Massachusetts Army National Guard Enhanced School Programs

STEM ROBOTICS SEMINAR

- Educator Guide -

SCIENCE TECHNOLOGY ENGINEERING MATHEMATICS

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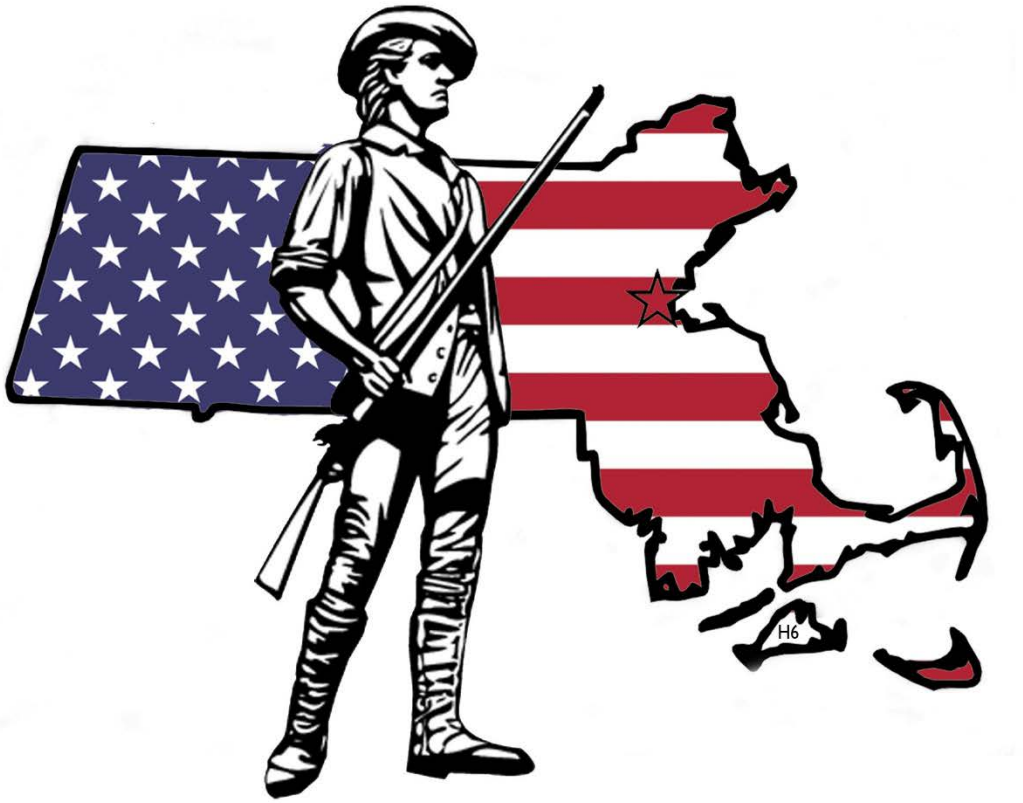
S.T.E.M. ROBOTICS SEMINAR OVERVIEW



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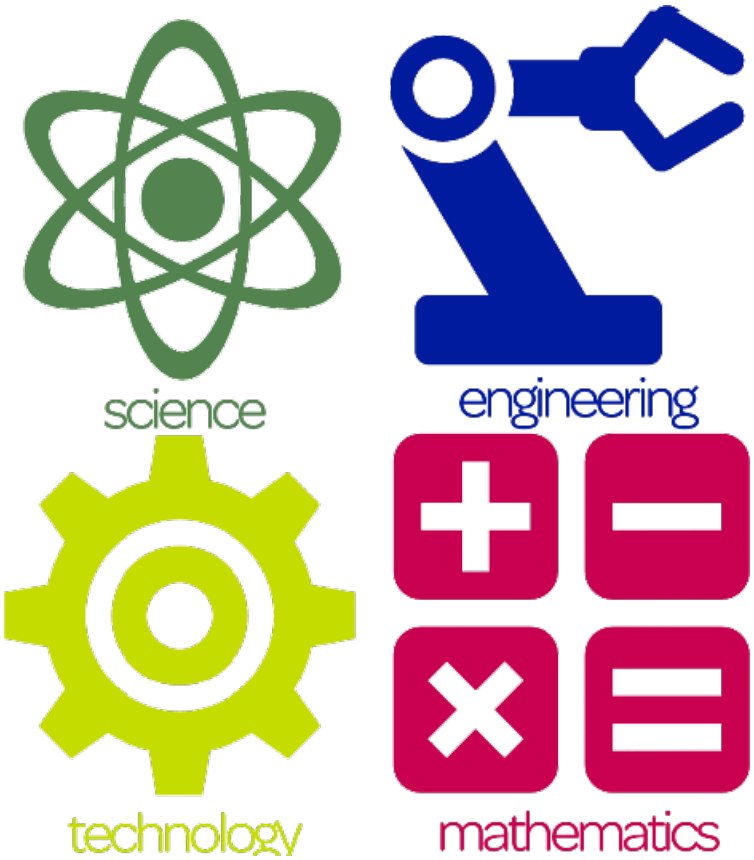
Overview



Why STEM?

