sets they require; and government wins because more people working in good jobs strengthens the local economy.

We recommend that state leaders establish STEM regional collaborative bodies in their state and 1) align these groups into a statewide strategic framework, 2) provide resources for groups with proven and demonstrable progress and 3) scale up those regional programs where possible.

**RECOMMENDATION 4: REVISE THE NO CHILD LEFT BEHIND ACT TO IMPROVE STUDENT ACHIEVEMENT IN STEM AND OPTIMIZE PREPARATION OF STUDENTS FOR PURSUING TECHNICAL CAREERS.**

Such revisions could include requiring all states to administer the same age-appropriate test on math and science set to the highest international standards; providing schools with resources to meet these tests; strengthening and improving leadership capacity for school administrators and teachers, including provisions on teacher recruitment and retention; and placing more emphasis on math, science and technology at all grade levels. The Obama Administration should consult with existing programs, such as Project Lead The Way, to consider establishing a national curriculum standard for pre-engineering.

The No Child Left Behind Act has enabled educational progress by implementing tests that evaluate student performance and holding schools accountable by linking federal funding to performance, although there appear to be many issues with the current state of the act's implementation.

We have heard a common complaint that educators now “teach to a test.” When teachers are pressured only to cover material that will be tested, students miss the real-world application of their lesson plans.

Another problem is that the rigor of these tests varies from state to state, making it difficult for teachers and students to define achievement. A student deemed proficient in one state might be much more advanced than a “proficient” student in another state.

Because the industry wants the best in its homegrown workforce and, in many cases, our positions require citizenship for security reasons, we believe strongly that 1) tests should be set to the highest international standards in order to make the American workforce as competitive as other nations, 2) tests should be designed so teachers are able to provide real-world context to their lessons and 3) the federal government must provide the policies, tools and resources schools need to meet this challenge. Such resources include not only funding but also provisions that give school administrators more authority and support professional development for teachers.

**RECOMMENDATION 5: ENHANCE SUPPORT FOR TWO- AND FOUR-YEAR INSTITUTIONS THAT PROVIDE STUDENTS WITH HANDS-ON EXPERIENCE DIRECTLY TRANSFERABLE TO THE WORKPLACE.**

Government should play a role in requiring hands-on and inquiry-based learning and in reducing barriers for schools to be involved in such curricular and extra-curricular programs.
AIA supports STEM programs that give students real-world, practical experience. As discussed in the previous section, many AIA companies engage in hands-on activity that will increase the motivation of young people to pursue careers in technical fields and develop skills they can ultimately use on the job.

In order to expand hands-on and interactive learning, schools need to have more technology in classrooms, increase the number of teachers with experience in the field, add to the number of classes geared toward specific interests and teach what the industry needs. Programs such as Project Lead The Way help achieve this.

At the elementary and secondary school levels, government should require interactive learning to be part of the curriculum and support these activities by providing the necessary technology and equipment for young people to use. Industry can assist. In secondary schools, career readiness should be emphasized and career technology education supported.

At the post-secondary level, government and academia should work with business to define the skills and competencies needed for the workforce and commit resources to meet these requirements. Additionally, many aerospace and defense companies offer internships and educational activities, but companies only have that capability where their facilities are located. We look to government to support post-secondary research that would enable young people to work on hardware. It’s not enough for students to read about rockets; they need to build and launch them in order to develop the skills aerospace companies will need. Consequently, we urge government to continue funding university research projects that allow students to gain hands-on experience.

**RECOMMENDATION 6: ENHANCE RECRUITMENT, PROFESSIONAL DEVELOPMENT AND INCENTIVES FOR NEW AND INCUMBENT STEM TEACHERS.**

Effective strategies must be developed to attract talented STEM professionals to teaching and to ensure that they are adequately prepared. Actions to increase the number of highly qualified K-12 math and science teachers could include strengthening proven teacher preparation programs; implementing comprehensive packages to recruit STEM teachers that include incentives such as scholarships, signing bonuses and differential pay; and establishing a national standard for STEM teachers.

Skilled STEM teachers are essential to the success of our students. We must position our teachers for success by providing better professional development and compensation. A few of our companies support programs for teacher development, and we believe that the federal government must step up and lead to ensure a nationwide impact in this important area. Government must support the expansion of proven programs, such as UTeach.

Government should also examine establishing national standards for STEM teachers. If a strong economic and competitiveness agenda demands that our students be held to world class standards, then their teachers must be judged in like manner. Raising the bar for STEM teachers will help make the profession more attractive. Government can lead the way on this, and industry can play an important supporting role if government enables our participation.

**RECOMMENDATION 7: PROVIDE TAX INCENTIVES FOR BUSINESSES THAT OFFER RESOURCES FOR STEM EDUCATION.**

Resources provided by aerospace companies should include research-related experiences offered to science and math teachers, sending visiting engineers for the purposes of informing students about STEM careers and loaning staff to support teachers in the classroom.
Aerospace companies have a variety of resources that can be employed to aid our educational system. AIA members encourage workers to volunteer as mentors, tutors and teaching assistants in their local communities, and many educators have contacted our members asking for assistance. While giving back to communities is a priority, for-profit enterprises with thousands of workers also need to be profitable.

Government can help reduce barriers for companies to participate in local schools by implementing tax incentives for allowing workers to go into classrooms to inspire students to STEM careers and assist educators with their lesson plans. Another option is to make time spent in classrooms supporting STEM education an allowable expense on federal contracts.

Government can also help produce new STEM teachers and enhance the development of existing ones by providing business with tax incentives for company activities that foster STEM teacher development.

**RECOMMENDATION 8: INCENTIVIZE AND REDUCE BARRIERS TO EMPLOYMENT OF RETIRING AEROSPACE WORKERS AS EDUCATORS OR TEACHING ASSISTANTS.**

Such actions include revising the federal tax code and other federal laws as appropriate to mitigate the financial impact for STEM retirees who decide to re-enter the workforce as teachers. Also, these actions would provide tax incentives to businesses for allowing employees time to enroll in an alternative teacher credentialing program toward becoming a STEM educator.

The existing aerospace STEM workforce possesses a wealth of knowledge and experience that can benefit students in the classroom. If offered strong teacher preparation/alternative credentialing programs, retirees who are looking to give back to the community can become a remarkable pool for the teaching workforce.

