

Outline/Script for TEAP Presentation

***** Note: Text in red designates content in Power Point.**

MARK:

1. Intro: We want to thank you for being here today and the TEAP board for the opportunity to present this morning. You'll notice that the title of presentation is "Robots in the Classroom – So What?" and it's our intent that our answer to that question will be self-evident throughout our presentation this morning, but we'll be sure to bring it all together in the end. We're really here to share a few things with you today: The Why, The What, The How of robotics in the classroom, and the answer to "Robots in the classroom – So what?"

That "what" of our presentation is one really powerful robotics activity called the IED Clean-Up that we are incorporating into the classroom. The "how" is our approach has to do the design process when it comes to robotics or any STEM problem-solving activity. And Rich is going to start off with the "Why" of our talk this morning.

RICH:

Perhaps the finest example of Why we robots in the classroom might be a good idea lies within a story **best told in reverse** Starting with the most recent – **2004 MER mission Spirit & Opportunity**. Most successful robotic mission ever. Just getting these two rovers to Mars was an incredible feat in, and of itself. Here's a video of **MER Entry Descent & Landing**. By the way, if you're looking for ways to "hook" students, NASA video can be a great tool. Here you'll see real world STEM activities and role models that cut across gender and ethnicity talking with great excitement about the important work they do as designers and engineers. (show vid).

Working in reverse, how did MER come into being? **1997 Pathfinder mission and robot Sojourner**. In 1997 this was the gold standard in robotic/martian missions, but the icing on the cake here is that Price Prichett publishers went on to use this mission as a business model of "faster-better-cheaper" showing how govt and private industry can partner, stay within time and budget constraints, and achieve phenomenal success. Things , however, weren't always this successful. Working backwards to the 1980's, NASA and JPL were working on **Robby**. Robby is an ancestor

of the current rovers, but had issues. (present stats on slide). Then one college intern changed the face of robotic missions forever. **Colin Angle** spent a summer with NASA and JPL while Robby was being “refined”. I’m paraphrasing here, but this was Colin’s internship in a nutshell (present info on slide and talk about what Tooth could do). So, the wild success story starts with one persistent intern, but the story gets better. Colin was eventually offered a job by NASA. He said, “no thanks” and makes an **impact** on our lives through his own company, iRobot, makers of industrial bomb “sniffing” and disposing robots as well as some very handy consumer robots. So the final word on **Why?** Colin is in our room somewhere. We need to make conscious efforts to find and nurture all of the Colin’s out there. If we don’t who will?

Mark:

The “**What**” of our presentation is the IED Clean-Up robotic challenge that we developed over a year ago; IED being “Improvised Explosive Device.” Building upon the idea of the Colin Angle story that there may be a student in our classes like Colin, we wanted to create a new activity that would provide a challenging opportunity for not only our potential Colin Angles, but all students. We already had a robotics challenge that we modeled after FIRST & TSA robotics challenges that engaged students in STEM. However we wanted one that was unique. One that had **real world applications for robotics**, involved a **social and environmental approach to problem solving**, AND involved the **entire class working together to solve the problem**. And of course **state and national standards** had to be addressed.

What we came up with was a challenge that incorporates a humanitarian project with the use of the **VEX Robotics Design System** to remove simulated **IEDs** (Improvised Explosive Device) to a detonation zone within a specified amount of time. It’s very easy for students to relate to this type of scenario due to 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 November 2005 article titled "The Baghdad Bomb Squad" documents a true humanitarian need for smart machines that can save the lives of soldiers and civilians in a combat zone.

Throughout the IED Clean Up activity 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.

Or as PA Standard: 3.8.12.B states: - **Apply the use of ingenuity and technological resources to solve specific societal needs and improve the quality of life. And at the national level standard level from chapter 4: Students will develop an understanding of Technology & Society.** Of all the standards these are the two that drive our Tech. Ed. program.

Robots in the classroom are not a new idea. As you can see here we found an old black and white picture of this elderly man controlling a robot from the 1920s. However our experiences have taught 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 here** – we're designing and building complex systems that serve an intended purpose - a humanitarian purpose! And best of all our students are getting it. They see the interdisciplinary connections of Science, Technology, Engineering, Technology, along with the value effective communication and

strategy. They quickly come to realize that personal biases and differences are of no use in solving the problem at hand – they must work together. In addition, teachers can take advantage of the natural student enthusiasm that comes with robotics projects. This stuff is fun.

Rich:

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 is designed to simulate a combat zone or post-war scenarios where there are unexploded bombs. The object of the mission is for multiple robotic inventions to safely pass and remove the simulated IED’s 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.

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 (www.tsarobotics.org). The wonder of this evaluation tool is that it addresses design process, technical criteria, and unifying themes on an equal playing field. Thus, problem solving, systems & mechanisms, and decision making/ethics all carry equal weight within the framework of reflection, feedback, and assessment.

Mark We'd like to share a brief video of our students' first attempt the first time we offered the challenge to them. [Explain video as needed]

VIDEO <http://video.google.com/videoplay?docid=-1014414722787281429> .

Mark:

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 safety zone before the semester ended.

They 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. This was a new concept for us in the Tech. Ed. classroom. Traditionally we wouldn’t share old ideas from projects. 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. 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. 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 metacognitive exercises provided for an enriched learning experience in both semesters of the 2006-07 school year. Here is a video of our second semester students’ work. [Explain video as needed]

VIDEO: <http://video.google.com/videoplay?docid=-3547260733346320301> .

