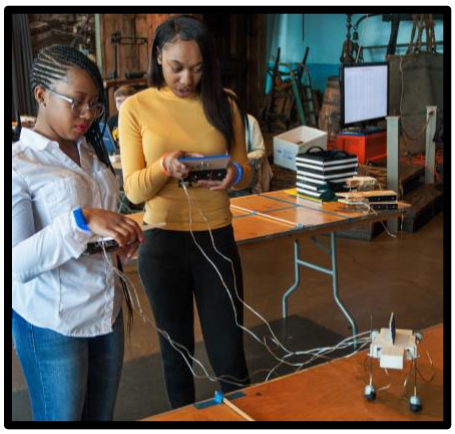
Maryland Engineering Challenges
2021 Robot Challenge

High School Level – Grades 9 to 12
Middle School Level – Grades 6 to 8
April 25, 2021

Sponsored by the:
Institute of Electronic and Electrical Engineers (IEEE)

Engineer Contacts:
Michael Pearse – mrpearse@gmail.com or Neville Jacobs - nevilleed@aol.com



Important Changes in 2020-2021

1) **THE ROBOT CHALLENGE, IN RECOGNITION OF THE UNCERTAINTIES RESULTING FROM COVID-19, HAS BEEN ADAPTED TO ALLOW FOR AN ENTIRELY VIRTUAL OPERATION IN THE EVENT THAT SCHOOLS DO NOT RE-OPEN; A PARTIAL VIRTUAL OPERATION IN THE EVENT THAT SCHOOLS OPEN BY APRIL 2021; AND AN ENTIRELY NORMAL OPERATION IN THE EVENT THAT SCHOOLS OPEN IN NOVEMBER 2020 (OR EVEN JANUARY 2021).**
2) **THE COST TO THE SCHOOLS FOR A 2-LEG ROBOT KIT WILL BE THE SAME AS LAST YEAR ($59), AND WILL NOT BE AFFECTED BY EITHER OF THE 3 ALTERNATIVES MENTIONED ABOVE. THE IEEE WILL ABSORB ANY INCREASED COSTS THAT MAY ARISE.**
3) **Teams that received kits last year, but were unable to participate in the Robot Challenge because of Covid-19, will be eligible to use the same robot to participate this year at no additional charge.**
4) **Those who built their robots last year and participated in the Written Report Competition, will be allowed to use the same report this year (and the same points), or they may modify or rewrite their report, and re-submit it for re-evaluation.**

Important Dates

Teachers' Virtual Information Session

⇒ **Wednesday, October 21, 2020** **Begins at 6 p.m., ends at 8 p.m.**

This "drop-in" virtual event hosted on Zoom is designed for adults interested in coaching a team to chat with engineers. Find out if a particular Challenge is a good fit for your student(s). The Coaches' Information Session is not required and there is no cost. Attendance is strongly encouraged. Contact Jessica at jcelmer@thebmi.org
Access the Information Session from this link: http://bit.ly/MECInformationSession

Teachers and Coaches' Virtual Workshops

⇒ **Wednesday, November 10, 2020** **Begins at 6 p.m., ends at 8 p.m.**

⇒ **Saturday, January 23, 2021** **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 to learn 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 11/8, 1/20 respectively). The January training will include some CAD instruction. Contact Jessica Celmer at jcelmer@thebmi.org , or Nevilleed@aol.com.
Access the Robot Workshops from this link: http://bit.ly/MECRobotWorkshop2021

Written Report Due

⇒ **Friday, April 16, 2020** **Prior to 4:00 p.m.**

If schools and the BMI are unrestricted by Covid-19 rules, the team's Written Report should be submitted as a HARD COPY to the Baltimore Museum of Industry, and will represent 25% of the total points awarded.
If Schools and the BMI continue to have restrictions, Written Reports should be delivered electronically. Teams who submitted Written Reports in 2020 may elect to retain the points awarded in 2020, or request to have their documents re-submitted - if they do so, those will be the points that will apply, even if they are lower that what they were previously awarded. The Written Report should be accompanied by the form shown on page 7.

The Robot Challenge

⇒ **Sunday, April 25, 2021** **8:45 a.m. to 4 p.m.**

The event will be held at the Baltimore Museum of Industry if the Museum is unrestricted by Covid-19 rules that apply at that time, or it will be conducted using Zoom if restrictions are still in place. Similar competition rules will apply, but details will be modified to meet Virtual requirements. All social distancing requirements will be adhered to.

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: http://bit.ly/MEC2021Registration and pay the $5.00 coach's fee here: http://bit.ly/MECcoachfee.

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).
They should then assign a team number to each team, and have one representative from each **2-leg team** register their team using Google Forms by copying the following URL (note only ONE registration per team): http://tinyurl.com/Robot-Challenge-2-Leg

4-leg teams should use the following:

http://tinyurl.com/Robot-Challenge-4-Leg

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.