The Massachusetts National Guard is America's oldest and most storied military organization. For nearly four centuries, local Soldiers here in the Commonwealth have served not only as protectors but also as mentors within their communities. We are doctors, lawyers, mechanics, students, and teachers. Our job has always been to improve the livelihood of our neighbors here at home, regardless of where our missions may take us.

As our extended global presence scales down, we see this time as an opportunity to turn our resources inward to serve as a built-in benefit to our own citizens and communities. By focusing on STEM skills and careers, we are able to best utilize the expertise of our members and the incredible advancements of our assets. We recognize that for the future scientists, engineers, code breakers, and mathematicians out there, setting out on the right path is vital to success. We're looking to help spark an interest in STEM for the next great pioneers who will soon be shaping our communities, country, and world.

Overview

What is the STEM Robotics Seminar?

The Massachusetts National Guard S.T.E.M. Robotics Seminar is a completely mobile learning laboratory capable of delivering our presentation to groups of any size, in any setting. The program challenges teams of students to design, construct, and pilot original robotic creations in a healthy, competitive classroom setting.

Our fully self-sufficient rolling laboratory allows our team to bring the experience to any school or community event across the Commonwealth. Presentations can be conducted indoors or outdoors and can be scaled and/or adapted to any time constraints or preexisting curricula. The program has been certified by the Homeland Security Institute, sanctioning us to present all successful participants with an official certificate of completion.

As with all of our Enhanced School Programs, the seminar is presented at co-cost. We are happy to bring our resources to communities and institutions as part of our outreach programs in order to share education, experience, and assets across the state.

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Overview

What is USAR?

The Urban Search & Rescue (USAR) Robotics Challenge is a national standardized robotics competition hosted by **SkillsUSA**. The program enables students to create a mobile robot like those employed by emergency service personnel (fire, police, and military). The robot is designed to secure an area by locating, neutralizing, moving, and disposing of explosive materials. The demand for designers, skilled technicians, and manufacturing workers who are fluent in mechanical design and electrical systems and highly skilled in troubleshooting and maintenance of robotic systems is projected to continue to grow. The current generation of students is expected to take artificial intelligence and robotics into the evolving world of emergency services, finding new ways to help trained personnel react more quickly and effectively. **It is imperative that our future labor force be on the leading edge of current and emerging technologies and possess the technical and team skills necessary to maintain industry leadership in design, manufacture, maintenance, and operation of life-saving robotic equipment.**

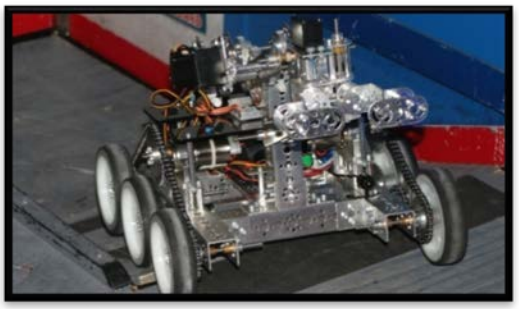
The Seminar

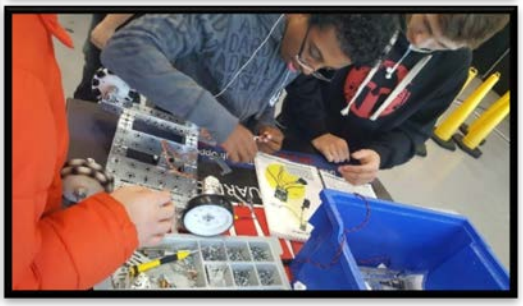
Our instructors are subject matter experts and have been certified through the *PITSCO Robotics* Professional Development Seminar to instruct everyone from beginners to experienced robotics students.

The seminar is typically conducted as a half or full-day course. It has been certified by the Homeland Security Institute and all participants receive certificates.

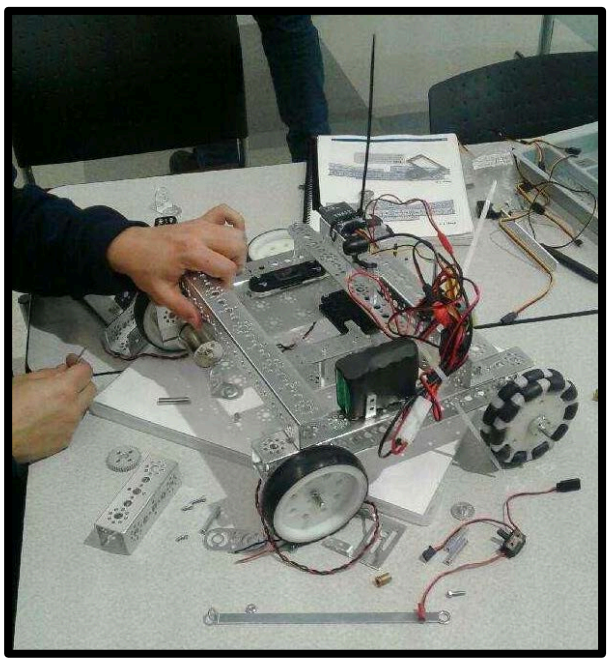
The program is completely scalable and can be presented as a simple demonstration/familiarization or a full-week course of study.

The Kits





We have worked closely with **PITSCO Education** and other corporate partners to create a state-of-the-art robotics program. These kits provide first-time builders with the tools and guidance they need to construct a functional robot and also offers advanced users advanced user the freedom to innovate and create robotic works of art.



