AC 2011-1796: NAVY METROLOGY ENGINEERING CENTER STEM OUT-REACH THROUGH THE STEP PROGRAM: CHALLENGES, LESSONS LEARNED AND APPLICATION TO DOD STRATEGY

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Navy Metrology Engineering Center STEM Outreach through the STEP Program: Challenges, Lessons Learned and Application to DoD Strategy

Background:

The United States and especially the Department of Defense (DoD) has historically relied heavily upon scientists, technologists, engineers and mathematicians to innovate, design, produce and maintain a technically superior capability to defend and advance the interests of the United States, both at home and globally. The United States maintained a leading edge technologic advantage through and beyond World War II until it was stunned by the Soviet Union’s launch of Sputnik 1 on October 4, 1957. Sputnik 1 was the first artificial satellite launched into a successful orbit around the earth. Then, a month later, Sputnik 2 was successfully launched carrying the first living being, a dog named Laika, into orbit. The first U.S. attempt to launch a satellite into space failed when its Vanguard rocket exploded during lift off. America’s Cold War rival had succeeded in being the first to space and suddenly appeared to be technologically superior to the United States. The United States finally succeeded on January 31, 1958 when it launched a successful Jupiter-C rocket that sent Explorer 1 into orbit. The space race had begun and America had its wake-up call resulting in an urgency to help take the United States back to the technologically superior leadership position it had possessed for so long.

With this backdrop, Congress signed the National Defense Education Act into law in 1958 which authorized DoD to increase the flow of talent into science and engineering, fund enrollment in higher education, and enhance public understanding of science and technology. For the past 52 years, DoD has used this authorization to help the United States advance science, engineering and technology through various efforts and programs. DoD has continued to encourage its many Commands and Laboratories to support Science, Technology, Engineering and Mathematics (STEM) initiatives at local, regional, and national levels. Scientists and engineers at DoD laboratories and military installations have proactively supported local STEM initiatives such as assisting with and judging science fairs and competitions, mentoring and tutoring local students, hosting DoD scholarship and fellowship recipients, providing laboratory tours to schools, and partnering with science and mathematics teachers in the classroom. However, DoD has come to recognize that although these many individual efforts at STEM outreach are important, they will not be sufficient in themselves to meet the domestic and global STEM education challenges that weaken the security of the United States. DoD has, therefore, developed and issued the first DoD STEM Education and Outreach Strategic Plan that is collaborative, integrative, and focused across all of DoD. The strategic plan establishes a DoD STEM Development Office to lead STEM education and outreach efforts and to track the progress of plan implementation.

One of DoD’s many engineering activities is the Navy’s Metrology Engineering Center (MEC) and Measurement Science and Technology Laboratory (MSTL) which is located at the Naval Surface Warfare Center, Corona, CA (NSWC/Corona). Like most DoD activities, NSWC/Corona had supported local and regional science and engineering activities with its own local outreach programs to school districts and colleges and universities since its founding in
1964. Corona scientists and engineers tutored students in mathematics and science, judged science fairs, provided laboratory tours, and hosted science events such as the Science Olympiad and Future Scientists and Engineers of America (FSEA) competitions. NSWC/Corona provided internships to college engineering and science students and partnered with universities in Metrology Research and Development (R&D) programs.

An event in 1995 caused NSWC/Corona and its engineering centers to re-evaluate their approach to STEM outreach and maintaining the engineering pipeline. This event was the implementation of the Base Realignment and Closure (BRAC) process. After narrowly surviving the 1995 Base Realignment and Closure round of Department of Defense base closures, NSWC/Corona and its Metrology Engineering Center and laboratories needed a long term strategic approach to providing a pipeline of engineers to replace those lost during the base closure process and a plan to replace the mass of baby boomers approaching retirement in the next 15 to 20 years. NSWC/Corona developed a proactive approach to maintaining a pipeline of engineers that involved numerous outreach activities into the local university and college systems and into the local high schools that helped solve more immediate needs of MEC and the MSTL.

NSWC/Corona had learned from its national recruiting activities that employee retention rates were extremely high when scientists and engineers were hired locally (with local support structures and family), whereas, retention rates for those hired with roots from far away states were disappointing and expensive. This led to looking at the flow of local students seeking engineering and science higher educations at universities and colleges. It became clear that the lack of sufficient numbers of qualified local students “entering” the engineering and science educational pipeline was the limiting factor in meeting the overall long term needs and increasing competition for locally raised engineers. Like DoD, Corona’s Engineering Centers had discovered the need to expand beyond the normal STEM outreach activities and into a more collaborative and focused strategy concerning STEM outreach. As an aside, fortunately, Southern California has such a diverse population that looking locally did not adversely impact the desire for diversity in the workforce as a result of any of these efforts. In fact, diversity increased.

Along came the beginning of the Science and Technology Education Partnership (STEP) Program. The beginning of STEP was sparked by California Congressman Ken Calvert who represents the 44th District that includes a large portion of the Inland Empire region of Southern California (Riverside, CA). In June 2000 at the Congressman’s urging, Community, Education, Business and Technology Industry Leaders began organizing to form the non-profit, 501C(3) STEP Corporation funded privately by partner companies investing in the education of local children to attempt to raise the numbers of high technology educated workers in the community. STEP’s Board of Directors is comprised of industry (such as AT&T, Boeing, Southern California Edison, Computer Science Corporation, and others), university/colleges (such as University of California, Riverside and California Baptist College and others), the local educational institutions (Riverside County Office of Education and its many school districts), and local high tech government agencies such as the Navy Metrology Engineering Center. Congressman Calvert, the co-founder of STEP, had been intimately involved with the base during the 1995 BRAC process and looked to NSWC/Corona as an early STEP partner. With this common interest, NSWC/Corona became a STEP partner and adopted STEP as the outreach program to use to help build an increasing number of local students qualified and interested in
pursuing careers in engineering.