The future of “IED Clean-Up” activity holds wonderful possibilities. 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 using more sensors. 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 where true STEM integration is growing. We have a long way to go as the project and course are still educational infants, but we’ve been pleased (to say the least) with the results.

RICH: The How

The “How” of our presentation has to do with our approach to the actual problem solving process. However, we can’t take full credit for the initial idea. Our original inspiration came from a quote by MIT Engineering professor, Woodie Flowers. The group he was addressing was a group of fellow MIT colleagues. He said, *“‘Students used to ask, ‘Why don’t you just give us something to analyze?’ What we really want to hear(from our students) is, ‘Show us someone who needs help.’ [In order for that to occur] culture shift is required.’”*

A culture shift is required. Well how do you shift that culture? It’s not any easy task. How do we get students, high school students in our case, to make a monumental shift in their thinking? So that they fully understand and believe that their Technology education, their entire education does not only exist for personal gain, but the gain of their school, community, and the world in which they live. Well we don’t have any easy answer, but we’re working on it. And we believe that we’re making progress. It’s a coincidence that that giant granite stone outside of our school states, “Enter to Learn – Go forth to Serve.” This is consistent with Woody Flower’s quote, “Show us someone who needs help.” Use your skills and knowledge to solve specific societal needs and improve the quality of life.

Our teaching practices were also greatly influenced by a term or approach that came from the FIRST Robotics community. Rather than a competition, FIRST referred to their events as a *cooptition – a combination of the words competition and cooperation - the idea of teams helping teams to solve a problem in a friendly, fun, and intellectually challenging atmosphere.*

We initially communicated this idea/message/world view if you will to the students in our Technology & Engineering club that competes in TSA and FIRST. And, not only was it well received, but it had a powerful impact. But it didn’t happen over night. Little by little we noticed positive results. At the end of the school year, when we have many of the students complete an exit interview and one of the questions in this document is, *“Why are you here?” We received answers like, “To make the world a better place, to teach others what I’ve learned, to have a*

positive impact in the school.” When we saw how well this was working in our club, we thought to ourselves, why aren’t we doing this in our classes. Well, now we are.

This "Coopertition" mentality/philosophy has overtaken/invaded everything we do in Tech. Ed. at LM. When it comes to competitions - it's no longer a "me versus you" mentality. But rather a "us versus the problem" mentality. Students are still responsible for designing and building their own projects, but when it comes to the initial creative problem solving experience - it's a team effort, a class effort. As they proceed through the design and problem solving process they share their ideas. This is creative problem solving with a social conscience. This is giving them a real-world industry and business problem solving experience. This is problem solving that yields the most solutions and the biggest variety of possible solutions.

MARK: We go as far to have our students read an article about Creativity and problem solving from an issue of *Psychology Today* written by Dr. Robert Epstein. In this article Epstein refers to something he calls the shifting game, where the brainstorming process starts off individually, then to a small group, then back to an individual activity. Epstein’s research has proven that this method produces more results because people are less inhibited to express ideas in this manner. We’ve taken this process a step further. Once our students have participated in the shifting game, we have them share their ideas to the entire class. And there’s a specific detail that’s important to point out. Whether it’s a mousetrap car or a robotic system, we have students sketch their ideas on large poster sheet of paper so everyone can see them. We discuss the advantages and disadvantages of all the ideas. And we leave the hanging up for additional review. Once students have individually chosen their solution to the problem, then they move on to the development of a prototype.

This process is new to our students, and its new to us. But we’ve noticed that Epstein was right. Students feel more open to share their ideas. They realize that this is an “us” approach to the problem. Their anxiety is lessened and their willing to help one another. Actually, our students receive additional points when they’ve documented that they have helped an opposing team.

Additionally it has helped express the value of making daily entries in their engineering design notebooks. They see the purpose of documenting their tasks and reflections.

So in order to change the culture what it really comes down to is addressing the **causal** relationship of language, thought, and behavior. Language, thought, and behavior have a causal relationship because if you change one, you change the other two.

We're changing the language: Competition is replaced with cooperation.

Where changing their thought by putting them in unique, friendly, brainstorming atmosphere where thinking outside the box is highly encouraged and praised.

And we're changing their behavior by giving them activities such as the IED challenge that has humanitarian, social, and environmental elements interwoven into it.

And all of this combined, we believe, coming back to our standard is:

Applying the use of ingenuity and technological resources to solve specific societal needs and improve the quality of life.

This is encouraging students to use STEM for its intended purpose.

Mark & Rich: Conclusion:

So, coming back to our title, "Robots in the classroom – So what" Well, when we first decided to bring robotics into our curriculum we did a great deal of research. We found many organizations and activities that had ties to our curriculum and standards. But, so what - something was missing. It wasn't enough for us to just build robots. It wasn't enough for us just create a challenge where students were pushing manipulatives around in a field. We wanted to an activity that hammered home the true purpose for their learning. We wanted an activity that left no doubt that their energies in our program, in their lives, exist to "apply the use of ingenuity and technological resources to solve specific societal needs and improve the quality of life." As Woodie Flowers might say

to, help someone in need. And has the granite stone outside our school states, “Enter to Learn – Go forth to Serve.”