The kits feature heavy-duty, aircraft-grade aluminum elements for construction, powerful drive motors, and expandable capabilities. Kits include cameras and transponders to allow participants to pilot their creations remotely from inside the command center or portable rolling television unit. Robots can be prebuilt to reduce class time or for unfamiliar participants.

Our program can be specialized for a variety of classes. Engineering students can design their creations from scratch using CAD models. Computer technology classes can take the program a step further by programming the movements and capabilities through coding. A virtual reality component will be launched this fall.

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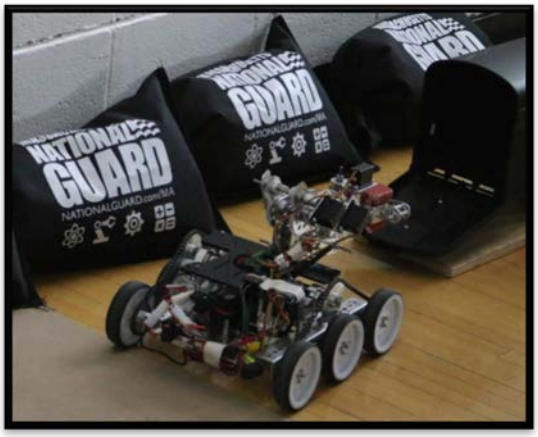
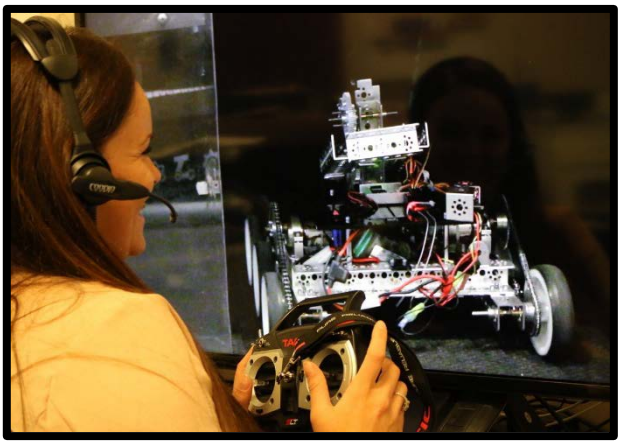
The Competition

Participants must work in pairs. The object of the competition is to discover, retrieve, and return a piece of simulated ordnance from inside of our two-story obstacle course. Courses can be adapted for indoor or outdoor use and can be scaled up or down to meet classroom restrictions.



We can run four of our collapsible obstacle courses simultaneously to allow for maximum participation.



One partner acts as a spotter, relaying instruction to the pilot, who must navigate the course using a live video feed directly from their robot.

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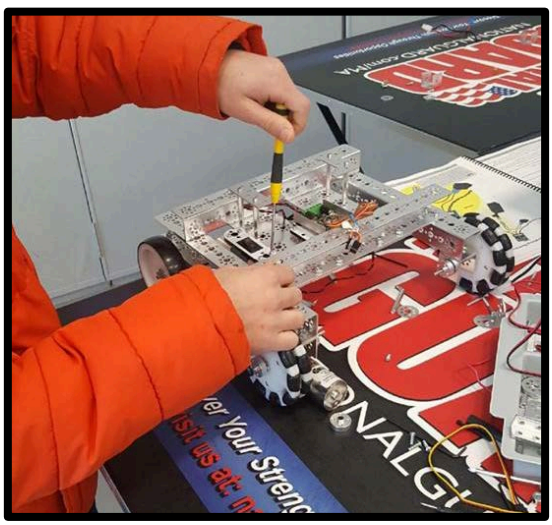
The Mobile Laboratory

Our fully-mobile 35’ trailer is a completely self-sufficient rolling laboratory which can be presented anywhere, in any setting, across the Commonwealth.



Custom-built rolling assembly stations allows up to sixteen simultaneous teams to design and construct their robotic creations.

The lab contains everything necessary to instruct the full seminar and enables four simultaneous teams to navigate four separate obstacle courses via remote control and video feed.

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Partners in Education

We have partnered with dozens of educational institutions, corporations, and non-profit organizations to bring the STEM Robotics Seminar to over **32,000** participants!

The program was featured as the main stage display at the **2017 Boston Hub Week Robotics Block Party.**

SkillsUSA®

The seminar was designed and built from the ground up to support our growing relationship with **Massachusetts SkillsUSA**. We are proud to support them at every District Conference as well as their full three-day State Competition.

brainstormers

FIRST Tech Challenge Team

FTC 8644

We have partnered with the **FTC World Champion Brainstormers 8644 Robotics Team** to evolve our program and keep it at the cutting-edge of robotics education.