The Navy Metrology Engineering Center has been a proactive and engaged partner in the STEP Program since its inception. STEP is funded privately by partner companies investing in the education of local youth to attempt to raise the numbers of high technology educated workers in the local community. STEP’s primary mission is to “Inspire students to pursue careers in math, science, engineering and technology” through an innovative, proactive approach that engages students, teachers and the local K-12 educational system with high technology companies, universities/colleges, high tech government agencies and all of their collective resources to achieve its purpose.

With this background in mind, this paper will explore the development of the original STEP Program with the challenges faced over the years that caused refinements to be made. The paper will address the importance of STEM outreach in the early grades along with the need to focus increased attention and resources at this early educational stage. The STEP Program model and its exportation to other regions will be provided along with the challenges involved. Current activities and information will be presented. The paper will then shift to show the similar driving challenges that currently face the nation and DoD that motivated their development of an overarching STEM Education and Outreach Strategic Plan. The DoD STEM Education and Outreach Strategic Framework will be presented along with the stated vision, mission, goals and objectives of this strategy. The Navy’s Metrology Engineering Centers STEM outreach activities through the STEP Program will be shown to support and enhance the DoD strategy in helping to meet stated goals and objectives.

The Science and Technology Education Partnership (STEP) Program

The factors that drove the formation of STEP:
As mentioned above, the beginning of STEP involves California Congressman Ken Calvert who represents a portion of the Inland Empire region of Southern California which is comprised of Riverside and San Bernardino Counties (an area 50 miles east of Los Angeles and about the size of the state of New Jersey). Congressman Calvert had committee assignments on the Science Committee and recently on Appropriations. He belongs to numerous House caucuses including the House Science, Technology, Engineering, and Mathematics Education Caucus.

The Inland Empire region, circa late 1990’s, had mostly missed out on the earlier high technology prosperity enjoyed by its neighbors in San Diego, Orange and Los Angeles Counties. There was a keen interest in building a high technology sector in the region. The Inland Empire region is as populous as San Diego; however, it lags far behind in high technology employment. The challenge to build a high technology presence in the region, especially in the face of the then newly released “California Report on the Environment for Science and Technology” (the CREST Report) was the start of the activity that lead to the formation of STEP.

In November 1999, Congressman Calvert received the CREST Report that was produced by the California Council on Science and Technology. The report indicated that 9.3% of all jobs in California were in high technology industries. This was well above the national average of 5.6% at the time. About 20% of the nation’s Research and Development (R&D) was performed in
California according to the report. This R&D helped sustain and advance California’s high technology industrial base. Basically, California was the nation’s leading science and technology state. Science and technology was the underpinning of California’s leadership in agriculture, aerospace, defense, electronics, computers, software, movie production, multimedia entertainment, biotechnology, medical devices, environmental technologies, and telecommunications. This leadership provided jobs, sustained a high standard of living, and offered numerous other benefits to California residents.4

The CREST report provided a wake-up call by announcing that California was at risk of losing the lead it once enjoyed. Several contributing factors were cited with the highlight being the inability of the state’s educational system to produce a technologically skilled workforce in sufficient numbers and capable of sustaining the R&D activity. Essentially, the state’s educational system was not yielding the numbers of highly educated employees necessary to the continued success of the high technology sector. Findings included that: a significant number of Californians did not have the education needed to benefit from job opportunities created in the high tech sector, the numbers of Californians being educated with the requisite skills was insufficient to meet the demand from industry, and that Californians graduating from the K-12 educational system and community college system were simply not adequately prepared to enter the high tech arena. Several recommendations were advanced to address the findings.

In January 2000, Congressman Calvert received a report from the Hispanic Outreach Task Force that he had assembled to study ways to improve science and mathematics skills among K-12 students, particularly among the region’s large Hispanic population. This report provided a similar call to action for the need to address the education of our youth. The Congressman’s Staff research further produced alarming facts: California ranked last among 40 states according to the results of the 2000 National Assessment of Educational Progress (NAEP) tests5. U.S. students in the final year of secondary school scored well below the international average in math and science according to the Third International Math and Science Study (TIMSS), the US ranked 18th among 21 industrialized nations also per TIMSS (surpassing only Lithuania, Cyprus and South Africa)6. New information from the Organization for Economic Cooperation and Development which consists of 30 member countries shows that American 15 year olds have actually lost ground in math and science compared to other member countries. In the organizations latest studies, the highest achieving U.S. students were either at or below its average across member nations. Almost 25 percent of U.S. students demonstrated very low proficiency in science and 28 percent scored below the minimum level in mathematics. In mathematics, Finland, Korea, and China were top performers with Finland taking top ranking in the science assessment.7 The evidence of a need for a proactive program to improve science and technology education was overwhelming if the Inland Empire was indeed committed to advancing in the high tech sector.

More recent studies continue to illuminate California’s problem. In 2004, California ranked 48th in the nation for high school students going on to college. Statewide, 47 percent of high school graduates in 2006 enrolled in a state public university. For the Inland Empire region, the numbers were even lower at 38 percent. Only about 26 percent of Inland Empire high school students met the admission requirements for the University of California and California State University systems.8
Besides the early evidence that drove the formation of the STEP Program, there has been evidence throughout STEP’s eleven year existence that indicates that matters continue to be dismal with regard to STEM education. A 2008 National Center for Education Statistics (NCES) Digest of Statistics, Science & Engineering Indicators article provides a most sobering look at the current state of the very leaky STEM Pipeline: “In 2001, there were a bit more than 4 million 9th graders. Four years later, 2.8 million of them graduated and 1.9 million went on to two- or four-year college; only 1.3 million were actually ready for college work. Fewer than 300,000 are majoring in STEM fields and only about 167,000 are expected to be STEM college graduates by 2011.”

