Maryland Engineering Challenges
2023 Robot Challenge

Now in its 27th year!

High School Level – Grades 9 to 12
Middle School Level – Grades 6 to 8
April 29 & 30, 2023

Sponsored by the:
IEEE Baltimore Section

IEEE
Advancing Technology for Humanity

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The robot challenge is an engineering challenge that teaches students key aspects of an engineering project and is not just a kit building exercise. These are typical of all successful engineering design projects in industry.

First, teamwork is required. Each leg requires a participant to operate it. More importantly, there are aspects of the project that required different skills: either wood cutting and drilling or CAD modeling, mechanical assembly, soldering, and creative artwork. Emphasis in scoring is placed on both neatness in assembly and creativity in creating a decorative and original robot.

Beyond that, a written report, bill of materials (what did you put into it), project planning timeline, and project notes are all important aspects of the challenge.

Participants are interviewed to discuss not only what was built, but what each member contributed and what was learned from the process.

Significant features for 2022-2023

1) **The Robot Challenge is available for both Middle School and High School students. They participate together, but scores and awards are kept separate.**
2) **These are walking robots, and students build them from scratch. The project offers 2 options, one that allows students to build the robots with wood parts that they fabricate hands-on in a wood-shop; or they may elect to use CAD to program the parts and create them in plastic with a 3D printer. If team does not have access to a 3D printer, the organizers provide this service at no additional cost. The cost of a 2-leg robot kit is expected to be $69.**
3) **Robots can have 2 or 4 legs and must be decorated with an external body. Students are required to prepare a Written Report documenting their experience, compete with other teams at a Track event where the robots have to climb over hurdles, and they must also make an Oral Presentation to a panel of professional engineers and answer questions about their project.**
4) **There are multiple levels of challenge, and typically Middle School students choose to use the Manual Controllers, though there are no restrictions on the level of challenge they can sign up for.**

Operation	2 Leg Robot	4 Leg Robot
Manual: all operations are controlled by closing switches. There are four switches per leg that control leg up, leg forward, leg down, and leg back.	Recommended for first time participants, especially Middle School students. Requires 2 team members, one per leg.	Requires 4 team members, one per leg.
Automation: a controller is used to sequence the operations. The controller may be either purchased with the robot kits as an add on, a kit to build your own controller may be purchased, or you may build your own controller from scratch.	Manual control operation must be completed first and then a 2nd run for automated. The operation is automated, but the team participants use the switches from the manual operation to guide the robot where it may drift off. This adds a level of complexity best suited for advanced High School students using the purchased controller. Building your own controller, either from a kit or from scratch, should only be tried in the 2nd year a team competes as that will take extensive time to build.	
Autonomous: the automation controller has additional feedback using switch connections on the legs for guidance.	Manual operation first, then automated operation runs must be completed before the autonomous operation is attempted on the third run.	

5) **On Saturday, April 29, the Challenge will be held virtually, and participants can be from Maryland or out-of-state; whereas on Sunday, April 24, it will be held in-person at the Baltimore Museum of Industry, which is located at 1415 Key Highway, Baltimore, MD 21230 (near the Inner Harbor).**
6) **For more details look at the write-up for the project under High School Engineering Challenges.**

Important Dates

Workshops for the Robot Challenge (Scheduled to be in-person, but might become virtual if circumstances change)

- ⇒ **Wednesday, November 16, 2022** **Begins at 4 p.m., ends at 7 p.m.**
- ⇒ **Saturday, January 21, 2023** **Begins at 10:00 a.m., ends at 2:00 p.m.**

This event is designed for Teachers and Mentors interested in coaching a team and learn more details about the project. Find out from the presentation if this Challenge is a good fit for your students. The training is not a requirement for this project but is strongly recommended, particularly for first-time participants. There is no cost. Registration is strongly encouraged (by 11/13, 1/18 respectively). Both sessions will include some CAD and automation instruction. If held in-person, this is a good opportunity to pick up kits without paying shipping costs. Contact Jessica Celmer at challenges@thebmi.org , or Neville Jacobs at Nevilleed@aol.com.
Access the Robot Workshops from this link: https://bit.ly/2023RobotWorkshopRegistration