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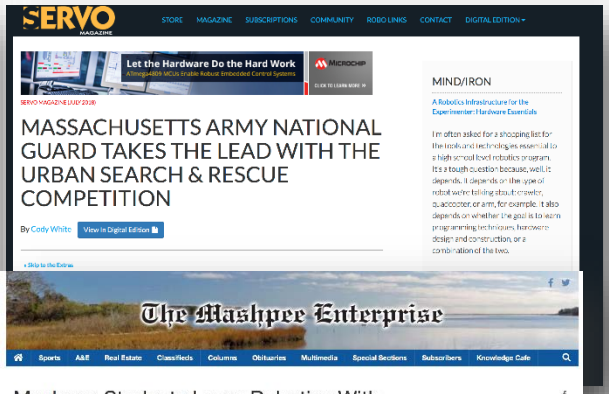
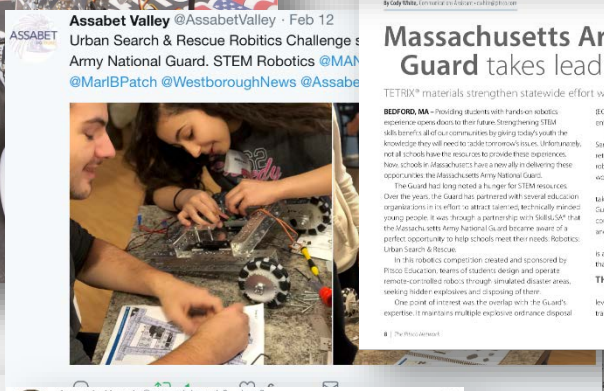
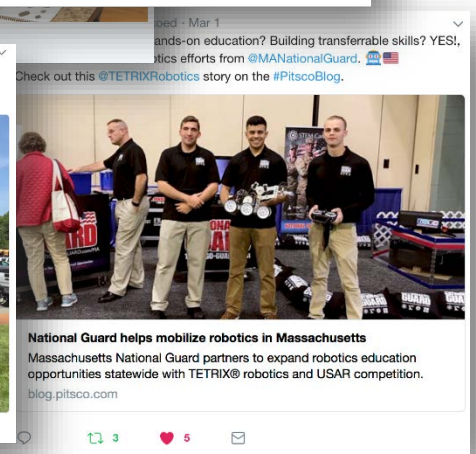
In the Media

The STEM Robotics Seminar has been featured in many local newspapers, websites, and social media blogs across the Commonwealth. The program recently appeared in NETWORK magazine and will be featured on the cover of the July 2018 SERVO Magazine!







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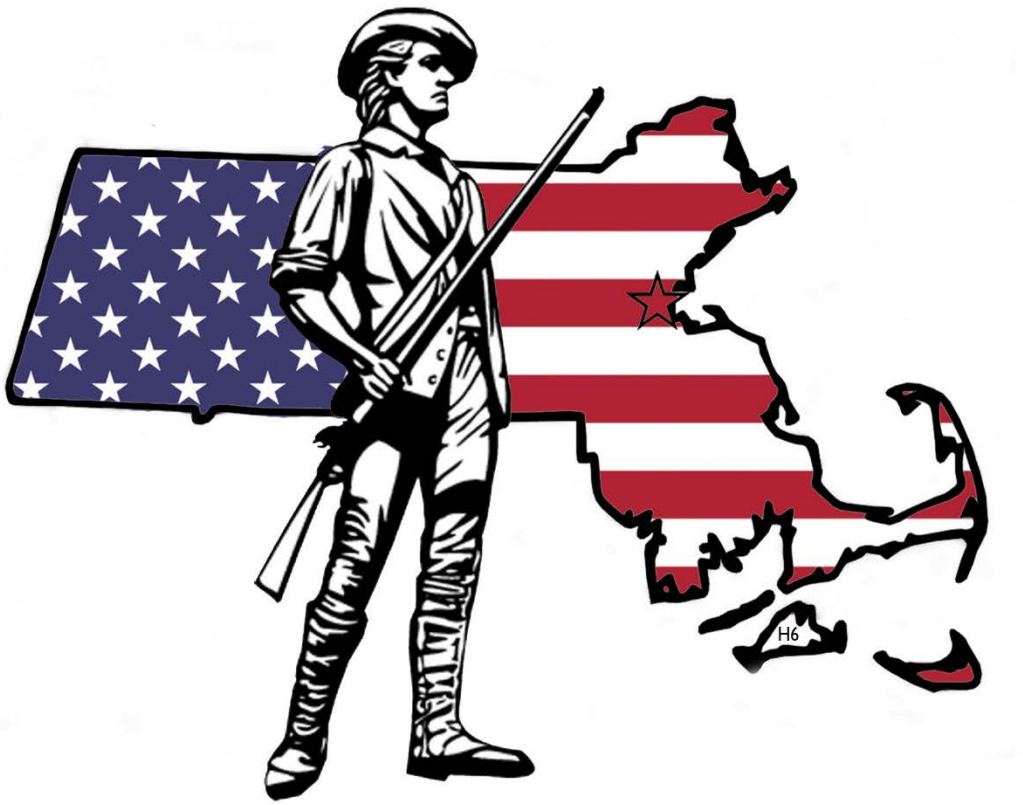
CURRICULUM



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LESSON PLAN FOR HIGH SCHOOL AND COLLEGE STUDENTS
MA NATIONAL GUARD S.T.E.M. ROBOTICS SEMINAR

Level: Grades 9-12+	**Lesson Duration:** 3 hours (flexible)

Lesson Objectives:
After this seminar, if presented in its entirety, students will have demonstrated basic literacy in all four STEM disciplines, most notably Technology and Engineering. The course of study provides a basic understanding of modern robotics as well as the fundamentals of mechanical engineering.