The Inland Empire is fortunate to have a number of innovative academic, government and business institutions involved in STEP to encourage students, especially those from underrepresented groups who do not have a family tradition of attending college. STEP believes that it is critically important to reach out not only to teachers (who can identify and nurture promising students) and to the students themselves, but also to families to create an environment conducive to success. STEP’s role is to make teachers, students, and families aware of the educational resources available to help them succeed in math and science, and aware of the programs that can help students prepare for and succeed in college.

**STEP’s Mission and Purpose:**

STEP’s primary mission is to “Inspire students to pursue careers in math, science, engineering and technology” through an innovative, proactive approach that engages students, teachers, and the local K-12 educational system with high technology companies, universities/colleges, high tech government agencies and all of their collective resources to achieve its purpose of increasing and sustaining the high technology job sector in the Inland Empire. Through the formation of new educational partnerships between businesses, academia, and government entities within the community, STEP seeks to pave the way to achieve a prosperous future for all Inland Empire citizens based on the sustainable growth of a high technology industry. Specifically, STEP seeks to: Raise parental, industry, and community awareness of the skills gap between K-12 students and the labor needs of the high tech sector, Stimulate and inspire children’s interests in pursuing math, science, engineering and technology educations, Motivate parents, teachers, the K-12 educational system, and business leaders to create a set of plans to address the educational situation to help achieve success, and Stimulate the Inland Empire into becoming a high technology leader.

**How STEP works:**

STEP is all about forming mutually beneficial partnerships with an eye towards the long term collective success and growth of the region. STEP is a people-centered, community building program aiming to strengthen the quantity and quality of our technologically skilled workforce. STEP causes the educational system at all levels to interact with high tech industry, business and government for the benefit of students, families and teachers. STEP’s purpose is not to reinvent the many resources available in the community, but rather to connect them together to help make them more effective. STEP serves as a repository of information and a catalyst for action.
makes teachers, students and families aware of the resources available to help them succeed. STEP helps them to connect to the services available. To help deliver these services, STEP sponsors an annual student and teacher conference; has educational outreach programs; provides seed money to pursue relevant recommendations to further its purpose, collaborates with business development organizations and individual businesses; and operates a website with information for all our conferences, partnering opportunities, and outreach activities. STEP’s website is at: www.myscienceeducation.com

STEP Operations:

STEP operates through annual Student and Teacher Conferences held in Riverside, CA and various other mission related outreach activities in addition to the STEP Board’s partnering activities. The STEP Student Conferences began in 2000 and have been conducted annually for the past 11 years. The student conference provides a free science show conducted by General Atomics engineers under an outreach grant. Also, about 30 companies set up booths and displays to provide a “hands on” exhibition for students to meet engineers and scientists from various technical fields. The science show lasts an hour and the exhibition lasts an hour. There are four science shows/exhibition periods per day over a two day period. About 3,500 students from local 3rd through 12th grades attend the two day conference each year although the preponderance of student attendees are 3rd to 8th graders. In addition, a Teacher Conference is provided separately from the Student Conference to engage teachers in activities to help them develop their skills in teaching math and science. Lesson plans and example activities are provided. About 150 teachers now attend each year’s conference provided free of charge by the STEP Program and the Alpha Center at UC Riverside. A STEP Community Leadership Luncheon is included during the conference week to renew commitment to STEP activities, review progress and obtain new and continuing support for the privately funded program. A keynote speaker is the center piece of the luncheon where speakers such as Arnold Schwarzenegger (former California governor), Dr Buzz Aldrin and Dr Sally Ride (former astronauts), and others have highlighted the need to inspire children to pursue educations and careers in mathematics, science and engineering.

The various STEP outreach programs have been bounded by financial considerations. STEP outreach can vary year-to-year based upon financial considerations and priorities. The Annual STEP Awards for the Inland Science and Engineering Fair division winners (STEP provides awards in each of the three divisions: Elementary-$200 savings bond, Junior-$500 savings bond, and Senior-$1,000 savings bond) has been a positive incentive for students. They are the largest monetary awards given at the regional Science Fair. STEP volunteers help to serve as science fair judges at local competitions throughout the region. The Science Olympiad assistance helps to keep the Inland Empire active in this national competition and helps the volunteer teachers improve their skills through the three stipends that have been offered. The annual STEP Conference poster and essay contests allow classrooms to engage before the conference with an opportunity to win a U.S. savings bond award for placing in the three different divisions. It also allows those students who lean more towards English, literature, or the arts to engage their minds on science and technology. STEP publishes a periodic newsletter called “In STEP” for teachers, administrators, sponsors, and community leaders to provide information on upcoming events, profile regional technology companies, and promote teaming and partnering activities. The In
STEP Newsletter is the periodic update on conference and outreach activities and resources available in the area. Finally, STEP provided seed money to Future Scientists and Engineers of America (FSEA) to jump start after-school Science Clubs at several local middle schools. A recent new outreach activity is to take volunteer engineers into local classrooms. This activity is coordinated with UC Riverside and is being lead by the Bourns Corporation CEO who is an active member of the STEP Board.

**STEP Basic Model and Template:**

The STEP Program Model requires that a central group of interested parties form and organize for the common purpose of inspiring local students to pursue educations in science, technology, mathematics and technology and to help focus the local educational systems to support this goal. Educational system involvement would include being active partners in the STEP Program as well as providing quality STEM field educations. Without the support of the local educational systems, the STEP Program cannot succeed or survive. Although the Inland Empire STEP Program is organized as a non-profit with a broad based membership as discussed above, any core group that is properly organized for continued operations could work. It helps to have local industrial partners and governmental participation, but again, this is not seen as essential. What is essential is a committed, organized core group that has support from the local educational systems and local government agencies that have a say in efforts such as STEP. The specifics of each local area considering starting a STEP-like Program need to be considered with adjustments made to the organization as required for local success. In the next section, “Exporting the STEP Program”, an example of local adaptation of STEP to local specifics that resulted in a continuing local STEP Program will be provided.