Industry, government and the education community must develop programs to help aerospace retirees transition to become teachers, mentors and serve in other roles. This approach would employ their experience and skills to help young people pursue STEM careers and transfer knowledge to the next generation.

Government must make it easier for retirees to re-enter the workforce by exploring legal and regulatory issues that pose barriers for older workers, such as within the Employee Retirement Income Security Act and the tax code. Government must remove the financial and other disincentives that actually make it more beneficial to retirees not to work. Keeping our greatly experienced older workers engaged in the workforce — contributing to the economy and helping educate and train the next generation of high-tech workers — is just common sense.

**RECOMMENDATION 9: STREAMLINE THE SECURITY CLEARANCE PROCESS WHILE STILL MEETING THE NEEDS AND REQUIREMENTS FOR THE NATIONAL SECURITY WORKFORCE.**

Actions might include working with the Office of Personnel Management and other agencies to reduce backlogs of security clearances, including implementing "universal reciprocity and portability" among agencies.

While security clearances are an imperative, we believe the process can and must be improved to meet the speed and security rigors of the 21st century. Tens of thousands of our industry personnel are subject to security clearance and renewal processes each year, and the heavy backlog means this process can take up to a year or longer to complete. This is unacceptable when our companies are working on contract deadlines and is costly to the government.
To make the process more efficient, we recommend that the security clearance process be managed and overseen by one government agency. This body should establish a universal system in which a clearance can follow a person from agency to agency, government to business, business to business and so forth — similar to how a social security number follows an individual.

CONCLUSION:

A COALITION OF COALITIONS FOR ALL STAKEHOLDERS

The long-term ability to recruit and retain a professional workforce with the needed skills will determine the viability of our industry for the remainder of this century and beyond. The challenges are real and they are growing. Absent positive action from national leaders, the future of the industry is at risk.

The aerospace workforce challenge is an intrinsic part of a much larger issue of economic competitiveness and growth. We urge the Obama Administration and the 111th Congress to make American competitiveness and the preparation of a robust, highly capable and technically skilled workforce a priority. This report lays out a number of recommendations in which the aerospace industry looks forward to working with government and others to solve this vitally important national issue.

AIA recognizes that there are many stakeholders in the STEM workforce issue. They include government, business, chambers of commerce, trade associations, K-12 educators, vocational-technical schools, community colleges, universities, nonprofit organizations, and the workforce development community — workforce investment boards, state and local workforce agencies. All stakeholders are trying to do their part but are working without the benefit of an overarching and integrated strategy. AIA’s membership, which is united in the need to fix this problem and present policy recommendations, is striving to coordinate its various education programs into an industrywide effort.

A major impediment to progress is that the American public is largely unaware of the STEM workforce challenge and how it is affecting the nation. To grow public awareness and support for STEM-related efforts and more effectively implement and integrate STEM programs, formalization of a “coalition of coalitions” is a logical next step.

AIA strongly believes that a politically neutral body whose only objective is to foster STEM education and U.S. competitiveness would be best suited to serve as the linchpin for the grand coalition. That organization would unite the coalition, guide the shaping of a national STEM education strategy and communicate the significance of solutions for all Americans, especially youth and their parents.

The AIA’s Industrial Base and Workforce Committee will follow up with a report in one year on the progress of the action items and solutions recommended in this report and with an update on the state of the industry and its workforce.
End Notes

2. It is important to note that while this report is written from an industrywide perspective and approved by several company representatives, most member efforts to date have been done singly rather than cooperatively. In fact, many AIA member companies have created their own STEM education programs. While this report is a call for partnership with the government, it is also a starting point for AIA to develop an industrywide collaboration with its membership.
14. Note: No data was collected to determine if workers choosing to leave their employer were leaving the industry or just the company/agency.
16. Note: Terminology of generation titles vary by demographers. For an example of intergenerational communication, see Harris, Rothenberg International, LLC, "Interpersonal Best: Working Tools for Life" Fall 2007.
17. Conducted by NAS Recruitment, an agency of McCann Worldgroup.
19. Presentation to AIA by Ken Disken, SVP of HR, Lockheed Martin.
20. AIA Member Survey, 2008. See "Methodology."
23. Those students being taught by teachers with no major, minor or certification were 21.9 percent for mathematics, 14.2 percent in science, 28.8 percent in biology/life science and 40.5 percent in physical science. Department of Education, National Center for Education Statistics, *Qualifications of the Public School Teacher Workforce: Prevalence of Out-of-Field Teaching 1987-88 to 1999-2000*, p. 10.
24. Education Week & EPE Research Center, *Diplomas Count 2008*.
30. PISA is sponsored by the OECD and is administered every three years with the latest test in 2006.
31. While these numbers are shocking, we might also take into account with comparative studies that the United States faces barriers that some of the higher scoring countries might not face. For example, top scorer Finland has a largely homogeneous population with few students who do not speak Finnish and fewer disparities in education and income levels. In contrast, the United States faces larger socioeconomic and even cultural disparities, such as a high English-learning population.
32. TIMSS is administered by the International Association for the Evaluation of Education Achievement and is administered every four years.
42. Ibid.
45. National Science Board, *Science and Engineering Indicators 2008*
48. Ibid.
49. Overall average is based on the number of respondents to AIA’s survey.
AEROJET

Aerojet has pursued many STEM-related initiatives to help prepare for future shortages in a competitive market.

Aerojet, through the GenCorp Foundation, seeks innovative and collaborative ways to enrich math and science education in our communities. Our mission is through grants, scholarships and employee contributions to support education in all the communities where we do business. Ninety-two percent of our contributions go to promote science, technology, engineering and math education with the goal of inspiring the next generation of aerospace engineers and rocket scientist.

Internally, Aerojet focuses on employee development by way of extensive technical training, mentoring in STEM-related disciplines, knowledge transfers, scholarships and a very competitive tuition assistance program to promote advanced degrees for our employees.

Externally, Aerojet is focused on education and employee community involvement programs that promote STEM education for children. We have two programs that are very successful:

• "Adventures in Aerospace" sends our engineers and scientist into schools to teach aerospace and propulsion through experiments and hands-on learning.

• "Educational Dollars for Doers" rewards employees for volunteering their personal time and talent in education. For 10 hours in the classroom, we make a $75 grant to the school on the employee's behalf. Our employees logged more than 14,000 volunteer hours last year.