Written Report Due

- ⇒ **Friday, April 21, 2023** **Prior to 4:00 p.m.**

Written Reports should be delivered electronically, and will represent 25% of the total points awarded. One member of each Team should update their on-line Registration at this time, using the following link: https://bit.ly/RobotChallenge2023

The Robot Challenge Event

- ⇒ **Saturday, April 29, 2023 (Virtual)** **8:45 a.m. to 4 p.m.**
- ⇒ **Sunday, April 30, 2023 (In Person)** **8:45 a.m. to 4 p.m.** **Awards on Zoom at 5 p.m.**

The Event will be held virtually using Zoom on Saturday, April 29, and will be open to Maryland teams and teams from out-of-State. On Sunday, April 30, it will be held in-person at the Baltimore Museum of Industry and is for teams able to travel to Baltimore. Teams may chose to participate either day, but they will need to announce their choice 3 weeks before the event. Only on Sunday will we provide a repair station for teams encountering technical difficulties. Teams planning to compete virtually can be from anywhere in the country, but note that technical advice will only be available on-line and must be solicited by e-mail at least 3 days before the event.

Preparations & Registration

Registrations - two are required:

- **One, for participation and to obtain the Robot Kits and Manuals**
- **A second, to register for the arrival time at the Robot Challenge Event – information will be sent to teachers in March.**
- **If using Google Forms to register (see below), the first registration will generate a response e-mail that should be carefully saved and stored, so it can be updated or corrected by clicking the "Edit Response" block.**

To register your team(s) for participation through the BMI fill out the registration here:
https://bit.ly/2023MECRegistration

If Teachers/Coaches KNOW how many 2-leg teams and 4-leg teams they plan to have, they can contact the IEEE directly at Nevilleed@aol.com and they will be given a batch of team numbers and the name of their IEEE mentor (no fees if processed this way).
Teachers/Coaches should then assign a team number to each team, and have one representative from each **team** register their team using Google Forms by copying the following URL (note only ONE registration per team):
https://bit.ly/RobotChallenge2023

Teams may choose to build the Classic Wood Robot, or a plastic robot using 3D printed parts. The classic wood robot requires a school wood-shop and shop tools for shaping the wood parts, whereas the 3D plastic robot can be built at school or at home with just basic tools. The actual 3D printing can be done at school if the school has a 3D printer; or if teams submit their CAD software, IEEE will fabricate the parts at no additional cost. The project cost will be the same for either option, and the Registration fee covers all expenses other than the "D" size Alkali batteries (we suggest students pay for these themselves to assure they will be careful with them).

Kits should be picked up from the IEEE representative. Please contact Neville Jacobs at Nevilleed@aol.com to arrange for the date, time and place. If kits need to be shipped to other locations, a shipping charge will be added to the cost of the kits. The project should be scheduled so that the robots can be completed approximately 2 weeks before the Robot Challenge Event (for information on how to do this, see later).

- **Note that by signing up for participation in the project, each team is committing to participate in the Robot Challenge Event, as this portion of the project represents a major part of the educational adventure. Photographs and video will be recorded during the Robot Challenge Event for training and documentation (non-commercial) purposes - it will be assumed that all participants give their consent to appearing in these pictures. Any team or team member not wishing to appear in such pictures should notify the organizers in writing,**

JUDGING GUIDELINES

I. **Design Development and Fabrication** (Competition value: 20 points)*

The team must use the parts provided in the kit, substitutions are not allowed, but additions are permitted. Wheels (if used, though not recommended) may not touch the table or be visible. Except for flexible electrical wiring, Robot should be free-standing and isolated from the students controlling it. Creativity and Artistry are important factors, and the robot body must be designed such that the team can fully expose all parts of the body and mechanism for inspection by the judges.

* Awarded during the Oral Presentation, based on the judges' findings – see below.

II. **Written Report** Competition value: 25 points

Points will be awarded for creativity, originality, neatness, grammar, sketches, photos, and the Robot's artistic body covering. A Gantt Chart is very helpful for showing the difference between the original schedule and the actual dates resulting from the problems encountered.

