

**U.S. Navy Science, Technology, Engineering, Math (STEM) Focus**  
**June 15 - 16, 2011 - Alexandria, Virginia**

**Executive Summary**

**Purpose:** To represent the Society of American Military Engineers by attending the Navy's first STEM Focus. <http://www.onr.navy.mil/Conference-Event-ONR/STEM-Forum.aspx>. (Note: I am the Northern Virginia Post K-12 Outreach Director). The two-day event was a tremendous success with more than 650 people participating, including many nationally recognized leaders and educators. I did not see any other SAME members present.

Attendees represented the Navy, academia, government and industry and were "STEM-focused" in their jobs/professions. The speakers were well experienced and had important messages to deliver.

**Recommendations:**

1. Create (or return) a **National K-12 Outreach Committee** to design and oversee a robust K-12 Outreach Program for the Society.
2. Posts designate a **K-12 Outreach Director** for liaison with the **National K-12 Outreach Committee Chair** to effectively execute the program.
3. Design and publish **Society K-12 Outreach Program pamphlets** for the Post K-12 Outreach Committees to use and distribute to elementary, middle and senior high schools when executing the program.

**"Take-Aways"**

The following 14 items were the major points that I observed during the conference. I strongly believe that our National K-12 Committee and Post leaders, especially our K-12 Outreach mentors, should be aware of our nation's STEM shortfall situation and various means to correct them.

1. U.S. education is rapidly declining when compared to other developed countries. We are now ranked 27<sup>th</sup> (of 29) in for the rate of STEM bachelor's degrees awarded each year. This negatively impacts on our nation's productivity and worldwide competitiveness.
2. U.S. 4<sup>th</sup> graders only rank: 11<sup>th</sup> (of 36) in mathematics and 8<sup>th</sup> in science among developed countries. (We used to be #1 in both math & science).
3. The U.S. is #27 in world producing STEM degrees and #48 in quality K-12 STEM education.
4. The U.S. is experiencing an increasingly greater problem attracting K-12 students to pursue STEM-related college programs and careers.
5. The country's shortages are being filled through outsourcing/"off-shoring" our STEM needs and foreign student graduates that elect to remain and become U.S. citizens.

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6. Elementary school children and most teachers are neither knowledgeable nor aware of the importance of STEM education. Consequently many students seek college programs that are easier and less demanding than STEM subjects and majors.
7. Graduates with engineering bachelor's degrees had the highest average starting salaries compared to all other disciplines.
8. The median salary of STEM workers is more than double the median salary of the entire U.S. workforce.
9. A great resource that addresses our country's STEM-related problems is the study **"Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future"**.
10. For every 50 high school graduates only four graduate from college with a STEM degree and only one of four of them pursue graduate programs. (i.e., 2%).
11. The main problem with our STEM student shortages is expectations, or lack thereof. 60% of students find school boring, lack motivation to learn. Only ~ 25% of charter schools actually work as designed. 90% of teachers still use the traditional approach of teaching.
12. The K-12 science education "turning point" --- 7<sup>th</sup>/8<sup>th</sup> grade Algebra.
13. Improved education requires a cultural paradigm shift in the U.S. The most effective means of turning these trends around is to replace the traditional teaching approach (i.e., lecturing, preaching) with "Intelligence-based" teaching employing "hands-on" learning experiences (i.e., robotics, science fairs projects, experiments, inventions, computer-simulated math/science games).
14. Therefore, it is imperative that students be taught by being directly engaged in learning by experimenting, testing, observing, questioning results, and reasoning with the teachers.

**Facts (from longitudinal nationwide studies)**

1. 89% of middle school students would rather do chores than do their math homework.
2. Only 33% of 8<sup>th</sup> graders are interested in STEM majors and careers; only 6% of high school seniors will earn bachelor's degrees in a STEM field.
3. Only 18% of high school seniors are rated as science proficient; 33% as math proficient.
4. The U.S. is ranked 27<sup>th</sup> (of 29) for the rate of STEM bachelor's degrees awarded in developed countries.
5. In the U.S. 6% of undergraduates major in engineering as compared with 12% in Europe and 40% in China.
6. Science and engineering undergraduate programs have 900,000 students entering each year, but represent the lowest retention among all academic disciplines. 2007 - only 137,000 U.S. citizen students completed a 4-year STEM degree.
7. Jobs requiring math are increasing 4X faster than overall job growth.