The STEP Program Template is quite basic. STEP is a cooperative effort that simply attempts to link helpful resources to the students and teachers in the existing educational systems of a local area or community. The STEP Program template requires formation of a core organization and an annual main operation to provide focus on the mission. The original STEP Program’s main operation is to provide an annual STEP Conference to bring students and teachers together to focus on inspiring students to pursue STEM field educations and assist teachers in educating in STEM fields. The STEP Conference is simply a central point of focus. The first STEP Conference in Riverside, California had a science show provided free of charge as its main event with just a few exhibitors having booths to interact with students and teachers. Any science related main event might work. For example, having a science exhibition with many high technology companies, colleges and universities participating could be the main focus. Basically, the idea is to have a day or two dedicated to STEM where students and teachers participate and interact with science and technology. From this single, annual event that keeps the core organization and educational community focused on inspiring STEM field educations, further ideas and efforts will evolve to address any key local needs.

**Exporting the STEP Program:**

The first attempt at exporting the STEP Program to another region occurred on the island of Kauai in Hawaii. Kauai is one of the Hawaiian Islands with a population of about 65,000. Kauai is a popular vacation resort and relies on its tourist industry as well as agriculture as predominate
economic income streams. Kauai is also home to the Pacific Missile Range Facility (PMRF) where Navy training exercises along with extensive and complex Navy system testing of developing systems such as ballistic missile defense systems are conducted. A highly educated and technical workforce is required to support the complex testing at PMRF. There are insufficient numbers of local workers with the proper levels of education in engineering and the sciences to provide enough of the required workers to support the complex technical programs being conducted at PMRF. This results in the PMRF workforce requiring other DoD activities and contractors to augment their workforce to accomplish their mission. The Island of Kauai, like the Inland Empire region of Southern California, also desired to increase the number of students educated and qualified to take scientific and engineering jobs in their local areas.

NSWC, Corona Division, has been a long term supporter of the Inland Empire STEP Program and also is one of the DoD activities that provides technical support to PMRF. In 2003, NSWC Corona introduced the STEP Program and its mission to the Kauai Economic Development Partnership and PMRF. The introduction sparked the interests of those in Kauai that had a stake in wanting more local Kauai natives to be qualified for the high paying technical jobs available at PMRF. STEP invited Kauai representatives to observe their STEP Conference in 2003 and also provided briefings and explained lessons learned to a team assembled in Kauai to identify adjustments needed to the Inland Empire STEP Program to allow for its success in the local Kauai environment. As a result, in 2004, the KAUA’I IN STEP (KIS) Program conducted its first conference for 4th, 6th and 8th grade public, private and home school students under Mayor Brian Baptiste’s Team Tech Kaua’I. The KIS Conference has been held annually ever since with 2010 marking its 7th year of successful operations. Since its inception, over 14,000 students have attended Kauai In STEP Conferences.

Several lessons were learned in adapting the Inland Empire’s STEP Program to another locale. Consideration of the local interests, both government and private, are extremely important. In Kauai, there already existed some efforts engaged with the local educational system with Team Tech Kauai being the one most focused on technology. In order for STEP to be accepted, careful consideration of where it fits into the current scheme of things was important. Further, getting the support of those interested stakeholders as well as the school system was critical. The Kaua’I In STEP Program was organized under the Team Tech Kaua’I which already had strong ties to the stakeholders. Without local acceptance, the program would never proceed forward. Likewise, adapting the STEP Program to the local resources and culture was required. In Kauai, the Team Tech Kaua’I organization was able to secure use of the Kaua’I War Memorial Convention Hall at no cost to KIS. The local school system provides for busing of all attending students at no cost to KIS. Therefore, KIS can be operated with minimal costs, which helps to insure its continued operations. Another interesting factor was: Who gets to attend the KIS Conference? The Inland Empire region of Southern California has well over a half million inhabitants. Therefore, the Inland Empire STEP Program uses a “first come, first served” policy and focuses on grades 3rd through 8th. STEP Conference registration opens and is closed upon reaching maximum attendance numbers. A “back up” list is kept for those wanting to attend after registration closes and is used if and when there are any cancellations. This results in maximum attendance being reached well before registration is scheduled to end as all cannot be accommodated each year. For fairness, STEP does try to first open the next years registration to those schools that could not get in the prior year to give all an opportunity. In Kauai, the local
culture is “all inclusive” and the school population is of a manageable size. KIS opens their conference up to all students in 4th, 6th and 8th grades from all schools on the island. That allows every student to eventually attend. The only wrinkle is that the science show must be revised every two years as nearly every student has seen the last show by the 8th grade. Other variations in organization and the like exist between the Inland Empire STEP Program and KIS, but the point is that the STEP mission remains the same and both are organized for continued operations by a dedicated, core group. Variations are simply necessary to make local adjustments to execution and acceptance necessary for STEP to succeed elsewhere. Experience from establishing a STEP Program in Kauai shows that it is best to start small and expand each year with manageable growth.

The success of KIS has since provided a framework for the neighboring island of Oahu to establish a STEP program for its students. Oahu is home to the Navy’s Pacific Fleet Command with major operations and activities conducted by a large military, civilian and contractor workforce. Oahu conducted its first STEP Program, Oahu-In-STEP (OIS), in August 2010. About 2,500 students and teachers attended this inaugural OIS Conference. It was a big success and is planned to continue with intentions of expansion already being discussed. OIS would like to serve many more students and teachers next year. The OIS core group will need more dedicated members for this to occur. However, the educational system is fully on-board and high technology companies such as the Computer Science Corporation are taking proactive roles. NSWC/Corona and their Metrology Engineering Center supported the Oahu-In-STEP inaugural conference as a natural result of their long time support of Navy activities in the Pacific Fleet. The lessons learned from Kauai made the adaptation of the STEP model easier for Oahu. Again, some variations were necessary to adapt the program to Oahu based upon resources and local realities. OIS has already reserved dates for its second OIS Conference.

