***IED Clean-Up: A Cooperative Classroom Robotics Challenge***
# The Benefits and Execution of a Cooperative Classroom Robotics Challenge

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*"Students used to ask, 'Why don't you just give us something to analyze?' What we really want to hear is, 'Show us someone who needs help.' [In order for that to occur] culture shift is required."*
- Dr. Woodie C. Flowers, MIT Pappalardo Professor of Mechanical Engineering (2005).

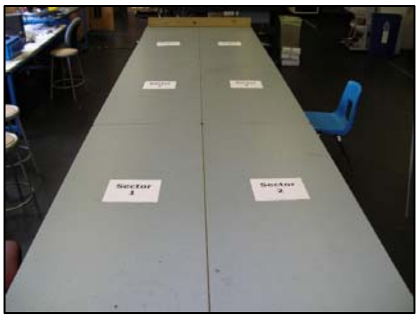
## Introduction:

Real world problem-solving, addressing societal needs, and improving the quality of life are all synonymous with Technology Education and its standards. In Pennsylvania, standard 3.8.12 encourages students to, "Apply the use of ingenuity and technological resources to solve specific societal needs and improve the quality of life," (Pennsylvania Department of Education, 2002). At the national level, Standards for Technological Literacy (STL) 4, 5, 6, and 13 all relate to the effects, impacts, development and use of technology on the environment and society in general (International Technology Education Association, 2000). However, the problem for the classroom teacher lies within the creation of those engaging, current, and relevant STEM related problem-solving activities that will have the most impact on students. In our program we have recently developed an activity that addresses the above stated standards, but also has strong interdisciplinary connections. The following classroom challenge was created to incorporate a humanitarian project with the use of the Vex Robotics Design System to remove simulated IEDs (Improvised Explosive Devices) to a detonation zone within a specified amount of time. The relevance of this activity to students is obvious given the deluge of war coverage in the news media. Some of this media coverage may actually be used as an anticipatory set and as part of the research phase of the design process. *Wired Magazine*'s article titled "The Baghdad Bomb Squad" (Shachtman, 2005) documents a true humanitarian need for smart machines that can save the lives of soldiers and civilians in a combat zone.

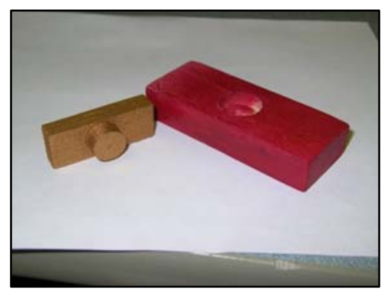
Throughout this activity, named “IED Clean-Up,” students work in pairs to design and build robots to perform appropriate tasks. However, the entire class works together to develop a strategy, a set of complimentary designs, and a collective plan for implementation to safely dispose of the IEDs. There within lies one of the unique aspects of this activity. Rather than competing against one another, teams of students are cooperating together to solve a problem. They quickly learn that the success of the team/class is dependent upon efforts and communication skills of each individual, which are real world life skills that apply to college, work, and life within our global society. Most importantly, students are learning the overarching goal of STEM and Technology Education, which is to use one’s skills and knowledge to improve the world in which we live.

Robots in the classroom is not a new idea and it’s true that projects involving the creation of these multi-system creatures can consume entire semesters in a heartbeat. However our experiences have revealed to us that robotics projects and challenges in the classroom just might be one of the best ways to deliver meaningful STEM instruction and address standards while purposefully helping to develop a more socially conscience student. We’re not building toys; we’re designing and building complex systems that serve an intended purpose, a humanitarian purpose! And best of all, a diverse range of students is “getting it.” They see the interdisciplinary connections of Math, Science, Engineering, and the value of effective communication and strategy. They see the need and “role of society in the development and use of the technology,” and the “effects of technology on the environment” as stated in STL 6 and STL 5, respectively (International Technology Education Association, 2000). In addition, students quickly come to realize that personal biases and differences are of no use in solving the problem at hand; they must work together. In order to invite the culture shift that Dr. Flowers and others see as so crucial to our future, implementation of a robotics challenge such as the one described below may just provide the magic mix of ingredients that helps produce the kind of contributing citizens that our world so sorely needs. An added benefit is that teachers can take advantage of the natural student enthusiasm that comes with robotics projects.  Such activities position students to discover a great deal about engineering, technology, teamwork, and their place in society. Also, the teacher has the added benefit of addressing a variety of related standards at an in-depth level.

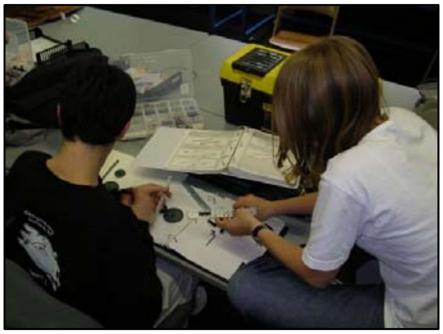
**Overview of the Classroom Challenge:**