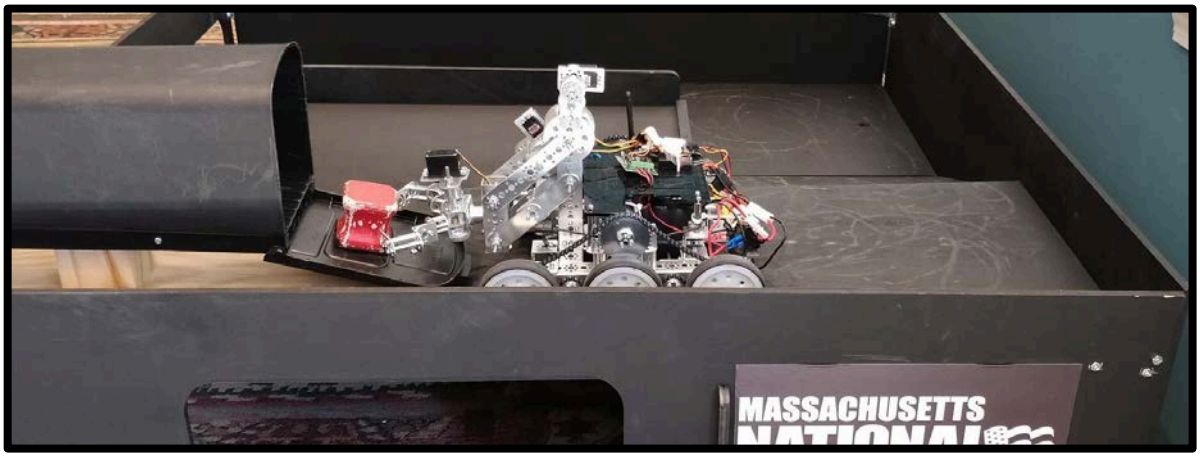
Summary of Tasks:
Instructor(s) will facilitate as students:

- Participate in collaborative discussion in order to design robotics based on information provided by written materials and teacher/instructor suggestion
- Practice technical proficiency by following detailed written instruction while also innovating artistically in a healthy, competitive environment.
- Get hands-on experience constructing components, and eventually an assembly of, robotics of their own architecture. Students will take turns as group leaders and are encouraged to participate at every stage.
- Adapt to sudden changes and challenges as building materials are broken, repurposed or become scarce during construction and event rehearsal.
- See their projects come to life as they navigate custom-built obstacle courses via remote control and video feeds.
- Attempt a unique mission, designed to fit classroom time and dimensional requirements, in which their creations will compete with each other to measure their creativity and technical retention.

Equipment / Materials:
The seminar is hosted in and around a fully-mobile 35’ command center/laboratory trailer which is self-sufficient, and can provide a full seminar experience to up to 60 simultaneous students. Participants are provided with a full robotics set which includes all components, transmitters/receivers, batteries, and video equipment required to build and operate an infinite number of possible robotic creations.

Extension Activity Ideas for Educators:
1. Students can pre-design robotics using CAD software or analog drafting techniques.
2. Given a digital overview of the obstacle course, ask students how they would best design a robot to navigate successfully. What would work well? What would not?
3. Host an open-forum, follow-on discussion to allow students to discuss best practices.
4. Expand the seminar to include other classes, such as Engineers to build obstacles, 3D printing of components, Law Enforcement to design a mission, etc.

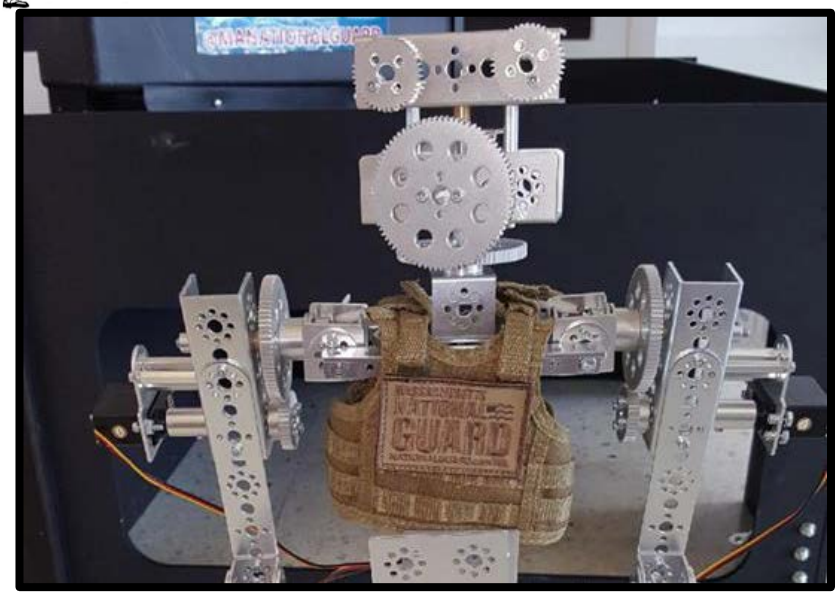
ACADEMIC SKILLS: Math



Math Skills

- Students use fractions in contextual applications to solve problems.
- Students use percentages in contextual applications to solve problems.
- Students solve problems through the contextual application of proportions.
- Students measure time, distance, and angles within contextual problem-solving applications.
- Students simplify numeric expressions.
- Students use comparisons, predictions, and inferences in analyzing data to solve a problem.
- Students utilize modeling techniques to solve problems.
- Students write and solve algebraic expressions in one or more variables.
- Students use derived measurements to solve problems.