The Project requirement is to:

1. Build a Walking Robot with the parts provided. Robot components can be built either in a wood-shop with shop tools, or using CAD and a 3-D printer (this service can be provided).
2. Document the process and submit a report to a panel of Engineer judges.
3. Compete with other teams to demonstrate their ability to meet objectives. Control of the robots can be Manual, Automated or Autonomous.
4. Present Orally to a panel of Engineer judges.

The Robot Challenge Event

This key part of the project will be done either at the Baltimore Museum of Industry (BMI), or Virtually using Zoom. If held at the BMI, the following details will apply, though the times may be subject to change.

- ⇒ **Sunday, April 25, 2021 8:45 a.m. to 4:00 p.m.**
- ⇒ **Teams can register for an 8:45 AM, 9:30 AM, or 10:15 AM starting time, but every member of the team should plan to arrive at the Museum at least 30 minutes earlier so their arrival times should be 8:15 AM, 9:00 AM, or 9:45 AM to register their team, pick up documentation, and have their team photo taken. If a robot scheduled for a 8:45 AM start is having structural difficulties or cannot walk, the team should plan to arrive at 8 AM – that is the time the Museum doors will open.**
- ⇒ **Any team unable to arrive for one of the three starting times, should contact Nevilleed@aol.com no later than April 20, 2021.**

Details are being worked out in case this Event will be handled through Zoom, but the times will probably be similar. The Track or Competition portion will either be done at your school

while maintaining social distancing, or it could be done in students' homes on the kitchen table.

While the judging of the Written Reports will take place several days earlier (25% of total points), the Challenge Event consists of a friendly competition with robots from teams from other schools (40% of the total points), followed by an Oral Presentation and discussions with a panel of engineer Judges (15% of total points). Judges will also review workmanship, teamwork, and artistic creativity (20% of total points). There may be additional details e-mailed to Coaches after registration.

Questions about Challenge specifications or judging should be sent to the Engineer Contact:
Neville Jacobs — **nevilleed@aol.com** or 410.653.4176

Museum questions?
Jessica Celmer jcelmer@thebmi.org or 410-727-4808 ext.113

Details

THE CHALLENGE

Project simulates what a practicing engineer would experience while working on an engineering project. In addition to building a walking robot, there is the required artistic creation of the outer body of the robot, as well as the need to demonstrate both written and verbal communication skills. 8 levels of challenge are available, and all registered teams must participate in the Challenge Event to be held on April 25, 2021. This year, the emphasis will be on creating CAD software to form the Robot body and the Control Units using 3-D printers.

Objective: Design and build a free-standing motor-powered robot that walks under direction. The robot body can have any form, 2 or 4 legs, and have the ability to go over uneven terrain. Each leg shall be controlled by one student using two independent motors; the control and co-ordination of the motors, and the smoothness and speed of the robot, will be factors considered by the judges. Any wheels used should not touch the table surface or be visible. Manual control of the robot is a basic requirement, but extra credit (up to 15 points) will be given for any form of add-on automation that furthers the above goals. The robot shall have an external body that is artistic and appealing. Kits can be obtained from IEEE, and range from $59 for a 2-leg robot with manual control (for 2 to 4 students), to an additional $198 for a 2-leg automation controller (other prices available upon request). Programming for most automation options is in C++.

Website: www.RobotChallenge.com Contains a lot of information about the project, FAQs, the latest version of the Robot Challenge Manual (password-protected), and helpful hints. Photos and Results of previous Challenges.

ENGINEERING TEAM REQUIREMENT

Each team should have 2-8 students (2 to 4 for 2-leg robots, 4 to 8 for 4-leg robots). There is no limit to the number of teams a school may have (unless we run out of kits or get more teams than we can handle). High School and Middle School students at Public, Private and Home schools, and Science and Scout Clubs are eligible to participate.

In the event that students are being taught at home and not allowed to attend school, the

teamwork that the project encourages and develops will need to be temporarily suspended in favor of safety from Covid-19. Teachers will need to assign component assemblies to individual students, then arrange for one student to handle the final assembly with the students communicating with each other by phone and text. Cable lengths have been extended to assure that social distancing guidelines are adhered to, especially when operating their robots.

SPECIFICATIONS AND SUPPLIES

The competition involves four main components, a written report, the construction of the entry, the robot's performance on a course with hurdles each robot must climb over as it meets in competition with other entries, and an oral presentation before a panel of judges (which may include an optional video presentation), verbal communication skills, workmanship, teamwork, and artistic creativity. The Institute of Electrical and Electronic Engineers (IEEE) will supply a kit with the materials needed to make up the power unit and the control unit, and provide instructions, drawings, training materials, and mentors for the basic electrical equipment. Each team will be responsible for creating the robot body and building the power unit, control units, and shipping container, and should contact their mentors by e-mail at 2 week intervals (or if they have a problem). Students will need to provide the D-cell batteries and learn to coordinate the operation of the motors (learn to walk) as a team.

Since it is likely that there be no Hands-on Workshops when kits would normally be distributed, all kits will need to be picked up from a central location in Mt. Washington (accessible from I-695 exit 22 or the JFX). Please contact Neville Jacobs at Nevilleed@aol.com to arrange this. Any delivery by mail will be subject to a handling and shipping charge. No entries accepted after February 21, 2021. Kit prices are shown below.