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8. Graduates with engineering bachelor's degrees had the highest average starting salaries compared to all other disciplines.
9. The median salary of STEM workers is more than double the median salary of the entire U.S. workforce.
10. More than 30% of current DoD science and technology professionals are expected to retire by 2020.
11. U.S. 4<sup>th</sup> graders only rank: 11<sup>th</sup> (of 36) in mathematics and 8<sup>th</sup> in science among developed countries. (We used to be #1 in both math & science).

**Notes**

1. Report **"Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future"** - National Academy of Engineering (NAE) funded study chaired by Norm Augustine and included 18 STEM experts.  
[http://www.nap.edu/catalog.php?record\\_id=11463](http://www.nap.edu/catalog.php?record_id=11463)  
A top priority: Use global standards to elevate STEM education so that U.S. is #1 in the world.
2. Research & Development:
  - Globally the U.S. represents 1/3<sup>rd</sup> of all R%D.
  - Fewer government R&D dollars available.
  - Industry = 70%; government = 30%. (Note: was just the reverse in 1963 --- previously driven by space program and military defense-related).
  - Future work: Sustainable energy; Autonomous machines (robotics); Directed energy & hypersonic; People: Health/Protection/Learning; Information dominance & cyber-security. STEM portion to grow to \$200M annually.
3. 900,000 college students start in science & technology each year in college.
4. Intelligence-based tutoring replacing the traditional 1:1 tutoring. More economically feasible.
5. Dr. Charles Vest, President, National Academy of Engineering (NAE)
  - A changing world. We're no longer #1. #27 in world producing STEM degrees; #48 in quality K-12 STEM education.
  - Issue: we have not done well in the "political arena" or create a "political will" for the U.S. to realize STEM problems.
  - China is, by far, leading the world in graduating engineering students. #2 - India.
  - 57% of all undergrad students are female. Only 18% of all graduating engineers are women (represents ~ 2% of all undergraduate students).

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--- Bottom line: this is the most exciting era in world history for science and education. We must inspire, challenge and educate students.

6. Dr. Clifford Stanley, Undersecretary of Defense for Personnel and Readiness

--- The "Power of One" - we represent as mentors and tutors to influence and inspire K-12 grade students to pursue STEM studies/professions.

7. Hon. Ray Mabus, Secretary of Navy

--- For every 50 high school graduates only 4 graduate from college with a STEM degree; only one pursue graduate programs. (Represents 2% of high school grads nationwide).

--- Colleges/universities have the capacity to produce what our country actually needs.

--- Only one in four 18-24 year old adults qualify for acceptance into the armed services. (Due to obesity, medical deficiencies or lack of education).

--- Problem: expectations are either undefined or unrecognized. So we get what we expect.

--- Solution: parents, mentors, teachers take a greater interest in helping our students pursue STEM degrees. They can achieve what they expect.

--- Students want to learn by doing. No substitute for "hands-on" teaching, experiences. Replace traditional teaching approach (i.e., lecturing, preaching) with "hands-on" learning. (Science fair projects, experiments, inventions, computer-simulated math/science games).

8. Panel 1 - STEM in the field

--- Nationwide, during 2010, more than 15,000 K-12 students involved with STEM outreach programs. Emphasis on robotics, Navy SEAPERCH, other competitions.

--- Within 10 years about 50% of Navy STEM employees will be retiring or retired. Creates huge "hole" for finding and hiring STEM educated professionals.

--- Success of STEM educational programs directly dependent upon **expectations**...high school, college students, teachers, parents.

--- Important to motivate parents to get involved in their children's education and place emphasis on the need for STEM education. (i.e., it all starts in the home).

--- **"Project Lead the Way"** <http://www.pltw.org/> is the nation's leading provider of K-12 STEM education. A non-profit 501 (c)(3) organization based in Clifton Park, NY. Includes more than 4,000 schools (of 133,000 in the U.S.), 350,000 students (of 57 million), with 15,000 trained instructors. Results...increased engagement of students.