We support many educational programs to encourage students to explore careers in engineering, such as Project Lead The Way, the Science Screen Report program, the Aerospace Museum of California, Discovery Museum, AIA's Team America Rocketry Challenge and many others.

The GenCorp Foundation gave nearly $1 million toward education in our communities last year. We have developed excellent relationships with the academic community to collaborate on issues that can be win-win for all of us.

Some of the programs we participate in are:

• Engineering internships.

• Diversity initiatives on various campuses.

• Educational gift matching program.

• University partnerships to help fund and support aerospace projects.

• Community college relations to assist in curriculum development.

• Support for science centers and science museums in our communities.

• The National Merit Scholarship Corporation.

• Many non-profit organizations with outreach to children.

• Regional science fairs.

• Challenger Learning Centers.

• FIRST.

We are proud of the commitment of our company and employees to make the world a better place one child at a time.

AMERICAN PACIFIC

We have a long history of providing scholarships to students at the University of Nevada - Reno. We are also active with the Engineering Council for UNLV, the UNLV Foundation and the Nevada State College Foundation. We fund research at Georgia Tech that involves both pre- and post-doctorate...
students. The research is primarily in chemistry but also involves electric propulsion. As a result of that program, we hired a key scientist who works in aerospace.

At times we employ co-op students during the summer from Southern Utah University and from Georgia Tech.

We encourage employees to participate in continuing education and reimburse their tuition expenses.

**BAE SYSTEMS**

In 2008, BAE Systems increased its contribution to FIRST (For Inspiration and Recognition of Science and Technology) to more than $1 million annually through donations of money, resources and employee volunteers. With this commitment, BAE Systems became a “Strategic Partner” of FIRST and its largest corporate contributor to FIRST Robotics Competitions (FRC). The financial commitment also funds FRC team grants and college scholarships for FIRST participants attending select universities across the United States.

Our strategic partnership with FIRST represents an investment in the future high-tech workforce that BAE Systems will need to draw upon to compete effectively in the 21st century. BAE Systems and FIRST share a common culture and goals — both organizations have a passion for science, engineering and technology combined with the social skills of cooperation, teamwork and leadership.

Since the early 1990s, BAE Systems has sponsored many teams and regional competitions throughout the United States, and more than a dozen former FIRST students have become BAE Systems employees while many more have interned in our offices. In 2008, BAE Systems directly supported more than 90 teams competing near our sites in 12 states and the District of Columbia. The company also sponsored seven FRC regional events as well as the FIRST Championship in Atlanta.

FIRST also provides opportunities for BAE Systems employees to get involved as team mentors and advisors, judges and competition hosts and coordinators.

In addition to our sponsorship of FIRST, we have committed to scholarship programs that support students pursuing engineering degrees at six focus schools: Penn State, Purdue University, the University of Arizona, the University of Maryland, Cal Poly and Rensselaer Polytechnic Institute. These schools were selected based on the following four factors:

- Geographic Proximity to one or more locations.
- Past Success (hiring, relationships, specific program).
- Diversity Enrollment.

BAE Systems supports approximately 200 internships at facilities across the company and also sponsors other STEM-related activities, including:

- Intro to Engineering Design – project designed and mentored by our engineers for first year engineering students.
- Engineering Diversity Technical Showcase – networking events for women and under-represented minorities in science and engineering.
- Diversity Awards Events – providing scholarship awards to students in The National Society of Black Engineers, the Society of Women Engineers and the Society of Hispanic Professional Engineers.
- Senior capstone design projects in the Inter-Disciplinary Design Program.
- College of Optical Sciences Industrial Affiliates Program (member).
- Senior Capstone Robotics Course.
- The Robotics Club.
- Project-Based Learning Institute – sponsor of three engineering design projects for senior capstone courses.

**B&E**

At B&E, we consider our employees our greatest resource, and company-sponsored education programs are promoted to ensure our success in the future. B&E has been able to retain the majority of employees that have gone through employer-sponsored education programs.

B&E offers its employees a tuition reimbursement program for work-related courses, with tuition reimbursement being a percentage based on the grade achieved.
B&E also sponsors a scholarship fund to Springfield Technical Community College.

B&E works with the Western Mass Tool Makers Association to provide offsite training for associates at the apprentice level. Apprentices also work alongside seasoned veterans to help hone their skills, which allows them to advance within the company. We are working on a mentoring system that will eliminate newer employees getting lost in the system.

To attract students into the machining industry, B&E sponsors school class trips down to the junior high level to tour our facility. The tours include giveaways and a lunch.

We have set up co-op work programs with local high schools in which students follow a work-based learning plan monitored by the school and B&E.

**BOEING**

Boeing has defined principles that guide educational involvement, including:

- Everyone deserves a quality education.
- Parents are the first and most important teachers.
- Learning starts at birth and continues throughout life in and out of classrooms.
- Additional resources are required to support minorities and under-served populations.
- All areas of society must be engaged in ensuring that our educational systems are producing individuals who can fulfill the requirements of the future workforce.

Five key strategies directing engagement and alignment of education-related activities and investments are:

1. **Early Learning**
   - Provides parents and other caregivers with access to training/resources in social, emotional and cognitive development for informed parenting to help children reach their full potential.
   - Raises public awareness of the importance of the first five years of life in social, emotional and cognitive skill development and ultimate success in life.

   **Example: Sid the Science Kid.** Boeing is a major supporter of this educational television series produced by KCET Public Television and The Jim Henson Company. This series promotes exploration, discovery and science readiness among preschoolers.

2. **Primary and Secondary Education - Teacher Development**
   - Provides quality professional development to teachers for delivery of rigorous curriculum in math, science and literacy that will motivate students to pursue challenging and fulfilling careers.

   **Example: Boeing Educators to SPACE CAMP®.** Since 1992, Boeing has partnered with the U.S. Space & Rocket Center to sponsor educators to its Space Camp facility in Huntsville, Alabama. More than 600 teachers have participated in Boeing’s program, reaching approximately 30,000 students around the globe.

3. **Primary and Secondary Education - Leadership Development**
   - Strengthens school leadership to improve and inspire teacher effectiveness.

4. **Primary and Secondary Education - Curriculum Alignment**
   - Promotes an aligned, comprehensive and coherent curriculum based on the highest international standards.