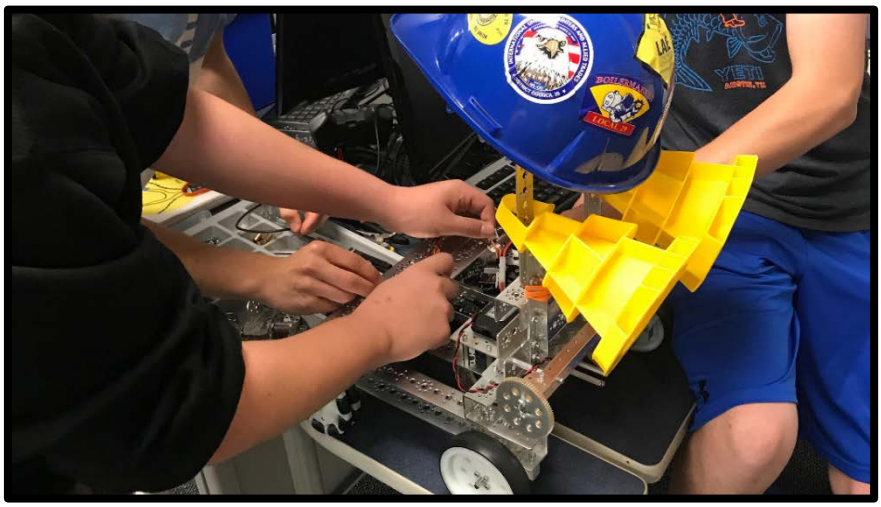
ACADEMIC SKILLS: Science



Science Skills

- Students apply the scientific method to plan and conduct experiments.
- Students apply knowledge of heat, sound, mechanical, chemical, electrical, and light energy within contextual problem-solving applications.
- Students apply knowledge of kinetic and potential energy in contextual applications to solve problems.
- Students apply knowledge of Newton’s laws of motion to solve problems.
- Students apply knowledge of simple and compound machines to solve problems.
- Students apply knowledge of gears, motors, and linkages to solve problems within contextual applications.
- Students apply scientific knowledge within the engineering design process.
- Students apply knowledge of force and motion concepts in contextual problem solving.

ACADEMIC SKILLS: Engineering



Engineering Skills

- Students apply the engineering design process to solve a contextual problem.
- Students apply the principles of circuit analysis.
- Students apply the elements of circuit design and construction.
- Students understand and apply energy and power types, sources, and conversions.
- Students apply methods of maintaining, servicing, troubleshooting, and repairing systems.
- Students apply skills and techniques related to building, repairing, and maintaining robotic mechanisms.
- Students apply techniques and technologies related to the production of technical drawings.
- Students apply basic mechanical skills related to robotic design, construction, and troubleshooting.
- Students understand and apply knowledge of safety during construction and use of equipment.
- Students apply problem-solving and engineering-design processes to solve unforeseen challenges.

ACADEMIC SKILLS: Language Arts

Language Arts Skills

- Students make effective use of spoken, written, and visual communications with team members within the problem-solving and engineering-design processes.
- Students make effective use of spoken, written, and visual communications with a variety of audiences.
- Students use appropriate information resources within the research-and-design process.
- Students organize and synthesize information for use in research-and-design processes and informal presentations.
- Students demonstrate the ability to correctly read and interpret rules, instructions, and specifications within the robotic challenge.
- Students demonstrate the proper use of language, both written and verbal.

LESSON PLAN

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LESSON PLAN: Full Day

00 – 30min || Introduction

A brief explanation of the history of robotics and the evolution of their presence in our society. The instructor(s) will review examples of the role of robotics in the military as well as government and civilian organizations. They will explain the purpose of the seminar and introduce the elements, tools, and components. Students will be broken up into pairs or small groups. The instructor(s) will describe proper techniques and best practices for assembly, wiring, and motor hub placement.

30min – 03hr || Construction

Participants will design and assemble their creations from the ground up. Depending on the students' familiarity, they will choose to stick with the suggested models contained in their instruction books, or design their own. Instructor(s) will monitor progress, provide advice, and assist with any mechanical issues that may arise.

03hr – 03hr 30min || Lunch

During this time, the obstacle course(s) will be assembled and placed by the instructor(s).

03hr 30min – 04hr 30min || Construction

Instructor(s) will assist with the mounting of cameras and give final spot corrections to the students' robots.

04hr 30min – 06hr || Competition

Teams select a driver and a spotter. The driver will operate the robot by video feed while communicating with the spotter via radio headset. Remaining team members will be on hand with tools for emergency "pit crew" robot repairs.

06hr – 06hr 30min || Awards & Review

Students will break down and repack their robots into their travel cases. Teams with the fastest times will be awarded special incentives. All participants will receive a participatory item as well as a certificate from the National Guard and the Homeland Security Institute. Students are encouraged to review they performance and offer suggestions for future improvements.