Envisioneering, Inc. (which has technical support contract connections and interests in several states including Hawaii, Alaska, New Mexico, South Dakota and others) has been a leader in the KIS Conference from the beginning. Envisioneering has approached the STEP Program and its key sponsors for advice and assistance for the potential of further expansion of the STEP Program model into some other states. Pilot science shows have already been conducted in Alaska and New Mexico. It can take a year or two before a STEP organizing committee can acquire the background knowledge and support needed for a STEP Program to succeed. Nonetheless, if a community is committed, enthusiastic and dedicated to creating a STEP Program, it can be achieved in a year or even less. Case in point, the original STEP Program in Southern California went from concept to completion in less than three months.

**STEP Conference and Outreach Summary:**

In this section, some overall impact information and data will be presented. For clarity, “STEP” refers to the Riverside, CA efforts, KIS refers to Kauai In STEP efforts, and OIS refers to Oahu In STEP efforts. As stated above, STEP has conducted a total of 11 STEP Conferences over the past 11 years. STEP 11 occurred in October 2010. Dr Ray Orbach the former Chancellor of UC Riverside and currently at UT Austin was the keynote speaker at the STEP 11 Conference luncheon. The STEP community leadership and partner luncheon provides an annual opportunity to renew and expand the partnership, make new connections, obtain continued and
additional support and sponsor funds, and outline past, present and future STEP plans. The STEP 10 Conference coincided with the 40th Anniversary of man’s first steps on the moon. It was most appropriate that STEP obtained Dr Buzz Aldrin to be the keynote speaker at the STEP 10 luncheon and also to speak to the students during the STEP science show. STEP’s 10th anniversary was well celebrated with the large number of STEP Program sponsors recognized for their continued support.

The STEP Student Conferences have exposed some 35,000 students and over 2,000 of their teachers to science, technology and engineering through the science shows and high tech expo held annually for the past 11 years. The STEP Student Conference format has stabilized and continues to serve about 3,500 3rd to 8th grade students and their teachers annually. The feedback forms obtained from attendees indicate continued high marks. STEP data indicates that there is only about a 10% repeat population in STEP’s attempts to provide the experience to those who haven’t yet had the opportunity to participate. Unfortunately, privacy laws make it impossible to track students that attended the STEP Program to see what direct impact the program has had. However, STEP partner companies have several former STEP attendees now showing up as engineering student interns and also in local universities and colleges. These students identify themselves when their workplace looks for volunteers to staff the exhibit booths and displays for their companies or colleges.

The STEP Teacher Conference has settled into an evening format hosted by the Alpha Center at UC Riverside. It is focused predominately on mathematics and science with teacher activities included to improve their skills. The STEP Teacher Conference also gives STEP an opportunity to thank the teaching community for their dedication to serving the communities children. Teacher evaluation forms collected at the conclusion of the STEP teacher training indicate that the training has been successful and, in many cases, has renewed the participants energy and interests in teaching in the STEM fields.

The KIS Conference serves about 2,000 students and teachers each year. KIS is now in its 7th year and has impacted a total of over 14,000 to date. KIS also has teacher training that is provided by engineers from General Atomics under their educational grant. Attendee evaluation forms have consistently given KIS high marks for their science show and technical exhibits.

The OIS Conference served some 2,500 students and teachers this past year. Teacher training is planned to start in the future. OIS expects to expand its size to 4,000 in the future and expand its exhibit area. The participating school districts gave high praise to the inaugural OIS Conference.

Collectively, these three STEM Conferences are impacting about 8,000 students annually with over 50,000 students and 3,000 teachers served to date.

**STEP Lessons Learned:**

The STEP Program has been in existence for going on 12 years now and is well past its infancy period. A number of lessons were learned along the way. The first lesson was how critical it was to engage the K-12 school system directly and involve them in the efforts. Buy in by educators is critical. An activity such as STEP can look as if it is moving into territory already
occupied by the educational system. Keeping it clear that STEP was simply helping to connect resources to assist an already taxed educational system was useful. The STEP Student Conference was a good first move. The feeling was that there was nothing wrong with providing a FREE science show and high tech booth exposition. Just the exposure of thousands of students annually to science and technology is progress. Engaging the community leadership, industry, businesses, academia, educational system, and government entities in a commonly focused interest area such as STEP has helped make STEP long lasting. The STEP Conference is now one of the “must attends” in the area. STEP’s Outreach efforts that work are non-invasive. STEP provides funds and volunteers only. STEP does not attempt to reinvent. STEP, although founded by a Congressman, has always been very careful to remain non-political. Politics can ruin it. The interest that we all share in serving the community and improving the lives of our children are above any political agendas. STEP welcomes all to help and draws from all walks of life, political affiliations and ethnicities. STEP volunteers were hard to obtain initially; however, there is nothing like four thousand enthusiastic kids at a science conference to cause volunteers to appreciate what they have worked on and agree to continue it.

Finally, the teacher training conference was the most difficult to get working well. At first, it looked like STEP was moving in on existing programs for training teachers. It was difficult to get good advice on how to be successful to help. For example, even something as simple as “when” to hold the training to obtain the maximum number of teachers received mixed advice from various “experts”. Hold the training on a Saturday when they are available. They’ll never come on a Saturday, hold it after school. Hold it in parallel to the student conference when the teachers are already there. Don’t hold it at the same time. We tried it all. Bottom line, we got between 100 and 150 teachers in attendance no matter what we did. Lesson was, just pick a date and hold it. Using the local university to provide teacher training seems to be the best solution for STEP. They are experts and it saved an entire STEP sub-committee the time to find individual training modules and schedule them into a conference. Now all we do is provide the training space and the teacher appreciation dinner (which is always well received!).