5. **Higher Education**
   - Supports educational programs for early learning, primary and secondary educators and school leaders.
   - Works to enhance undergraduate math, science, business, engineering and technology curricula.
   - Facilitates access to undergraduate students, including under-represented and economically challenged students, at educational institutions key to Boeing

   **Example: Boeing supports FIRST Robotics scholarships.**
   - Ensures alignment of curricula and programs to Boeings need for current and future employees.
   - Supports the company’s engagement with these institutions, including selected HBCU/MIs.
   - Fosters relationships with faculty to ensure students are prepared to meet the broad challenges in our society.
**Example: The Boeing Welliver Faculty Fellowship.** Since 1995 this eight-week program competitively selects professors globally to “look over the shoulder” of working professionals in technical, business and management career paths. This experience is transferred into the classroom with a practical application of technical and business skills.

- Support research and development to increase the technical knowledge base.

**GE AVIATION**

The GE Foundation Developing Futures™ in Education program seeks to create positive social change by using a systemic approach that begins with collaboration among key constituencies. Focusing on the entire district, not just one or several schools, grant activities engage central offices, teachers’ organizations, school administrators, local GE volunteers and other members of the community.

The core components of Developing Futures are:

- **Curriculum and Instruction:** Implementing research-based, districtwide math and science curricula aligned with globally competitive standards.
- **Professional Development:** Enhancing the ability of teachers to use meaningful, innovative and research-based strategies in the classroom through high-quality professional development.
- **Constituency Engagement:** Forming a common vision through facilitating collaboration among education leaders and administrators, teacher organizations, parents, GE leaders, students and community leaders and organizations.
- **Management Capacity:** Developing systemwide capacity to improve functional and financial efficiency and effectiveness within district central offices.
- **GE Engagement:** Leveraging the professional capacity and skills of GE senior executives and GE volunteers to support district improvement and student success.
- **Evaluation:** Tracking key metrics of change to support the implementation of the initiative and document success.

The grants are districtwide serving K-12 students in targeted GE communities. GE Aviation, which is headquartered in Cincinnati, is integral in supporting the grant objectives.

Cincinnati Public Schools received a five-year, $20 million grant in October 2006 from the GE Foundation, marking the largest nongovernmental grant ever received by the district.

Cincinnati Public Schools Interim Superintendent Mary Ronan said, “This grant is systemic, strategic and smart.”

**GENERAL ATOMICS AERONAUTICAL SYSTEMS**

General Atomics Aeronautical Systems, Inc. (GA-ASI) of San Diego, California, provides comprehensive solutions for military and commercial applications worldwide. A leading designer and manufacturer of unmanned aircraft and high-resolution and radar imaging systems, the company has a strong and ongoing need for talented, dedicated engineers and technicians.

GA-ASI recognizes the critical need to develop young people’s interest in engineering and technology and to help steer them to the educational choices that will feed into the company’s employee pool.

To stimulate their interest, GA-ASI encourages and supports its employees as volunteers in local schools from the primary grades through universities. The company sponsored teams of engineering students at the University of California, San Diego, in four of the annual AIAA Design/Build/Fly Competitions.

To help steer students to the educational fields that support the company’s business, GA-ASI maintains ongoing relationships with colleges and universities, such as the University of California at San Diego, the University of San Diego, Cal Poly at San Luis Obispo, the University of North Dakota, Iowa State University, Redstone College in Denver and Stanford University, Palo Alto, Calif.

To demonstrate to students the impact of their career choices, the company participates in workshops, such as the AUVSI Youth Education Program, at the association’s annual meeting. In 2008, GA-ASI financially supported the workshop and gave a dynamic presentation about the industry.
GA-ASI was ranked second in Aviation Week & Space Technology magazine’s 10th annual workplace survey for promoting diversity in the workplace and valuing its employees.

GOODRICH

Goodrich began a focus on STEM several years ago as a way to strengthen the core pipeline of a diverse workforce as well as develop ways to generate curiosity and excitement about the worlds of math and science for K-12.

The company’s business depends on children who will learn more than just basic reading, writing and arithmetic. The Goodrich philosophy is a comprehensive approach to education reform through broad programs that deepen a focus on STEM — whether through mentoring engineering students, an innovative middle school arts program with proven ties to increased science abilities, an after-school science program for at-risk and low income students or a STEM-focused Junior Achievement pilot program Goodrich hopes to model across the company's enterprise.

Research conducted by Goodrich has shown that K-12 continues to be the richest environment for these types of learning programs. While the company’s programs are presented to the general school-aged populations, Goodrich continues to allocate donations with a special emphasis on diverse, at-risk and low-income populations.

HARRIS

As a responsible corporate citizen, Harris Corporation plays an active role in strengthening the quality of life in America and the communities it calls home.

The corporation contributes generously to initiatives and nonprofit organizations internationally, nationally, regionally and locally. Employees also donate countless volunteer hours to advance a variety of causes that are shaping a difference throughout the world.

Harris is dedicated to the learning development of students within the fields of math, science, technology and engineering and its commitment to quality STEM education is evident in the programs Harris Corporation supports and funds.

Harris supports the following K-12 educational programs through funds, employee volunteers and mentors, or other company resources:

- Teach the Teacher Seminars, providing Brevard County secondary teachers and administrators with the most current information and resources within four primary subjects.
- Harris-sponsored art and science fairs, supporting all public and private schools in Brevard County participating in the fairs.
- Harris Science Teacher of the Year in which a teacher is given a stipend and inducted into the Harris Hall of Fame.
- Mini-grants for funding proposals from private and public school teachers to provide support for math and science programs.
- Harris Science Saturdays, creating engagement within the STEM fields at an early age.
- Mentors, funding and development opportunities for Bayside Engineering and Technology Academy.
- Engineering Week to engage high school students in STEM-related professions.
- Harris support of 65 district wide STEM-related teams, such as FIRST/SCHEME/OM and Florida Future Problem Solving Program.

Harris is also committed to supporting young talent at the college level through the funding of several STEM-focused universities and programs, including the University of Central Florida’s Harris Corporation Engineering Center, Computer Lab and Atrium; the Rochester Institute of Technology's Harris Laboratory; Georgia Tech’s Harris Nanotechnology Lab; the University of Florida’s Harris Corporation Rotunda and Lecture Hall; North Carolina State University’s Harris Corporation Student Leadership Office; Purdue University’s Harris Corporation Classroom; Clemson University’s Harris Corporation Interview Room and Florida Institute of Technology’s Harris Center for Science and Engineering and Harris Institute for Assured Information.