IED Clean-Up is performed on a 20-foot by 5-foot elevated rectangular surface (adjacent tables) that we call “The Flats.” The Flats are divided into equal sectors and a 2-foot “Detonation Zone” separated from the sectors by a 5.5-inch wall.  The challenge simulates a combat zone or post-war scenario where there is unexploded ordinance.  Only recently have robotic solutions to these types of problems become viable. The object of the mission is for multiple robotic inventions to safely pass and remove the simulated IEDs across the sectors, to the Detonation Zone where the ordinance can be safely disposed of without harm to local villages or people.  Each IED has a “pin” and a “base” and separation of these two components is equivalent to detonation.   Model villages in various locations must remain safe and undisturbed by IEDs and robots. The entire class must work together to develop a plan for safe and timely execution of the mission. Each team is assigned a sector and is solely responsible for building and operating its robot, but strong communication and design collaboration between teams is essential to mission success.  Point values are assigned for tasks and scores are tabulated.  A “perfect” score is the ultimate goal for the class that is only obtained through appropriate use of all robots to

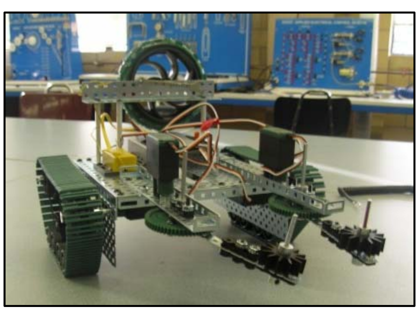


safely remove all IEDs within the prescribed time limits. Initial full challenge rules, along with other pertinent files may be found at: www.chiefdelphi.com/media/papers/1897.



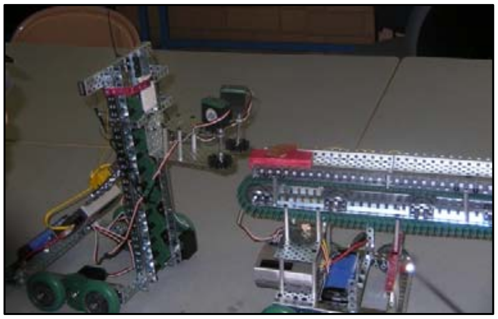
In addition to building and competing, the paired teams of students document their design and process in an engineering notebook, complete with sketches. As a reflective exercise, they also must create a presentation that evaluates their own design and process utilizing the *Rubric and Evaluation Criteria for Standards-Based Robotics Competitions & Related Learning Experiences* developed by TSA through an NSF grant as part of the 2006 Robotics Education Symposium (TSA, 2006). The details of the challenge rules (specific makeup of robots, time constraint, etc.) were altered slightly in the second semester to better engage a slightly different group of students, but the essence of the challenge remained the same and these two important meta-cognitive exercises provided for an enriched learning experience in both semesters of the 2006-07 school year.

**Reflections and Future Plans:**



Our class's first semester attempt with this activity was successful in the sense that our students grasped the big picture. They realized that there was a true purpose to their learning and a connection to the skills, knowledge, and hard work involved. The notion that design skills and inventions in general should be used to better the world in which we live came through loud and clear. Their notebooks showed purpose and genuine desire to think outside the box to collectively solve a unique problem. However, this first class was not able to successfully remove all of the IEDs to the Detonation Zone before the semester ended. Video of the fall 2006 inventions at work is available at http://video.google.com/videoplay?docid=-1014414722787281429.

This first class did, however, set the bar for the next class of spring students who took the course and attempted to surpass their predecessors. In semester two, the decision was made to share the designs from the previous class. If cooperation and a better society are indeed end goals, as teachers we needed to model those principles and resist the urge to “hide” what had been done before and overcome our fears of “copycat” designs. Some of the challenge rule changes we made addressed that issue and we also discovered the real value in sharing the designs. There was a real-world learning that took place and students truly embraced design as an iterative process. Just like STL 13 intended, students saw first hand how their designs and reflective practice helped them “develop the abilities to assess the impact of products and systems,” (International Technology Education Association, 2000). The access to previous designs and the desire to “outdo” the previous class led to dramatic improvements in just one semester of a brand new course. Video from the spring 2007 semester’s successful mission is available at http://video.google.com/videoplay?docid=-3547260733346320301.



The future of the IED Clean-Up activity holds wonderful possibilities. The Vex Robotics Design System provides affordable solutions and the platform has proven to be very flexible and reusable in the classroom setting. As the next group of students comes in to take on IED Clean-Up there is no doubt that the bar will be raised even higher. We look forward to adding to the challenge by integrating a higher level of programming and autonomous operation and using more sensors. Given our successes, we plan to incorporate even more content related to the “cultural, social, economic and political effects of technology” to keep STL 4 at the forefront (International Technology Education Association, 2000) along with increased sophistication in robotic systems. We will also build upon the STEM approach, continuing to emphasize the big picture. Robotics with a social conscience has not only energized our students with desire to improve our world, but it has also begun to bring teachers from Mathematics, Science, and even English to the Technology Education lab at Lower Merion where true STEM integration is growing. We have a long way to go as the project and our robotics course are still educational infants, but it's for certain that we are on our way to using robots in the classroom to make a powerful difference in the lives of our students while increasing their technology literacy skills.

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**Authors:**

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Rich Kressly has been a public educator for 14 years, currently serving Lower Merion High School's Technology Education and English departments while also acting as an educational consultant for Innovation First, Inc. He's served FIRST Robotics as a Regional Senior Mentor and has also been part of the yearly international robotics challenge design for FIRSTs intermediate program. He has played roles in designing robotics curriculum and support materials at the local, state, and national levels and has received Who's Who Among America's Teachers honors twice. He can be reached at kresslr@lmsd.org.