STEM Education and Outreach

Strengthening Science, Technology, Engineering and Mathematics

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The Better Buying Power 3.0 initiatives identified by Under Secretary of Defense for Acquisition, Technology, and Logistics Frank Kendall in April 2015 outlined numerous items, with the common major focus of Department of Defense (DoD) support for Science, Technology, Engineering and Mathematics (STEM) education and outreach.

The Defense Acquisition University (DAU) is known as a corporate university with its mission of training the DoD acquisition workforce. In addition, DAU conducts STEM outreach at high schools in the Fort Belvoir, Virginia, area near DAU's headquarters. Since the fall of 2010, DAU has been offering the STEM Engineering Management Workshop (EMW). The challenge has been to coordinate efforts with school districts in order to find opportunities to engage high-school students throughout the academic school year and over the summer, along with expanding the STEM outreach opportunities from kindergarten through the 12th grade while developing professional development opportunities for educators.

The EMW is one of the principal STEM events conducted by DAU and was derived from the DoD EMW workshop (Workshop Engineering, WSE-006 in the *DAU iCatalog*). The EMW initially was developed as a mission assistance targeted training class in support of the Defense Contract Management Agency (DCMA). A number of adaptations have been incorporated into the EMW in order to meet the needs of various DoD organizations. In the EMW, DoD employees experience an accelerated version of a typical DoD system acquisition. Throughout the 1-week course, participants are actively involved in the designing, building, coding and testing of a robotic vehicle that must meet

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The three-wheeled robotic vehicle shown here and the four-wheeled vehicle on the next page, are the kind of robotic vehicles built and tested in the Engineering Management Workshop. Items in the background, such as the computer mouse, provide an idea of vehicles' size.
Photos by the author

specific cost and performance requirements. The students use a Lego Mindstorms EV3 Education kit to create their hardware design/vehicle and use the Lego Mindstorms software language and modeling environment to develop software coding for programming the vehicle to perform specific functions. This workshop simulates the processes and situations DoD employees face on the job, where they are required to design, build, code and test systems that meet specific requirements while preparing for and conducting technical reviews along the way. Throughout the workshop, participants are introduced to and practice various engineering management skills and competencies such as:

- Systems engineering
- Project management
- Engineering management and design
- Software development
- Risk management
- Technical reviews and audits
- Configuration management

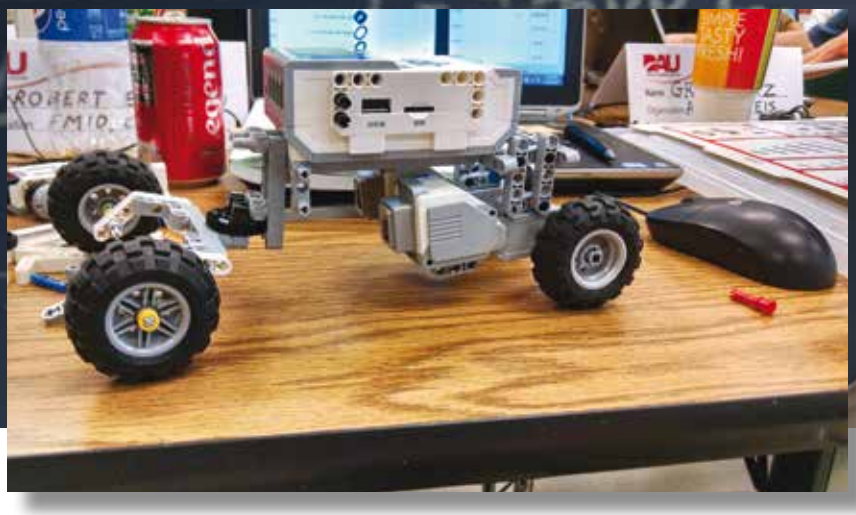
The final day culminates with the teams demonstrating the performance of their vehicle designs during a number of test events, including trial runs around a complex obstacle course. The workshop concludes with a source selection, in which team designs are evaluated based on cost, schedule and performance. One team is declared the winner, based on a best-value trade-off determination.

The STEM EMW is a version of the EMW that is tailored to fit high-school students through the removal of DoD specific acquisition topics. In the STEM EMW, high-school students face many of the same technical challenges and time constraints. The aspects that most challenge the high-school students are critical thinking, team-based project completion and the overall competition as a best value trade-off winner. The high-school students must quickly come together to form a cohesive team to tackle the challenges of the workshop. They must apply critical thinking to many of the issues that arise throughout the workshop, such as developing a hardware design robust enough to meet the requirements, testing on the track to validate results, or redesigning to meet the requirements. Team members also face individual tasks and must communicate their ideas with the other team members in order to refine the hardware and/or the software along with scheduling the time to test the robotic vehicle.