Several Harris employees also volunteer and mentor through STEM educational programs and sit on the boards of directors. A few of the organizations for
which Harris holds board of director seats include
the Florida Center for Research in Science,
Technology, Engineering & Mathematics; the
Aerospace Industries Association; the Florida High
Tech Corridor Council; the University of Florida;
the University of Central Florida and Florida
Institute of Technology Colleges of Engineering
STEM Dean’s Advisory Board; North Carolina State
University Department of Electrical and Computer
Engineering Industrial Advisory Board; the Florida
Space Authority; and the Florida Research
Consortium.

HONEYWELL

Through a unique community outreach initiative
called Honeywell Hometown Solutions, Honeywell
and its employees (via contributions to the annual
Employee Giving Campaign) provide an array of
innovative programs and activities aimed at
stimulating student interest in math and science,
especially at the middle school level.

Under the general theme of “Creating the Next
Generation of Scientists,” the program equips math
and science teachers to do an even better job of
teaching space-based science and opens student
minds to the possibilities of a career in the technical
fields.

A centerpiece of these efforts is a traveling road
show called “FMA Live!” Created in partnership
with NASA, “FMA Live!” is an award-winning
science education program named for Sir Isaac
Newton’s second law of motion (force=mass X
acceleration). It uses professional actors, original
songs, music videos and interactive science
demonstrations to teach middle school students
Newton’s Laws of Motion and the universal
principle of gravity. More than 170,000 youngsters
at 450 schools in 39 states have now seen this
program.

Other key programs include the Honeywell
Educators @ Space Academy STEM, a scholarship
program for middle school science teachers to
attend a week-long immersion program at the U.S.
Space & Rocket Center in Huntsville, Ala. Since this
program’s inception, Honeywell and its employees
have sponsored more than 1,000 scholarships for
teachers from 24 countries and 49 U.S. states. They
are now back in their classrooms, reaching more
than 70,000 middle-schoolers with interesting and
effective lessons in science.

Also, through the Honeywell – Nobel Initiative, the
company provides live, on-campus events that bring
Nobel laureates in physics and chemistry to
universities in North America, Europe, India and
China for high-impact interaction with students and
faculty. By so doing, one generation of leading
scientists is linked with the development of the next.

Through the Honeywell Fiesta Bowl Challenge, a
massive school competition is conducted in
conjunction with the annual Fiesta Bowl in which
schools compete for the best design of the next-
generation of the International Space Station.
Judging is done by NASA astronauts and Honeywell
engineers.

Beyond these special programs, Honeywell
continuously encourages and creates opportunities
for employees to serve as mentors in nonprofit
organizations in their communities that are focused
on advancement in the fields of math and science.

IBM

Improving public schools around the world
continues to be IBM’s top social priority. Through
strategic initiatives, the company is helping solve
education’s toughest problems with solutions that
draw on advanced information technologies and the
best minds IBM can apply.

To prepare the next generation of leaders and
workers who will lead in the Innovation economy, a
number of IBM’s projects are focused on science,
technology, engineering and math education.

EX.I.T.E. Camps: Industry experts says that girls
as young as 10 to 12 have already developed
misperceptions about technical careers that steer
them away from the advanced math and science
courses necessary to earn a technical degree in
college. The IBM EX.I.T.E. Camps are week-long,
summer day camps for middle school girls (ages 11-
13) designed to show them the exciting career
opportunities in technology and engineering,
introduce them to female role models who can
demonstrate what they can achieve in these fields
and give them hands-on experiences in technical
activities that are fun, challenging and educational.

PowerUp! (www.powerupthegame.org): IBM
developed PowerUp!, a free, multiplayer 3-D online
game to help lure students to careers in engineering.
The game relies on student interest in virtual fantasy worlds to teach about engineering principles as they save the planet “Helios” from ecological disaster by enabling them to ride over rugged mountains in buggies to build solar towers or search through grim junk yards to repair wind turbines.

The activities within the game, which were developed in partnership with the New York Hall of Science as part of IBM’s TryScience initiative, have been correlated to U.S. national science standards and developed with input from high school students. It also includes lesson plans for teachers to leverage PowerUp! in the classroom. Young people also learn about energy conservation by the choices they make in completing their missions.

PowerUp! was chosen as the official game of Earth Day 2008.

**Transition to Teaching:** Through Transition to Teaching, IBM is helping address the critical shortage of math and science teachers by leveraging the brains and backgrounds of some of its most experienced employees, enabling them to become fully accredited teachers in their local communities upon electing to leave the company. Transition to Teaching began as a pilot in January 2006, and currently has about 100 participants. Eight IBMers have graduated from the program and have become math and science teachers. IBM is reimbursing participants up to $15,000 for tuitions and stipends while they student teach as well as providing online mentoring and other support services in conjunction with partner colleges, universities and school districts.

**TryEngineering** (www.tryscience.org): IBM is the technology partner of TryEngineering, a new Web site owned by IEEE. Designed to appeal to a wide range of audiences, TryEngineering.org, aims to inform teachers, school counselors, parents and students about engineering and what engineers do through a Web site, launched June 2006, that combines interactive activities with valuable information on careers in engineering.

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**Employee programs include:**
- Educational assistance in the form of tuition payment for undergraduate, graduate and post-graduate academic education.
- In-house training and education related to job specific skills and knowledge education.
- Purchase of outside educational content as well as owning a business unit, DP Associates, that develops eLearning and CBT content.
- Satellite broadcast live training and Webinars.
- More than 1,500 eLearning courses and other courses taught by subject matter experts as well as synchronous and asynchronous courses.

**Programs for students, teacher academic institutions and communities include:**
- Support legislation at the state level to fund technology enhancement programs, provide co-op and internship programs, scholarships and funding for academic social organizations.
- Sponsor design competitions and provide employees to lecture on current technology and challenges.
- Provide funding to enhance teacher proficiency in math and science.
- Support “Operation Spark” to foster an interest in math and science among students in grades 6 to 9, increase proficiency in math and science for students in grades 6 to 9 and increase teacher proficiency in instructing math and science.