**STEP Results/Value:**

The STEP Program is attempting to inspire students from the early years of elementary education to become interested in math and science. That is a long term view and charge. One of the frustrating realities of an activity such as the STEP Program is the extreme difficulty in providing concrete data to show your results and value in real numbers. Numbers of students and teachers exposed to science and technology through STEP conferences is a weak metric when attempting to show results. Due to the privacy laws prohibiting the collection of student data and information as they flow through the educational system or even identifying actual students who attended STEP conferences leaves STEP with using examples of students and teachers who voluntarily identified themselves (with parental permission for students) as being actively assisted by STEP. We have industry engineering interns at local companies today who were early STEP Conference student attendees. We have science fair participants who use industry partner laboratory facilities and equipment and are mentored through their science fair projects. They do extremely well. STEP has compared its activities and outreach to studies conducted over the years to validate its active approach to improving K-12 engineering and science education. The 2004 American Society of Engineering Educators K-12 Leadership
Workshop presented in an ASEE paper entitled “Engineering in the K-12 Classroom: An Analysis of Current Practices & Guidelines for the Future” provides a basic validation of STEP’s activities. In this workshop, a set of six guidelines for improving engineering education and outreach were offered: Hands on learning (demonstrate relevance); Interdisciplinary Approach (add tech component to all subjects); Standards (map to state standards); Use/Improve K-12 Teachers (engage K-12 teachers in outreach); Make Engineers “Cool”; and Partnerships (create incentives). STEP has worked on actively addressing each of these areas to some extent, and heavily worked four of the six. A quote from the Executive Summary of this paper follows:

“Many groups with a stake in K-12 science, engineering, and mathematics (STEM) education make a strong case for improved technical literacy…..However, repeatedly making the case to each other is simply “preaching to the choir.” The larger issue, then, is the upshot---where do we go from here?”

STEP’s answer was to become proactive and actively attack the problem to make a difference. STEP is an example of a locally grown program involving a partnership of companies, government, universities/colleges, and the educational system committed to achieve the goal of increasing the numbers of local students qualified to become America’s future scientists and technology professionals. STEP remains an active participant in the science education community in the Inland Empire region of Southern California. STEP partners are dedicated and committed to making a difference.

Increase in Regional and National Activity and Focus on STEM Outreach:

Although the original STEP Program was formed to address the local needs of the Inland Empire community, several larger STEM outreach efforts have emerged over the years that companies, colleges/universities and government entities might consider to augment their own STEM outreach efforts. One such regional effort is the San Diego Science Festival which “is a collaboration of over 100 leading science organizations and is facilitated by BioBridge, a program of UC San Diego.” The San Diego Science Festival includes a multitude of events over a weeklong period including an Expo Day. For more information on the San Diego Science Festival visit their website at: (www.sdsciencefestival.com). Another growing national effort is the USA Science & Engineering Festival Expo which held their 2010 event on the National Mall in Washington, DC in the Fall of 2010. For more information on the USA Science & Engineering Festival, visit their website at: (www.usasciencefestival.org). These are but two of the STEM outreach efforts that now exist to provide a venue to attach STEM outreach efforts to if organizing a local STEP Program is not practical. Additional national focus on STEM education can be expected as the President “tapped Xerox Chief Executive Ursula Burns to help lead an education initiative aimed at helping students excel at science, technology, engineering and math.” Several other well known individuals such as “former Intel Corp CEO Craig Barrett, Time Warner Cable Inc. CEO Glenn Britt and former astronaut Sally Ride, among others” were named to help lead this important effort.

The DoD STEM Education & Outreach Strategic Plan with the Navy Metrology Engineering STEM Outreach through the STEP Program Highlighted in Support of the Plan’s Goals:
The background section at the front of this paper highlighted the initial impetus that caused Congress to authorize DoD through the National Defense Education Act of 1958 to increase the flow of talent into science and engineering among other things. The background also provided examples of the various STEM education and outreach activities that DoD and its multitude of bases and laboratories have traditionally been involved in during the 50 some years since the congressional authorization. In this section of the paper, the challenges that drove the DoD to develop a strategic plan on STEM education and outreach will be presented along with some specific examples of these general challenges as experienced by NSWC/Corona and its Metrology Engineering Center. The DOD STEM Education & Outreach Strategic Plan for 2010-2014 will be provided through use of the strategic plan’s framework from Vision and Mission through the specific broad DoD Goals and Objectives. Again, specific examples of the Navy Metrology Engineering Center activities in the STEP Program will be presented to indicate alignment and support for this DoD framework. The full DoD STEM Education & Outreach Strategic Plan can be obtained at: http://starbasedod.org/images/resources/OASDRA_Directives/dod-wide%20stem%20plan%20final.pdf

The Challenges Cited In the Strategic Plan

Global Pressures:

The main global pressure is that the United States leadership in STEM is diminishing. The Organization for Economic Co-operation and Development (OECD) found that the United States had the highest high school graduation rate among its 23 members in 1970. By 2007, the U.S. had dropped to eighteenth among the 25 member nations. Other countries are now producing many more scientists and engineers than the United States due to their increased educational capabilities. For example, China and the U.S. granted about the same number of first year engineering degrees in 1985; however, China granted nearly four times as many in 2005. A comparison of college graduation rates for all fields among OECD members showed the United States dropping from first place in 1995 to fourteenth in 2007. This drop was due to the growth in graduation rates by the other OECD countries rather than a drop in U.S. graduation rates (which actually increased by 4%).