This above is an example timeline. The program is completely scalable to accommodate existing class structures and time constraints. The seminar can be conducted indoors or out, utilizing our mobile laboratory or smaller rolling elements.

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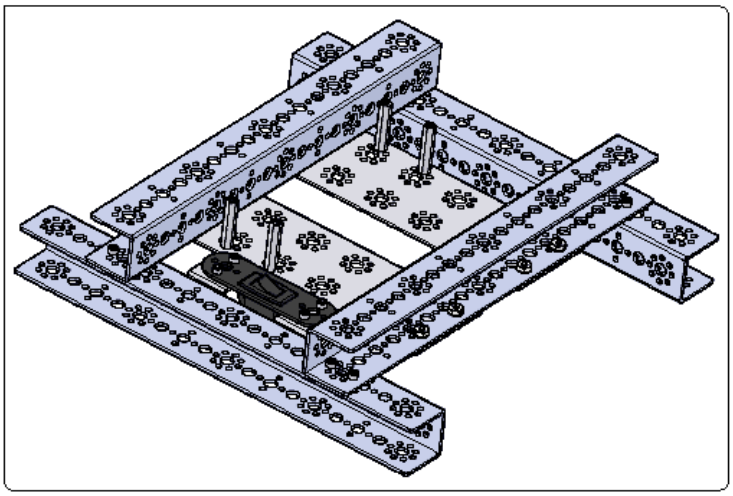
ROBOT BULDING PHASES: Full Day

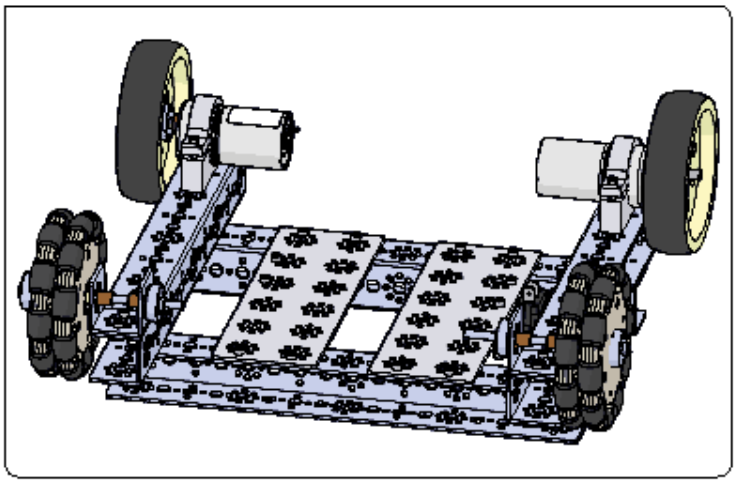
PHASE 1:
- BASIC FRAME OF BASE BUILT
- SWITCH IS MOUNTED
- FLAT PLATES AND AXEL RODS ASSEMBLED

ELAPSED CONSTRUCTION TIME: ~45 MIN



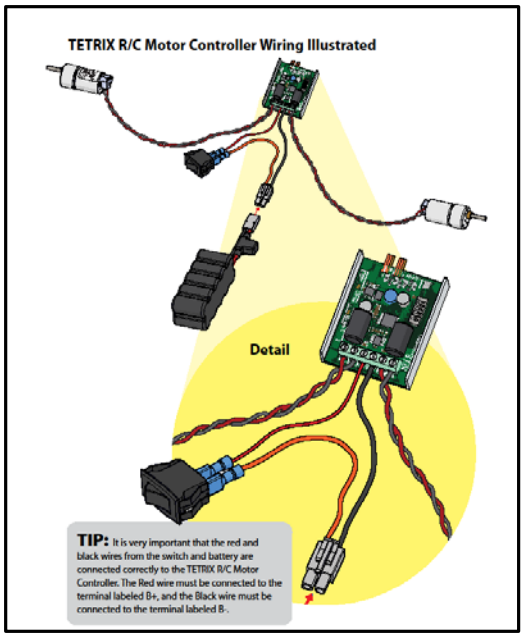
PHASE 2:
- OMNI WHEELS ASSEMBLED
- MOTORS AND MOTOR MOUNTS INSTALLED
- MOTOR WHEELS MOUNTED

ELAPSED CONSTRUCTION TIME: ~80 MIN



PHASE 3:
- MOTOR CONTROLLER WIRED
- BATTERIES INSTALLED
- CAMERA MOUNTED
- REMOTE CONTROL LINKED TO RECEIVER

ELAPSED CONSTRUCTION TIME: ~120 MIN



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LESSON PLAN: ½ Day

00 – 15 min || Introduction

A brief explanation of the history of robotics and the evolution of their presence in our society. The instructor(s) will review examples of the role of robotics in the military as well as government and civilian organizations. They will explain the purpose of the seminar and introduce the elements, tools, and components. Students will be broken up into pairs or small groups. The instructor(s) will describe proper techniques and best practices for assembly, wiring, and motor hub placement. Universal elements of the robots will be partially preassembled in order to reduce the time required for construction.