“Operation Spark” is a $200,000, three-year project in cooperation with Texas A&M and Greenville ISD. It is a cooperative L-3 and Texas A&M science and math education outreach initiative to enhance awareness of technology and engineering in middle schools. It is an enabler for educating non-technical classroom teachers as well as students.

**Academic and industry initiatives include:**
- Support academic and industrial educational initiatives through memberships, funding, leadership, mentoring, serving on boards, councils, and university consortiums, FIRST robotics competitions, Operation Spark, National Society for Black Engineers, National Society for Hispanic Engineers, National Society for...
for Women Engineers, STEM programs and the Naval Academy Foundation.

**LOCKHEED MARTIN**

Education is the primary focus of Lockheed Martin’s community outreach with 50 percent of contributions and activities geared toward strengthening student capabilities in engineering, technology, science and math. While the corporation has a focused, strategic, K-12 education initiative called “Engineers in the Classroom,” Lockheed Martin supports other education activities to bolster local community priorities, diversity, and infrastructure.

**Engineers in the Classroom:** Focused on developing the next generation of engineers and technologists, this initiative is based on a whole-systems approach to involve students, teachers, parents, Lockheed Martin engineers and community partners. Nationwide in scope and tied to national standards, the initiative will grow to put an estimated 11,000 students in the STEM pipeline over the next five years. Mandatory teacher training and optional guidance counselor training are embedded in the initiative.

**Strategy:**

- Partnerships with high schools near Lockheed Martin facilities that have or will establish a STEM focus. Then partner with the middle schools that feed into those high schools. Then partner with feeder elementary schools.

**Initiative Components:** School partners

- Engineering-related curriculum to provide academic rigor.
  - Project Lead The Way is Lockheed Martin’s curriculum partner. Schools must have or put in place the PLTW curriculum.
- Extracurricular activities to show real-world relevance
  - Support for a multitude of activities that provide project-based, hands-on reinforcement of concepts learned in the curriculum, like Space Day, Team America Rocketry Challenge, FIRST Robotics, National Science Bowl and Science Olympiad.

- Engineer role models to building lasting relationships.
  - Lockheed Martin engineers volunteer to go into classrooms or coach extracurricular teams.
- Merit-based scholarships for graduates of the partner school who are accepted into engineering-related, post-secondary degree programs.

**Other Activities**

- **Space Day** is a year-round program founded by Lockheed Martin that uses space-related activities to interest and inspire students to pursue aerospace careers.
- **National Engineers Week.** Through classroom visits, Lockheed Martin engages more than 50,000 students each year.
- **Teacher training.** Lockheed Martin supports initiatives in local communities to train teacher-leading who initiate, implement and sustain math and science reform efforts.
- **Out-of-school program curriculum** supported the Girls Scouts to develop curriculum related to information technology and are currently working with 4-H to develop a broad, K-12, engineering-based curriculum for use by a variety of out-of-school groups like scouts, YMCA, and Boys & Girls Clubs.

**Post-secondary Activities:** Lockheed Martin supports a a variety of programs at the collegiate level, including many with a diversity focus:

- Internships.
- Co-ops.
- Scholarships.
- Senior design projects.
- Student competition teams.
- Student chapters of engineering-related professional societies, such as the Society of Women Engineers.

**NORTHROP GRUMMAN**

**Philosophy:**
Northrop Grumman Corporation, a leading global defense and technology company, has designed and implemented a program to increase student interest in math and science called “Defining the Future.” Multifaceted and active at both national and local...
levels, the program relies heavily on partnerships with the community and employee volunteerism. “Defining the Future” places a heavy emphasis on working with women and people of color, groups particularly underrepresented in the math and science field. It also provides teachers with tools and resources to inspire student interest in math and science.

The program addresses the declining number of engineering students in technical/vocational schools in the United States. All Northrop Grumman Corporation business sectors are involved in the nationwide program at all educational levels — elementary through college.

Programs include curriculum development, teacher development, mentoring, support to schools, support to the community and scholarships and sponsorships.

The company’s key STEM support includes programs such as:

- California Science Center.
- Connecting Educators to Engineering legacy project.
- CyberChase Television Show and National Exhibit.
- High School Involvement Partnership (HIP) Program.
- MATHCOUNTS.
- National Board for Professional Teaching Standards.
- National Conference on Aviation and Space Education.
- National Diversity Engineer Programs.
- National Science Foundation Extraordinary Women in Engineering Coalition.
- Partners in Education.
- Project Lead The Way.
- Sally Ride Science Festivals/Toy Challenge.
- Scholastic curriculum Define Your Future.
- Smithsonian Heritage Family Days.
- Teach for America.
- Weightless Flights of Discovery Program for Teachers.
- Company sector local programs, including tutoring, mentoring, career day presentations.

**RAYTHEON**

Raytheon believes it is essential to secure the technical talent pipeline for the future. With a great generational transition on the horizon as “baby boomers” near retirement, the company believes it is imperative to help students prepare for the skills they will need to enter careers in science, technology, engineering and mathematics (STEM).

Raytheon’s most visible activity is its MathMovesU® program designed to engage middle school students on their own terms and make the connection between math, their interests and “cool” careers. The program’s cornerstone uses a favorite medium for youth — an interactive Web experience.

The Web site is “immersive,” designed to create “aha” moments by presenting math in its relation to some of the topics middle school students care most about — music, sports and fashion. It uses a variety of puzzles and games to encourage development of math skills in fun and creative ways.

The goals of MathMovesU are to

- Transform math’s image among middle school students.
- Motivate students to meet their potential in math and science education.
- Help create and sustain a strong, talented and diverse workforce by supporting math and science education.

Since its inception, the MathMovesU Web site has attracted more than 600,000 visitors from every state, the District of Columbia and 107 countries. The program awards hundreds of scholarships and grants to students, teachers and schools nationwide each year. In the last two years, Raytheon has awarded 900 MathMovesU scholarships to students along with matching grants awarded to their schools and 65 “Math Heroes” (teachers and tutors) who each received $2,500 grants.

In addition to MathMovesU, Raytheon is a national sponsor of MATHCOUNTS®, a nonprofit organization that promotes math excellence among U.S. middle school students by providing financial and volunteer resources.

Raytheon is one of the largest supporters of FIRST Robotics, supporting as many as 29 high school teams across the nation. The company provides scholarships to select students who have participated
More than 4,000 Raytheon employees volunteer to support math and science education in their communities each year through MathMovesU, MATHCOUNTS, FIRST Robotics and other activities. And the company holds more than 100 events annually to engage middle school students in math and science.