Challenges within United States Education:

The public educational system in the United States is challenged by an increasingly diverse student body, increased graduation requirements; and outdated, underfunded, and poorly maintained facilities for the study of science. Access and opportunities for all students to develop STEM skills and abilities are uneven across the country. For example, most low-performing schools are in areas of high levels of poverty and high percentages of minority students. Research indicates that STEM success for students requires high-quality experiences along the educational continuum from the early grades through employment. The current environment needs bolstering of essential elements to this educational continuum. The STEP Programs findings of the need to inspire and mentor students, provide assistance and help the K-12 teachers with STEM parallel the findings in DoDs strategic plan.
Challenges Facing the Department of Defense:

Specific challenges to DoD beyond the more general challenges discussed above (and also presented in the founding of the STEP Program above) take into account a variety of realities facing DoD and it’s workforce. As a DoD activity, NSWC/Corona and its Metrology Engineering Center and Measurement Science & Technology Laboratory have experienced similar challenges as presented below; therefore, information specific to NSWC/Corona will not be presented. Suffice it to say that NSWC/Corona’s challenges and those discussed in the DoD STEM Strategy are mutually supportive.

Diminishing STEM capabilities in the workforce:

The average age of DoD scientists and engineers (S&E’s) continues to rise. In 2005, 57.8% of all federal scientists and engineers were age 45 and older. A significant number of these workers will likely leave DoD science and technology jobs by 2020 through either retirement or attrition. DoD’s current S&E workforce also lacks diversity. As an example, the proportion of women S&E’s in DoD laboratories has not kept pace with the proportion found in the U.S. workforce as a whole.

In further support of this DoD finding, an article by Dr. Pamela S. Clute, professor of mathematics and education at the University of California, Riverside, again highlights this long known fact. She states that: “While it is true that women [now] represent 57 percent of the nation’s college population, less than one-third major in science, technology, engineering, or mathematics. Research shows they [females] have the ability, but lack the interest.”

Federal Government Hiring Practices:

Criticism that the federal government’s hiring procedures are too cumbersome and take too long from initial engagement to hiring are well known. The Office of Personnel Management (OPM) is in process of reforming hiring practices in partnership with agencies. The present cumbersome hiring system places DoD at a competitive disadvantage when attempting to hire S&E’s in short supply.

Competition for World-class Talent:

Starting salaries in the private sector average about $49,000 per year compared to the $45,000 per year salary offered for substantially similar S&E talent in the public sector. This salary difference is a systemic challenge for DoD. This difference is very significant for many seeking employment, particularly those that are carrying student loans which average $23,000. Additionally, DoD challenges to obtain world-class S&E talent is heightened by the fact that DoD requires that its employees be United States citizens capable of obtaining proper security clearances. Finally, DoD lacks good data on it’s STEM workforce as data is not maintained on educational disciplines, educational institutions, and employment history prior to DoD employment.

Laboratory Revitalization:

DoD laboratories employ more than 35,000 S&E’s which require a steady pipeline of new
employees. DoD laboratories are a nexus of discovery and innovation. Essential to attracting and retaining world-class STEM professionals is a technically strong and productive DoD laboratory system.

**DoD STEM Education & Outreach Strategic Framework:**

The basic framework of the DoD STEM Strategic Plan is presented in this section of the paper along with the brief specifics of how the Metrology Engineering Center’s STEM outreach through the STEP Program supports each of DoD’s four goals and their objectives. The DoD framework verbiage is unaltered from the original DoD STEM Education & Outreach Strategic Plan and is footnoted only once at the end of this section for simplicity. Indented paragraphs are not part of the DoD STEM Strategic Plan, but are the NSWC support commentary and; therefore, do not pertain to the footnote at the end of this section. The strategic plan contains: a Vision statement a Mission statement, and four (4) Goals, each with Objectives. The Vision and Mission will be presented first, followed by each Goal and its broad Objectives. Specifics of NSWC/Corona’s Metrology Engineering Center support of each DoD goal and its objectives through their current STEM outreach through active participation in the STEP Program will follow each goal and objectives section.

**Vision and Mission:**

**VISION:** A diverse, world-class STEM talent pool with the creativity and agility to meet national defense needs.

**MISSION:** Inspire, develop, and attract the STEM talent essential to deliver innovative solutions for the Nation’s current and future challenges.

**Goals and Objectives:**

Goal: INSPIRE---A Nation of students, parents, teachers, and the public inspired to engage in STEM discovery and innovation.

Objectives: (1) Increase the awareness and importance of STEM and foster discovery and innovation, (2) Provide opportunities and resources for learning and personal growth that stress academics, knowledge, skills, abilities, and attributes required for STEM discovery and innovation, (3) Strengthen, expand and enable communities of stakeholders to provide a continuum of formal and informal STEM programs and opportunities, and (4) Directly engage populations in STEM fields.

The Metrology Engineering Center has used the STEP Program to support each of DoD’s objectives under this goal to “Inspire”. The primary mission of the STEP Program is “To inspire students to pursue careers in math, science, engineering and technology”. STEP engages students, teachers, parents, the educational system and the community in STEM. STEP’s partnerships with academia, industry and government engage the community and educational system to focus on the importance and need to enhance STEM education. The Metrology Engineering Center’s participation in STEP and the STEP Conferences helps to increase the awareness of the importance of STEM and the STEP Conference Exhibits helps to foster discovery and innovation in the students and teachers. This also holds true for their participation
The STEP Program helps strengthen, expand and enable communities of stakeholders to provide a continuum of formal and informal STEM programs and opportunities. The STEP Conferences including KIS and OIS directly engage large populations in STEM fields. STEP is an excellent example of a STEM outreach program geared to satisfy these objectives on a local level and might be considered as a model for use by DoD at other activities. The Metrology Engineering Center at NSWC/Corona is heavily involved through STEP to help satisfy DoD’s “Inspiration” goal and objectives.

Goal: DEVELOP---A future world-class STEM workforce talent pool. Objectives: (1) Identify current and future STEM workforce needs, (2) Increase the diversity of participants in STEM programs, (3) Build a portfolio of DoD STEM programs to cultivate the desired competencies of the talent pool, and (4) Increase the number of military personnel with STEM competencies that transition into the defense workforce.

