Maryland Engineering Challenges
2020 Robot Challenge

High School Level – Grades 9 to 12
Middle School Level – Grades 6 to 8
April 26, 2020

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 2019-2020

1) **The Robot Challenge will be open to Middle Schools as well as High School students, though scoring will be kept separate.**
2) **Last year Teachers requested a minor design change to reduce some problems that were frustrating their students. We can provide this change with a small price increase, the first we've had in over 20 years, but we believe it will make the project more enjoyable, and provide more reliable operation.**
3) **The cost of a 2-leg robot kit suitable for 2 to 4 students is $59 and covers the entire program (except the D-cell batteries). Many options are available, including building a 4-leg robot, and automated and autonomous operation.**
4) **There will be additional information available on-line for Teachers that will supplement the information provided in hard-copy for the students. This should be particularly helpful for teachers that are doing the project for the first time.**

Important Dates

Coaches' Hands-On Workshops (at the BMI)

⇒ **Wednesday, November 13, 2019** **Begins at 4 p.m., ends at 7 p.m.**

⇒ **Saturday, January 25, 2020** **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 11/11, 1/23 respectively). Contact Jessica Celmer at jcelmer@thebmi.org , or Nevilleed@aol.com.

Written Report Due

⇒ **Tuesday, April 14, 2020** **Prior to 4:00 p.m.**

The team's Written Report should be submitted as a HARD COPY to the Baltimore Museum of Industry, and represent 25% of the total points awarded. The Written Report should be accompanied by the form shown on page 6.

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 for participation through the BMI, coaches should go to https://48278.blackbaudhosting.com/48278/MEC-Coach-Fee, and submit a $5 Coach's Fee.

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 can be picked up at one of the two Workshops (see below). Teachers/Coaches requiring more information may contact the IEEE directly at Nevilleed@aol.com (no fee). The project should be scheduled so that the robots are 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 is a major part of the educational process.**

The Robot Challenge Event (times are subject to change)

- ⇒ **Sunday, April 26, 2020 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.**
- ⇒ **Any team unable to arrive for one of the three starting times, should contact Nevilleed@aol.com no later than April 21, 2020.**

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

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 teams that register do so with the understanding that they will participate in the Challenge Event to be held on April 26, 2020.

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. Automation hardware can be developed by the team to simulate how they got their robot to walk manually, OR they may purchase a kit of parts and an instruction manual or a fully assembled ready-to-program re-usable custom controller from the IEEE. In the latter case an additional “closed-loop” option is available using sensor feed-back to assure the robot steps are carried out faithfully even when conditions vary – this more reliable mode is referred to as Autonomous operation. Programming for most automation options is in C++.

The robot shall have an external body that is artistic and appealing, and a carrying case that protects the assembled robot on the way to the Museum.

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 Clubs are eligible to participate.

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 that protects the assembled robot. They 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.

Kits need to be ordered ahead of time and will be distributed, with no shipping and handling fees, at the November 13, 2019 and January 25, 2020 Hands-on Workshops at the BMI. Other pick-ups by special arrangement with Nevilleed@aol.com. Any delivery by mail will be subject to a handling and shipping charge. No entries accepted after **February 28, 2020**. Kit prices are shown below.

THE BASIC KITS for most teams (and all a team needs to participate in the Challenge)		
1	Two Leg manual kit	$59.00
2	Four leg manual kit	$114.00
For the very advanced who want to build the circuit boards to automate their robot:		
3	Two leg classic automation (Breadboard is not set up for autonomous operation)	$99.00
4	Four leg classic automation (Breadboard is not set up for autonomous operation)	$133.00
For the advanced team: Automation and C++ Programming, with an Autonomous Option		
5	Pre-assembled board for two leg robots (Needed for both automated and autonomous operations). Automated Feed Back (AFB) Kit for autonomous operations is separate.	$198.00
6	Two Leg AFB Kit (Optional)	$37.00
7	Pre-assembled board for four leg robots (Needed for both automated and autonomous operations). Automated Feed Back (AFB) Kit for autonomous operations is separate.	$266.00
8	Four Legged AFB Kit (Optional)	$52.00

* All prices include one instruction book per kit.
* Prices do not include the cost of "D" sized or "AA" batteries.

Other kits and one-year lease prices are available by request**.**

- Though Robot kits will be available in November 2019, 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 end of February.
  2 hours a week (14 weeks): start mid-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.
- Allow up to 28 hours for a 4-leg manually controlled robot, 30 hours for a 2-leg automated robot, and up to 38 hours for a 2-leg robot doing automated and autonomous operation.
- Teams planning to automate their robot would need to start <u>significantly earlier</u> than the dates shown above, but <u>coaches doing this project for the first time are strongly advised to build just the 2-leg robots with manual control.</u>
- As mentioned earlier, teams ordering kits are required to participate in the Robot Challenge on April 26, 2020.
- Teachers and Coaches are urged to attend the no-charge training sessions on November 13, 2019, 4 to 7 PM; and/or January 25, 2020, 10 AM to 2 PM (lunch included).

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) + 1 point
(>60 min) – 1 point per 30 minutes = PTS

MARYLAND ENGINEERING CHALLENGES 2020
THE ROBOT CHALLENGE

Please complete one copy of this form for each team and return with their Written Report no later than 4 PM, April 14.
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)*

- ☐ Sunday, April 26**, 8:15 a.m.**
- ☐ Sunday, April 26, **9:00 a.m.**
- ☐ Sunday, April 26**, 9:45 a.m.**

Would your team be available to come Saturday April 25 if we are overbooked	Circle Yes or No

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.

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	**In composing their reports, students will:** • Demonstrate the ability to summarize data (measurements/observations).

The student will use appropriate methods for communicating in writing and orally the processes and results of scientific investigation.	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!