15min –2hr 15 min || Construction

Participants will design and assemble their creations utilizing a preassembled base deck. Depending on the students' familiarity, they will choose to continue with the suggested models contained in their instruction books, or design their own. Instructor(s) will monitor progress, provide advice, and assist with any mechanical issues that may arise. Instructor(s) will assist with the mounting of cameras and give final spot corrections to the students' robots.

2hr 15min – 3hr || Competition

Teams select a driver and a spotter. The driver will operate the robot by video feed while communicating with the spotter via radio headset. Remaining team members will be on hand with tools for emergency "pit crew" robot repairs.

03hr – 3hr 15min || Awards & Review

Students will break down and repack their robots into their travel cases. Teams with the fastest times will be awarded special incentives. All participants will receive a participatory item as well as a certificate from the National Guard and the Homeland Security Institute. Students are encouraged to review they performance and offer suggestions for future improvements.

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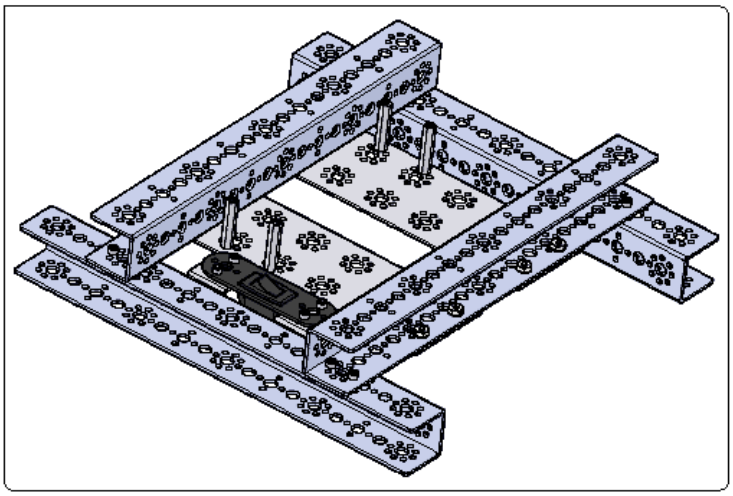
ROBOT BUILDING PHASES: ½ Day

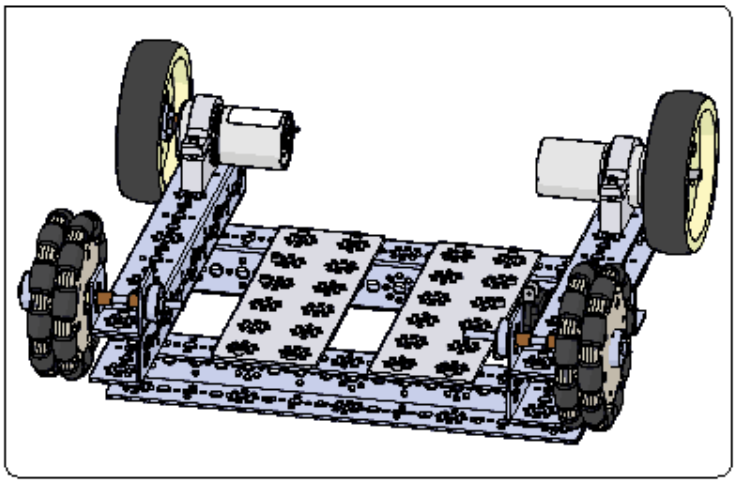
PHASE 1:
- BASIC FRAME OF BASE BUILT
- SWITCH IS MOUNTED
- FLAT PLATES AND AXEL RODS ASSEMBLED

PHASE 1 IS COMPLETED BY INSTRUCTOR(S) PRIOR TO THE START OF CLASS IN ORDER TO REDUCE CONSTRUCTION TIME



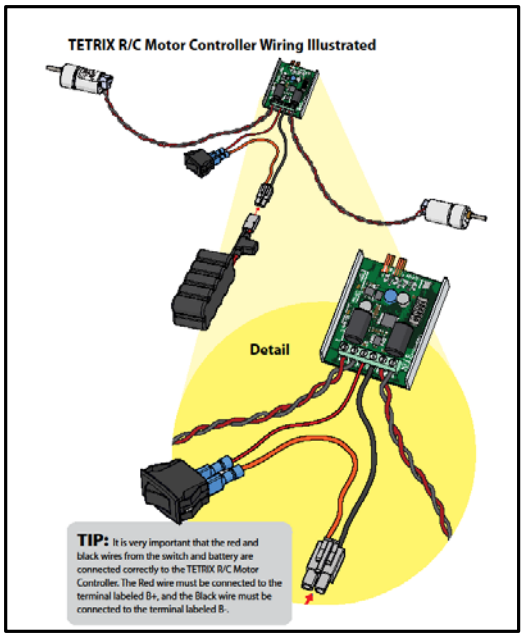
PHASE 2:
- OMNI WHEELS ASSEMBLED
- MOTORS AND MOTOR MOUNTS INSTALLED
- MOTOR WHEELS MOUNTED

ELAPSED CONSTRUCTION TIME: ~45 MIN



PHASE 3:
- MOTOR CONTROLLER WIRED
- BATTERIES INSTALLED
- CAMERA MOUNTED
- REMOTE CONTROL LINKED TO RECEIVER

ELAPSED CONSTRUCTION TIME: ~90 MIN



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