The Metrology Engineering Center’s active role in the STEP Program has helped to increase the Center’s activities and partnerships to increase the diversity of participants in STEM programs. NSWC/Corona has developed a number of relationships with university and college STEP partners that allow a better interaction in reaching a more diverse population of students. The relationship with a key STEP partner, the Alpha Center at UC Riverside, which focuses on outreach to minorities and females is a good example. Additionally, STEP’s expansion to Hawaii to provide STEM outreach to native Kauai and Oahu Island students is another example where NSWC/Corona actually lead the expansion and outreach effort. Likewise, the STEP Program itself reaches many local schools with large minority populations. NSWC/Corona was identifying its own current and future STEM workforce needs when it began its partnership with the STEP Program. The STEP Program can be offered as one of the programs in DoD’s portfolio of STEM outreach. As NSWC/Corona has few military personnel, the last objective here is not really impacted greatly by STEP Program involvement except that STEP’s expansion to Kauai and Oahu where large populations of military reside has drawn in military personnel at these sites.

Goal: ATTRACT---A dynamic and innovative work environment in DoD that attracts and retains world-class STEM talent. Objectives: (1) Identify programs and best practices that attract and retain world-class STEM talent, (2) Ensure a DoD work environment that attracts and retains world-class STEM talent, and (3) Strengthen and promote the awareness of STEM-relevant opportunities within DoD.

Although the Metrology Engineering Center does attempt to satisfy objectives number (1) and (2) through various proactive means, its participation in the STEP Program has little to do with its internal motivations and actions to enhance its programs and work environment. However, by participating in the STEP Conferences as a visible exhibitor of STEM focused booths and demonstrations, the Metrology Engineering Center highlights its STEM-relevant opportunities to some 4,000 students and teachers each year in Riverside, California as well as to some 4,000 additional each year during Kauai-In-STEP and Oahu-In-STEP Conferences. The news coverage of these annual STEP Conferences (both newspapers and television news as well as Navy News services) provide added benefit and awareness of STEM importance and opportunities.
Goal: DELIVER---A coordinated, collaborative, and cohesive set of DoD STEM programs that inspire, develop, attract, and retain world-class STEM talent.

Objectives: (1) Develop a systematic approach to identify STEM education and outreach programs across the DoD components and agencies, (2) Provide and maintain a publicly accessible inventory of DoD STEM programs, and (3) Implement a STEM inventory communication strategy.

Clearly, the DELIVER goal and objectives are owned by the DoD STEM Development Office. This goal requires the identification of existing DoD STEM outreach activities such as the STEP Program and others, maintain and provide an inventory of these STEM programs, and develop a communication strategy. Over 100 STEM outreach activities in DoD have already been identified. STEP is but one of these many STEM activities. As stated in the DoD STEM Strategy, “The STEM Development Office will lead DoD and intergovernmental summits to establish a transparent, forward looking framework for current and future STEM investments. DoD’s inventory of STEM programs can be a way to engage participants.”

**Conclusion and Benefit of the STEP Program to NSWC/Corona’s Metrology Engineering Center and DoD:**

NSWC/Corona’s early and active involvement in the STEP Program has given them visibility as a STEM outreach leader in the Navy and DoD. It has allowed them to easily support and comply with the new DoD STEM Education & Outreach Strategic Plan and policies as well as proactively provide a concrete STEM outreach program that has been successful, active, collaborative and expanding for over 10 years. Further, it has positioned them to be a leader in the DoD arena on STEM outreach as well as in the Navy.

Besides being an activity that has been an early STEM outreach participant through a successful STEP Program, a number of other benefits to NSWC/Corona have occurred as a result of STEP participation. The visibility of being active in the local community has been of great value. NSWC/Corona is seen as a player and large technical employer in the Inland Empire that offers jobs in STEM fields. The community has come to place a high value on NSWC/Corona as a member of the community for its visible interaction in STEM outreach to local schools as well as a partner in STEP. This became clearly evident during the most recent 2005 BRAC rounds where NSWC/Corona was again closely reviewed for closure and relocation. The local community raised a serious voice of support and defended the base from relocation. This contributed greatly to the 2005 BRAC Commissions unanimous decision to leave NSWC/Corona in place. The STEM outreach through the STEP Program did not, in and of itself, save the base from closure; however, the community support to keep the base open was a contributing factor. Other benefits include the strengthening of NSWC/Corona’s partnerships with the local universities and colleges due to STEP participation. Navy metrology now has a couple of engineering interns from the local university that were early STEP student attendees. A local science fair 10th grade student linked up with the Measurement Science and Technology Laboratory through a STEP Conference and, using lab grade instruments, completed a project on determining the potential usefulness of using thermal imaging technology to evaluate autonomic vascular reactions. The study showed that thermal imaging may be useful in detecting pre-
clinical stages of circulatory problems. This particular student not only placed in the state science fair competition, but also presented the paper at the Measurement Science Conference in Long Beach, CA during January 2007 receiving the Youth Achievement Award. This student was the youngest to ever present at this Conference. The Navy Metrology Engineering Center now has hired this student as an engineering intern in their metrology programs. Over 50,000 students and 3,000 teachers have been exposed to metrology engineering and measurement science through the STEP Program and its expansion programs in Kauai and Oahu. NSWC/Corona engineers who volunteer for the STEP Conference leave with a sense of satisfaction of sharing what they do and its importance to our future generation of engineers. Repeat volunteers are common. The list of benefits is long, with some being unanticipated. STEP has been a win-win for the Metrology Engineering Center, the Navy and DoD.

Bibliography:

1. Smithsonian Institute, National Air and Space Museum, “Milestones of Flight”
   http://www.nasm.si.edu/exhibitions/gal100/sputnik.html
14. ASEE First Bell article, “President Taps CEO’s, Former Astronaut to Lead STEM Education Initiative”, November 24, 2009.
24. John Berry, Director, OPM, Memorandum, “Office of Personnel Management Assistance in Meeting Hiring Reform, Employee Satisfaction and Welfare Requirements”, contained in the President’s Fiscal Year 2011...