The STEM EMW is conducted in two different formats to provide an opportunity for students to attend during the school year and the summer vacation. During the school year, the STEM EMW is part of a high-school engineering design class, and students participate in a 3-week delivery of the workshop. Over the summer, students are invited to participate in the STEM EMW during a 1-week workshop that runs all day for 5 consecutive days. Regardless of the format, DAU provides the Lego Mindstorms EV3 Education kits along with a travel laptop for each team as well as the relevant software language and modeling environment. The STEM EMWs are conducted free of cost to the high schools.

The school year STEM EMW is conducted during a regularly scheduled engineering design class that meets 5 days a week in 90-minute sessions. During Week 1, DAU instructors conduct the STEM EMW at the local high school through short lectures, student exercises and hands-on practical applications. These include deliverables such as creating a company name, identifying positions, creating a schedule along with tasks, identifying risks, creating and evaluating hardware designs and preparing for and conducting a technical review. During Week 2, the high-school engineering design instructor assists the students in creating a design using existing CAD/CAM software within the classroom. During Week 3, DAU instructors return to the classroom to deliver short lectures, student exercises and hands-on practical applications.

The students begin creating and testing hardware designs along with developing and coding software using the Lego Mindstorms software language and modeling environment to provide the necessary functionality for test-track operation and testing of the vehicle. The students also conduct a



The culminating event is a demonstration of their vehicles on a test track with one team announced as the overall winner on a best-value basis.

technical review, providing finalized information regarding their project that includes scheduling, risks, testing results, software development packages and enhancements, assembly procedures and training results. The culminating event is a demonstration of their vehicles on a test track with one team announced as the overall winner on a best-value basis.

The summer STEM EMW is conducted over 1 week, meeting for the entire school day over 5 consecutive days. DAU instructors conduct the STEM EMW at the local high school through short lectures, student exercises and hands-on applications. These include deliverables such as creating a company name, identifying positions, creating a schedule along with tasks, identifying risks, creating and evaluating hardware designs and preparing for and conducting a technical review over the span of the first 2 days. DAU recognizes the need to train educators in middle school and high school to provide STEM courses along with creating a menu of STEM events and activities. This is a tentative effort under development at DAU. The challenges in this area are the lack of enough teachers with the necessary STEM backgrounds or STEM professional development. Time is required to research ideas, procure materials necessary for the event and to develop curriculum in support of STEM events.

DAU is developing a train-the-trainer STEM educator course called the STEM Problem-Based Enhanced Educator Development (SPEED). The request to create the SPEED workshop came through a STEM outreach effort at DAU's South Region in Huntsville, Alabama. This workshop provides STEM Educator Professional Development from the 7th through 12th grade level that includes STEM Team Problem-based curriculum planning and development. The pilot course for the SPEED workshop was set for the second quarter of Fiscal Year 2016 at DAU South with an additional offering planned during the summer of 2016, with no attendance costs to the STEM educators or the school districts.

DAU also is working with Missile Defense Agency Headquarters at Fort Belvoir, Virginia, to tentatively begin efforts to research and develop STEM courses for educators across all primary and secondary school grade levels (1st through 12th grades). While the STEM EMW is one 5-day course designed for the high-school level, other organizations across the DoD conduct STEM events of various lengths designed for the elementary-, middle- and high-school levels. The U.S. Naval Academy conducts short-duration STEM events over a few hours that can be expanded as required, and the topics covered include Energy, Cyber, Mechanical Engineering and Engineering Design for the middle-school level.

Collecting best practices and developing STEM short courses along with creating the curriculum, identifying materials and classroom requirements will enable STEM educators across the country to pick and choose topics of interest and also will enable them to quickly insert and deliver STEM courses and incorporate them into their classrooms.

Each of the five DAU regions—Capital Northeast (CNE) at Fort Belvoir, Virginia, Mid-Atlantic at California, Maryland, Midwest at Kettering, Ohio, South at Huntsville, Alabama, and West at San Diego, California—conducts various forms of STEM outreach within their local communities. The impact of the relationship CNE has fostered between Fauquier County Public Schools (FCPS) in Virginia has increased demand and interest in STEM courses within the FCPS. The STEM outreach efforts are not limited to the FCPS. CNE continues to establish and develop relationships with other school districts. As a result, CNE has received multiple inquiries and requests for STEM EMWs at Quantico high school (DoD school on the Marine Corps Base at Quantico, Virginia) along with Stafford County and Spotsylvania County, Virginia, public school districts. All of this STEM outreach can be traced back to the Better Buying Power 3.0 initiatives with the only limitation now being travel expenses to conduct STEM outreach beyond the local DAU regions.

For more information about DAU's STEM outreach within CNE, please contact the author at the e-mail address below.

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