In addition to these activities, Raytheon partners with the Business-Higher Education Forum to provide corporate leadership to strengthen STEM education and to promote college readiness, access and success for underserved populations, particularly in the STEM disciplines. BHEF is an organization of Fortune 500 CEOs and senior executives, college and university presidents, and foundation leaders working to advance innovative solutions to our nation’s education challenges in order to enhance U.S. competitiveness.

Raytheon Chairman and CEO William H. Swanson is a member and the current vice chair of BHEF.

**ROLLS-ROYCE NORTH AMERICA**

**Project Lead The Way (PLTW)**

A program that embodies the expectations of rigor and relevance as outlined in the U.S. Department of Energy’s High School Leadership Summit is a not-for-profit engineering program. Its mission is to ensure the success of an increasing and more diverse group of students in engineering and technology study — fields experiencing critical shortages.

PLTW offers:

- Fully developed contemporary curriculum for all of its courses in middle and high school programs.
- Rigorous professional development for classroom teachers at more than 30 university sites nationwide.
- A four-year college credit for high school students in PLTW courses through a school certification process and a college-level end-of-course exam.
- An optional national bid on all equipment and supplies needed to implement the courses at significant savings.
- A strategic plan that focuses on success for all students, including female and under-represented minorities.

**Building the Innovation Generation**

This program is a collaborative effort between industry, government and academia in the form of internship opportunities for faculty and students as well as meaningful student projects to develop high-calibre engineering skills and leadership.

**Pathways to Engineering**

The intent of this program is to create a math, science and pre-engineering concentration at the fifth grade level that will provide a bridge between middle school and Project Lead The Way or math and science magnets in high school. High schools will develop courses that will integrate into Indiana University-Purdue University at Indianapolis with credit hours awarded. The collaboration will include internships with Rolls-Royce.

The benefits of participation in this proposal are:

- Community involvement.
- Diversity.
- Increasing the engineering pipeline.
- Increasing retention by recruiting local talent.

**High School Senior Internship Program**

- Pre-college internship for outstanding high school seniors interested in pursuing the engineering field.
- Upon graduation from high school, students will be eligible to apply for the co-op program.
- Requirements:
  - Work as part of academic curriculum.
  - Must be a senior in high school.
  - Minimum GPA 3.5.
  - Demonstrated interest in engineering.
  - Demonstrated performance in math, science and physics coursework.
  - Faculty recommendation.

**FIRST Robotics**

- Multinational nonprofit organization that aspires to transform culture, making science, math, engineering and technology “cool” for kids.
Minority Engineering Advancement Program

- Established in 1976 in response to the small number of minorities in the engineering profession.
- Dedicated to improving the recruitment and retention of minority students in engineering and technology.

Try-Math-Lon

- Rolls-Royce supports the Regional and National “Try-Math-Lon” competition sponsored by the National Society of Black Engineers.

ROCKWELL COLLINS

Rockwell Collins invests in programs that inspire students to pursue studies in math, science and engineering to build a foundation for careers as engineers and innovators in our industry. They use hands-on activities that provide real-world applications of math and science.

Rockwell Collins strives to involve its employees and retirees as professional role models in our communities. The company has taken a leadership role in driving this K-12 education outreach at its headquarters in Iowa and has expanded to regional locations with the greatest need. Guiding principles incorporate a national scope with a local focus and teamwork, collaboration and inclusiveness between all partners in the education system.

Under the banner of ENGINEERING EXPERIENCES, Rockwell Collins engages K-12 education levels to develop life-long learning opportunities. Some activities are:

- FIRST (For Inspiration and Recognition of Science and Technology) partnering on LEGO League, Tech Challenge and Robotics Competitions.
- EWeek classroom, community and diversity event/activity engagement through Introduce a Girl to Engineering, career awareness events with engineering societies.
- Project Lead The Way sponsor.
- Future City Competition sponsor.
- Team America Rocketry Challenge supporter.
- University Partnerships - providing resources and student teams and research initiatives.
- Corridor STEM Initiative - a pilot business, government and education community partnership model in Cedar Rapids/Iowa City funded by the state to build awareness of STEM importance and career opportunities.
- Rockwell Collins’ Initiatives.
  - Rockwell Collins Road Show – employees demonstrate actual business engineering problems and solutions in schools.
  - Local tutoring for K-12 students.
  - Job shadowing, mentoring, internships, tours, career presentations to increase career awareness in higher education.
  - REACT (Rockwell Educational Access to Computer Technology), providing refurbished computers schools.

Rockwell Collins’ goals are to better prepare students for careers in our industry and to keep the U.S. workforce competitive through sound STEM experiences that begin early in education.

TEXTRON

K-12 Programs

FIRST Robotics. Across the country Textron sponsors 13 FIRST Robotics teams, providing funding of up to $10,000 and engineering mentors. Bell Helicopter introduced the Dunbar High School team from the Fort Worth Independent School District to Astronaut Sally Ride for a dialogue on their project and aspirations and her space exploration experiences.

BEST Robotics. Cessna sponsors BEST Robotics teams that encourage students to learn about engineering, science and technology by developing a robot and participating in competition.

Math & Engineering Summer Camp. Twenty-five high school students attended a Math and Engineering Summer Camp this summer at Bell Helicopter's flight test facility where they were challenged with design-and-build projects.

Charitable Trust. Bell contributes thousands of dollars each year to schools and colleges through the Textron Charitable Trust. This is in the form of scholarships and cash contributions to the general fund of organizations. For instance, Bell contributed $10,000 this year to Dunbar High School to promote its Robotics Program.
Employee Volunteers. Textron volunteer in a variety of ways, including the Expanding Your Horizons program to encourage young women to pursue science, technology, engineering and mathematics (STEM) careers and A World in Motion program that brings together teachers, students and industry volunteers to explore physical science while addressing mathematic and scientific concepts and skills.

Facility Sharing. Many Textron facilities are shared with high school and college students and teachers to help them appreciate technology and offering experiences, providing material teachers can use to inspire students to pursue STEM careers.