9. Dean Kamen

--- Founder of **First Robotics** <http://www.usfirst.org/> and First Robotics Competition 20 years ago. [http://en.wikipedia.org/wiki/FIRST\\_Robotics\\_Competition](http://en.wikipedia.org/wiki/FIRST_Robotics_Competition)

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--- In 2010, the 19th year of competition, 1,808 high school teams with roughly 45,000 students from [Australia](#), [Brazil](#), [Canada](#), [Turkey](#), [The Netherlands](#), [Israel](#), the [United States](#), the [United Kingdom](#), and [Mexico](#) were involved.

--- In 2011, 2,075 teams participated in competitions in the [United States](#), [Canada](#), and [Israel](#).

--- Improved education requires a cultural paradigm shift in the U.S.

--- Demand is the issue, not supply. What should we focus on? What's important for our country?

--- Motivate and inspire K-12 students to pursue STEM education and careers involves creating science and technology into a "sport"... better yet a "super-sport." (A means is through digital games involving science and technology).

--- 38% of children are minorities. **First Robotics** helps builds confidence, self-reliance and respect.

**10. Panel 2 - Industry Perspective - Workforce (Needs and Potential Solutions)**

--- Dr. Linda Rosen, CEO, Change the Equation, Inc. <http://www.changetheequation.org/>

- \* Men dominate the STEM professions and college students

- \* 81% males pursuing engineering degrees

- \* 81% males pursuing computer science degrees

- \* 79% males pursuing physics degrees

- \* However, 57% of undergraduate students are females and 60% of them pursue advanced degrees.

- \* Objective is to emphasize awareness of STEM education to K-12 programs.

--- Deborah Wince-Smith, President & CEO, The Council on Competitiveness

<http://www.compete.org/>

- \* Issue: STEM challenge is the "heart" of American competitiveness for the future.

- \* The U.S. is at the cusp of innovation and productivity increases for national defense and security.

- \* Services and manufacturing are merging (i.e., higher tech farm tractors...).

- \* Trades requiring more technically qualified workers.

- \* Manufacturing is requiring fewer humans, more robots.

- \* Imagination and creativity involve STEM educated graduates.

--- Brian Fitzgerald, CEO, Business Higher Education Forum (BHEF), Inc.

<http://www.bhef.com/>

- \* 13% of teachers leave the profession every year.

- \* Will take a long time to cut the attrition in half.

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\* Teachers represent the highest asset for leveraging STEM education.

--- Dr. Carl Wieman, Associate Director for Science, White House Office of Science & Technology <http://www.whitehouse.gov/administration/eop/ostp>

\* President Obama placing full support behind STEM education and programs.

\* National Science & Technology Council (NSTC) for STEM education --- started March 2011 --- collaborating with Academic Competitiveness Council (ACC)

<http://www.ACC/Academic+Competitiveness+Council/>

\* Major advances in past 10 - 20 years...inter-relationship between "College Science Classroom Studies", "Brain Research" and "Cognitive Psychology."

\* New paradigm - brains are very changeable...brain development and growth facilitate learning and understanding complex information (e.g., STEM).

\* Thinking like an expert is the new scientific approach to teaching.

\* Expert competence =

\*\* Factual knowledge

\*\* Mental organizational framework (retrieval, application)

\*\* Ability to monitor own thinking and learning

\*\* New ways of thinking - requires many hours of practice

\*\* Involves a change in brain "wiring" - biological development, similar to developing muscles - requires intense focus, self checking, reflection, correction.

\*\* Teachers - essential for effective feedback and guidance to help shape students' thinking abilities.

\*\* Traditional teaching & learning approach (i.e., lecture, preach) studies show that <30% of what students were taught was actually learned... method not effective.

\*\* Must change teaching approach...teachers act as facilitators, mentors as students learn through "hands-on" or research approach...doubles students' ability to learn.

\*\* **Summarizing...essential for students to be directly engaged, testing, observing, questioning results, reasoning with the teachers...much more effective approach to learning.**

--- **Science, Mathematics & Research for Transformation (SMART) - Scholarship Program** - <http://smart.asee.org/> established by DoD to support undergraduate and graduate students pursuing degrees in STEM disciplines. Program aims to increase the number of civilian scientists and engineers working at DoD laboratories.