- The cost for 2-leg kits is $59. A 4-leg robot is twice as much work, and is more challenging to operate. Additional 4-leg kits are $114. Classic Automation kits: $99 for 2-leg, $133 for 4-leg robots. NEW pre-assembled (re-usable) Automation Controller board kits: $198 for 2-leg, $269 for 4-leg robots. Other kits and one-year lease prices are available by request.
- All kits ordered for 2020-21 have been adapted for a construction from home rather than a school wood-shop – hence the wood block and plywood have been removed and replaced with drawings that permit coding for a 3-D printer, some of the parts pre-cut to size, and longer wires for the Control Units. We do have a limited number of kits with the wood parts that can for ordered for those schools that insist upon using their wood-shops for its hands-on experience.
- Though Robot kits will be available in November 2020, or earlier by special request, teams are requested to try to complete their projects shortly before the competition date in April. To meet the early April completion objective, coaches will need to determine how many hours a week the students will work on the project, then use the figures below to estimate when the students should begin, based on the following:
  2-leg Robot (21 hours required*), 3 hours a week (7 weeks): start mid-February.
  2 hours a week (14 weeks): start early January
  1 hour a week (21 weeks): start early November
  * These numbers can vary based on student skills, the number of students in a team and their absences (we have tried to allow for winter and spring breaks and snow days). Building the robot body with a 3-D printer may reduce this figure by 4 hours, but it

will require a knowledge of CAD, which itself will require instruction time.

- In the event your school or group has a 3-D printer, the CAD approach should not present a problem. If you do not have a 3-D printer, IEEE will provide one set of 3-D parts per team at no cost as part of their Covid 19 contribution.
- Allow up to 28 hours for a 4-leg manually controlled robot, 38 hours for automated and autonomous operation, and up to 36 hours for full automation.
- Teams planning to automate their robot would need to start significantly earlier than the dates shown above, but coaches doing this project for the first time are strongly advised to build just the 2-leg robots with manual control.
- As mentioned earlier, teams ordering kits are required to participate in the Robot Challenge on April 25, 2021.
- Teachers and Coaches are urged to attend the no-charge Virtual training sessions on November 11, 2020, 6 to 8 PM; and/or January 23, 2023, 10 AM to 2 AM.
- For more information, please call the organizers on 410-653-4176.

MANDATORY REPORT REQUIREMENT:

This cover sheet should be printed and included in submitted report.

For Administration use only: Registered Arrival Time:	
	Ready for Track: ..... (<30 min) Points + ...
	(>60 min) Points – .....

MARYLAND ENGINEERING CHALLENGES 2021
THE ROBOT CHALLENGE

Please complete one copy of this form for each team and return with their Written Report no later than April 17.
Please enter in parenthesis below whether High School (HS) or Middle School (MS).

School _ (_ _ _ _) **County** _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

Name of team _ **Name of Robot** _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

Team number* _ _ _ _ _ _ _ **Category of entry** (please check): 2-leg _ _ _ _ 4-leg _ _ _ _
*Add suffix A if team intends to do an Automated Run, and AFB if team intends to do an Automated and an Autonomous Run

	Team member Names	Grade
1st TRACK [ ]	_ _	_ _ _ _ _ _ _ _
2nd TRACK [ ]	_ _	_ _ _ _ _ _ _ _
3rd TRACK [ ]	_ _	_ _ _ _ _ _ _ _
	_ _	_ _ _ _ _ _ _ _
ORAL PRES [ ]	_ _	_ _ _ _ _ _ _ _
	_ _	_ _ _ _ _ _ _ _
FINAL [ ]	_ _	_ _ _ _ _ _ _ _

Name of teacher or adult leader_ _

Work Phone (_ _ _)_ _ _ _ _ _ _ _ _ Home Phone (_ _ _) _ _ _ _ _ _ _

Preferred Arrival Time: *(check one) (Note that starting times may need to be re-assigned later to assure an equal number of teams in each time slot)*

- ڤ Sunday, April 25**, 8:15 a.m.**
- ڤ Sunday, April 25, **9:00 a.m.**
- ڤ Sunday, April 25**, 9:45 a.m.**

Return completed form with written report to: Engineering Challenge Coordinator, Baltimore Museum of Industry, **1415 Key Highway, Baltimore MD 21230**. Phone 410-727-4808 x113.

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.

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.

III. Performance Demonstration — Competition value: 40 points

The course will have 2 tracks on an 8 foot table, 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. The robots will first race two at a time in manual mode, and team members (one per leg) must stay at their side of the table. 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 interfere with their opponent. 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.

In the event this event is done virtually, there would be a single track, and it would either be done at your local school, or with slightly different requirements, on a kitchen table. Depending on what rules may apply in April, a decision will be made that will be fair to all teams.

IV. Oral Presentation to Judges (and review of fabrication)* — Competition value: 15 points

CURRICULUM TIES-- Maryland Engineering Challenges and 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!