College Programs

Engineering Student Boot Camps. In 2008 Bell Helicopter conducted its first Engineering Boot Camp. Ten junior-level engineering students from the University of Texas participated. The students were competitively selected and equally split between aerospace engineering and mechanical engineering majors. They were assisted by six Bell engineers, who had graduated from UT less than three years before, and Engineering & XworX Technical Fellows.

Students designed a flight control system for attitude independent aircraft. At the conclusion of the boot camp, they briefed Bell's leadership team on their approach.

Bell credits this type of recruiting strategy with building excitement for Bell Helicopter, Textron and the aerospace industry.

The camp was repeated in March for two more schools and will be continued into 2009. Ten of the 25 students in the boot camps were from under represented groups. The key performers from the boot camp were offered positions as summer interns for Bell.

Summer Intern Program. Most Textron engineering organizations conduct summer intern programs to give students exposure to engineering jobs and to give the company exposure to potential employees.

Promoting Diversity. Textron is a corporate member of the Society of Women Engineers, the National Society of Black Engineers and the Society of Hispanic Professional Engineers and sponsors employees in local and national activities with the societies.
APPENDIX B:
AIA Member Company Education-Workforce Survey Highlights

In June 2008 AIA prepared a survey of its member companies to acquire accurate and comprehensive data about current and anticipated STEM workforce demands in order to present a compelling case. The survey was sent to 105 regular member companies. AIA received 31 responses, a 30 percent response rate. Companies of all sizes and scopes responded, providing industrywide trends.

Respondents were asked to report corporatwide numbers for current and future workforce turnover data and STEM education program efforts. Individual company data was aggregated and analyzed to identify leading STEM concerns. Data provided by smaller companies was often much different than larger companies. Therefore, in addition to total aggregations, data belonging to only the largest 70 percent of respondents was also aggregated for separate analysis.

Additionally, some respondents included a brief company profile that outlined efforts regarding their STEM inspiration, education and training efforts.

Following is a sample of survey questions and cumulative responses.

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>How many of your employees are eligible to retire?</td>
<td>8.3 percent of employees are eligible to retire, although only 1.33 percent retired in 2008.</td>
</tr>
<tr>
<td></td>
<td>In 5 years, the aerospace industry will have 110,501 employees eligible to retire.</td>
</tr>
<tr>
<td>What, if any, percentage of your workforce has retired in 2008?</td>
<td>1.33 percent actual retirements is much lower than percent eligible to retire.</td>
</tr>
<tr>
<td></td>
<td>8,772 workers retired from the aerospace industry in 2008.</td>
</tr>
<tr>
<td>How many STEM-focused education programs does your company support?</td>
<td>26 (the average number of educational programs supported by each company).</td>
</tr>
<tr>
<td>How much funding does your company contribute to these education programs?</td>
<td>$8,027,864 (the average funding contributed to educational programs each year per company).</td>
</tr>
<tr>
<td>What other forms of support does your company provide to its STEM education programs?</td>
<td>Employee mentors and employee volunteers are equally popular (71 percent each).</td>
</tr>
<tr>
<td>Does your company require or encourage its employees to volunteer or mentor students?</td>
<td>No companies require their employees to volunteer or mentor students.</td>
</tr>
<tr>
<td></td>
<td>90 percent of companies encourage their employees to volunteer or mentor students.</td>
</tr>
<tr>
<td>What demographics do your company’s STEM education programs address?</td>
<td>Aerospace companies most frequently support STEM programs that target high school students (75 percent of respondents).</td>
</tr>
<tr>
<td></td>
<td>Aerospace companies most frequently support STEM programs that target high school educators (50 percent).</td>
</tr>
<tr>
<td>What type of STEM education program does your company offer or support?</td>
<td>91 percent of aerospace companies offer or support some kind of STEM program.</td>
</tr>
<tr>
<td></td>
<td>Internships are the most popular STEM program with 72 percent of all aerospace companies offering internships.</td>
</tr>
</tbody>
</table>
APPENDIX C:  
Workforce Goals and Commitments for America’s Aerospace Industry

Alarmed over the critical need for improved development and preparation of America’s aerospace workforce for the 21st century, the member companies of the Aerospace Industries Association reaffirm their commitment to intensify support for education and workforce initiatives, including but not limited to

- Partnering with existing programs, such as Project Lead The Way, FIRST Robotics and Team America Rocketry Challenge.
- Encouraging, supporting and motivating industry professionals to participate in mentoring and other volunteer opportunities in schools and community programs.
- Supporting the transition of retirees to K–12 science and mathematics teaching, certification and enrichment programs in paid or volunteer positions.
- Earmarking corporate grants to educational programs.
- Developing and managing company-initiated educational and workforce development programs.

In declaring our commitment to develop and strengthen the aerospace industry’s workforce for the 21st century, we agree to the following goals and actions:

**GOAL 1: Revitalize the U.S. aerospace and defense workforce.**

1. Each AIA company commits to the revitalization of the aerospace and defense workforce by approving the actions recommended in this workforce report.

2. Each AIA company will designate a senior executive responsible for implementing the company’s commitment to workforce revitalization. The executive will be aware of all STEM-related education activities in which the company is engaged and ensure the alignment and coordination internally and externally. That executive will be accountable for measurable progress in revitalizing and growing the STEM workforce.

**GOAL 2: Motivate and inspire young Americans to study and pursue careers in STEM disciplines.**

1. Each AIA company, in concert with other stakeholders, will commit to market research to determine how best to inspire young Americans toward careers in science, technology, engineering and mathematics.

2. Through associations and companies, the industry will energetically promote the aerospace and defense industry as offering rewarding and attractive career choices.

**GOAL 3: Endorse, financially support and promote STEM education, workforce activities and policies that have proven successful.**

1. Each AIA company, working with the association and other coalitions, will allocate resources to create an effective national STEM awareness campaign, including making available high-profile spokespersons.

2. Each company will conduct a thorough review and assessment of its current STEM efforts with the goal of coordinating effective programs in a strategic framework within each company and industrywide.

**GOAL 4: Make government a partner in achieving the future technical workforce.**

1. Advocate passage, implementation and funding of STEM-related initiatives, including but not limited to the America COMPETES Act. Maintain support for existing programs, such as the Interagency Aerospace Revitalization Task Force. Pursue legislative incentives to encourage skilled retirees to become STEM teachers.

2. Make the future of America’s technical workforce a top issue for the next administration through engagement with candidates, science advisors, transition teams and executive branch appointees.
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