III. **Performance Demonstration** Competition value: 40 points

The course will be a single track on an 8 foot table or floor, with the start and finish lines 6 feet apart. Two half-inch high hurdles (known in a hardware store as a "quarter-round") will have to be climbed over. All robots will first race in manual mode, though social distancing can only be assured for robots built from 3D printed kits. Points will be awarded for the time taken, the smoothness of the robot's movements, and the coordination and cooperation of the operating team. Points are lost if team members touch their robot or cross the boundary lines. In the event that some degree of automation has been added, the robot shall run a second or third time in that mode for bonus points.

On Saturday the event will be done virtually, and it can either be done at your local school, or on a kitchen table or floor. Each team will be furnished with a cardboard Track (which they can decorate for extra points), and the two hurdles. On Sunday, extra points will be given for the decoration of the shipping containers.

IV. **Oral Presentation to Judges** Competition value: 15 points

a. The judges are looking for a **formal prepared presentation** where every team member is expected to participate. They may bring in a video on their laptop so long as the clip does not exceed 3 minutes. Judges are looking for a description of the project and the difficulties they encountered and had to overcome. Students may also fill in the gaps between when the Written Report was submitted up though and including the results of the Track Run and what they learned from it. Judges will ask questions and grade the students on their answers.

b. Review of Fabrication* Competition value: 20 points

Judges are looking for the quality of the fabrication of the robot including the soldering. They will need to examine the robot closely, and may need to expose all the parts to do so.

CURRICULUM TIES-- Maryland Engineering Challenges comply with the listed sections of the Next Generation Science Standards

Core Learning Goals: Science - Goal 1: Skills and Processes - Expectation 1.1 The student will explain why curiosity, honesty, openness, and skepticism are highly regarded in science.	**In preparing for the challenge, students will:** • Recognize that real problems have more than one solution and decisions to accept one solution over another are made on the basis of many issues. 1.1.1 • Modify or affirm scientific ideas according to accumulated evidence. 1.1.2
Core Learning Goals: Science - Goal 1: Skills and Processes - Expectation 1.2 The student will pose scientific questions and suggest investigative approaches to provide answers to questions.	**In researching project designs, students will:** • Identify meaningful, answerable scientific questions. 1.2.1 • Formulate a working hypothesis. 1.2.2 • Defend the need for verifiable data. 1.2.8
Core Learning Goals: Science - Goal 1: Skills and Processes - Expectation 1.3 The student will carry out scientific investigations effectively and employ the instruments, systems of measurement, and materials of science appropriately.	**In constructing their projects, students will:** • Develop and demonstrate skills in using lab and field equipment to perform investigative techniques. 1.3.1 • Demonstrate safe handling of the chemicals and materials of science. 1.3.3 • Learn the use of new instruments and equipment by following instructions in a manual or from oral direction. 1.3.4
Core Learning Goals: Science - Goal 1: Skills and Processes - Expectation 1.4 The student will demonstrate that data analysis is a vital aspect of the process of scientific inquiry and communication.	**In testing their projects, students will:** • Analyze data to make predictions, decisions, or draw conclusions. 1.4.2 • Describe trends revealed by data. 1.4.6 • Determine the sources of error that limit the accuracy or precision of experimental results. 1.4.7

Core Learning Goals: Science - Goal 1: Skills and Processes - Expectation 1.5 The student will use appropriate methods for communicating in writing and orally the processes and results of scientific investigation.	**In composing their reports, students will:** • Demonstrate the ability to summarize data (measurements/observations). 1.5.1 • Explain scientific concepts and processes through drawing, writing, and/or oral communication. 1.5.2 • Use, explain, and/or construct various classification systems. 1.5.7 • Communicate conclusions derived through a synthesis of ideas. 1.5.9
Core Learning Goals: Science - Goal 1: Skills and Processes - Expectation 1.7 The student will show that connections exist both within the various fields of science and among science and other disciplines including mathematics, social studies, language arts, fine arts, and technology.	**In reflecting on the engineering process, students will:** • Identify and evaluate the impact of scientific ideas and/or advancements in technology on society. 1.7.2 • Investigate career possibilities in the various areas of science. 1.7.5 • Explain how development of scientific knowledge leads to the creation of new technology and how technological advances allow for additional scientific accomplishments. 1.7.6

GOOD LUCK TO YOUR TEAM!