\* Great testimonials in support of Navy STEM program and the benefits of "hands on" training and educational programs and processes.

\* Mentors were essential means of facilitating students' learning.

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- \* Students enjoy what they are doing was essential.
- \* Computer applications were very meaningful for educating young students.

**11. Panel 3 -STEM Technologies - Real World Examples**

- Problems: (1). 60% of students find school boring, lack motivation to learn. (2). Only ~ 25% of charter schools actually work as designed. (3). 90% of teachers still use the traditional approach.
- Solutions: Provide students with: (1). more engagement. (2). Simulations of aerodynamics, thermodynamics, chemistry, other scientific applications to increase learning.
- Increase math and science scores by .5 sigma (i.e.,  $\frac{1}{2}$  of standard deviation) would increase GDP by ~1%.
- Digital tutors (i.e. computers) embody principles of effective learning at a much cheaper cost than the traditional teaching approach. Finding: 51M (out of 53M) students play video games. Using STEM video game programs can result in 4X increase in learning.
- Video games, such as Tabula Digita products  
(<http://www.dimensionu.com/dimU/Home/DimUContent.aspx?MainNav=AboutUs&ref=td>)  
employ science, technology, math --- provide powerful tools for learning. Students play and compete against other students or teams vs. teams. Implemented in more than 70 school districts, 1200+ schools. Results --- 20% score improvements on standardized tests.

**12. Dr. Nancy B. Jackson, President, American Chemical Society (ACS)  
(<http://portal.acs.org/portal/acs/corg/content>)**

- Congressionally mandated and chartered independent membership organization which represents professionals at all degree levels and in all fields of chemistry and sciences that involve chemistry.
- 2011 - the "International Year of Chemistry".
- Secondary education for 2009 Chemistry graduates:  
BS - 14,577; MS - 1,986; (3) Ph.D. - 2,543
- Engineering and science are the "engines" for increasing our nation's productivity.
- Reforming STEM - must increase emphasis on multidisciplinary education.
- Project SEED <http://www.projectseed.org/> - a dynamic nonprofit organization that works in partnership with school districts, universities and corporations. Founded in 1963 with the goal of using mathematics to increase the educational options of urban youth, the program is still on the cutting edge. More than 9,000 students with summer internships available at Los Alamos National Labs.
- ACS provides scholarships to support under-represented minorities interested in chemistry programs and teaching.
- Problem: Unemployment of chemists rising --- 9.5% in 2009, salaries dropping. Expect

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situation to worsen in the near future. Causes: (1). Pharmaceutical companies moving production "off-shore"; (2). Recession impacting young STEM college graduates.

**13. Bill Nye (the "Science Guy")**

--- International assessment (currently) - USA is 23<sup>rd</sup> in education among developed nations.

--- **K-12 science education "turning point" --- 7<sup>th</sup>/8<sup>th</sup> grade Algebra.** (Triggers kids to drop out of school in L.A.). However, you cannot have too much Algebra education.

--- U.S. educational policymakers --- only ~100 --- for 10M kids, 250M "others".

--- **Problem "Solving for [X]" - <http://dep.disney.go.com/solvingforx.html>** downloadable programs --- very helpful for teaching and learning.

--- **Essential --- getting kids engaged and involved with STEM education before they are ten years old.**

--- Exploring the mysteries of our universe is a great means to interest, challenge and inspire children to pursue a STEM education. The universe is still expanding and ~ 94% is unknown. (e.g., we know that Helium (He) and hydrogen (H) occupy less than 3% of the universe). Therefore there is a whole lot of "other" physics out there for us to discover.

**14. The U.S. Naval Academy Programs**

The Naval Academy has extensive STEM and K-12 Outreach Programs. SAME should investigate and use them wherever appropriate.

<http://www.usna.edu/STEM/activities.htm>

<http://www.usna.edu/STEM/communityoutreach.htm>

**15. U.S. Navy's 'STEM Grand Challenge' (<http://www.onr.navy.mil/en/Media-Center.aspx>)**

At the STEM Forum the Office of Naval Research (ONR) announced a [grand challenge](#) to award up to **\$8 million** for ideas aimed at boosting **K-12 education in the sciences**. The challenge is one of many efforts the Navy has developed to encourage students, parents and teachers to pursue science education and careers.