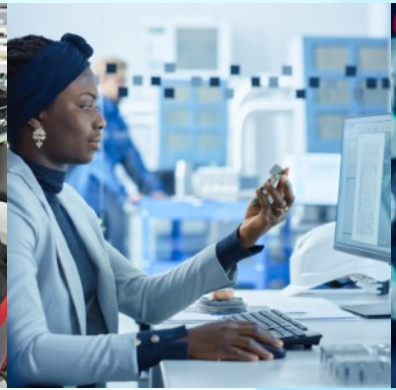



Now in our 29th Year

sponsored by:

IEEE Baltimore Section

Baltimore Museum of Industry

BMI MARYLAND Engineering CHALLENGES

IEEE Advancing Technology for Humanity

The Robot Challenge - What it is

- A learning Opportunity for students in Middle School and High School
- STEAM Project + More
  - Science
  - Technology
  - Engineering
  - Arts
  - Math
- Introduction to Project Management, Written Reports
- Communication with Professional Engineers & Technologists
- Team building -
  - 2 to 4 team members for a 2 leg robot
  - 4 to 8 team members for a 4 leg robot

The Robot Challenge - What it is NOT

- **Not** a kit assembly or cut & paste code
- **Not** only for students interested in engineering or technology
- **Not** a high barrier for students, teachers and coaches who are not specialists
- **Not** high cost
- **Not** strictly a competition -
  - this is a challenge to build and operate a robot, read engineering drawings, interact with experienced professionals and learn skills including woodworking or CAD, soldering, hand assembly, time management & teamwork.

The Robot Challenge - Key Dates

- Teachers' & Coaches Information Sessions https://bit.ly/2025RobotWorkshopRegistration
  - Wednesday, October 23, 2024 at the BMI 4:00 PM to 7:00 PM
  - Saturday, January 25, 2025 via Zoom 10:00 AM to 2:00 PM

- Registration https://bit.ly/2025RobotChallenge
  - You MUST register to receive a team number and be assigned a mentor.
    - Even if your teacher or coach has picked up kits, we do not know who you are.
  - Deadline is Friday, March 28, 2025. Update your team registration with preferred start time and whether you will participate in person or on line.

- Written Report Due
  - Thursday, April 24, 2025 Submit on line prior to 4:00 PM
    - Late reports will have a 5 point deduction

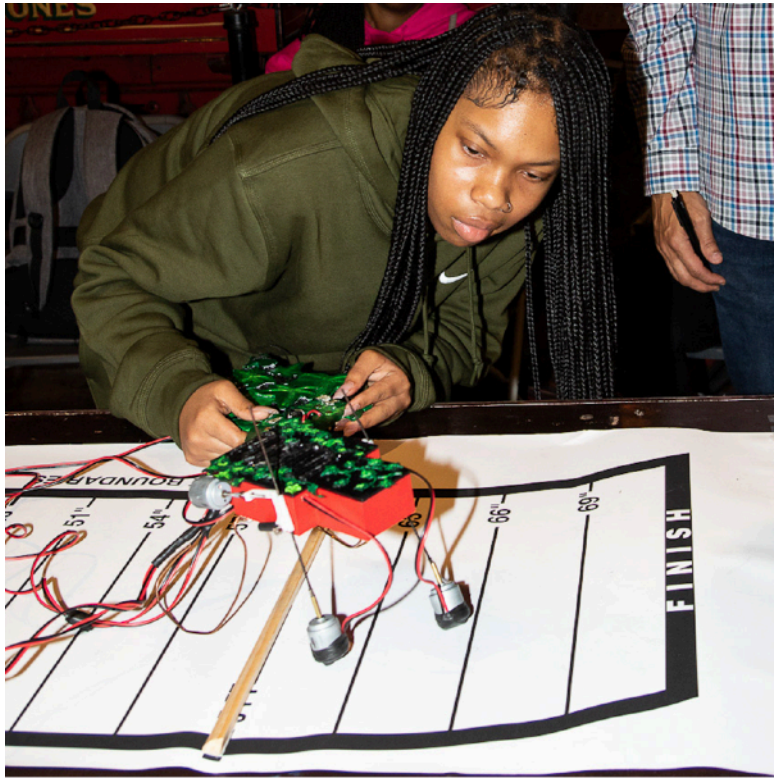
- The Robot Challenge Event - teams must select which event by Friday, March 15, 4:00 PM
  - Saturday, May 3, 2025 (Virtual - on line) 9:00 AM to noon https://bit.ly/2025RobotChallengeEvent
  - Sunday, May 4, 2025 (In Person) 8:15 AM to 3 PM
    - Participants only need to be present during their track & oral presentations, not the full day.

  - Sunday, May 4, 2025 (Virtual - on line) https://bit.ly/2025RobotChallengeEvent
  - Awards for both virtual & in person events 7PM

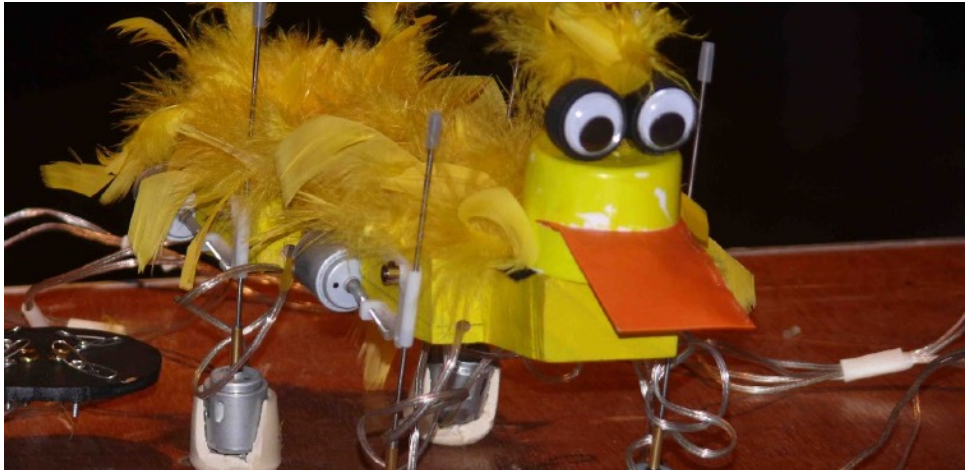
The Robot Challenge - Requirements

- A written engineering report - 25%
- Compete on a 6 ft. track with an “S” bend & 2 hurdles ½” high - 40%
- Oral Presentation to the judges - 15%
- Judges evaluation of workmanship, originality & artistic creativity - 20%

- Mentors who are experienced engineers or technologists are assigned. Teams should communicate by e-mail with updates at least every two weeks or sooner if problems are encountered.



Not your typical robot

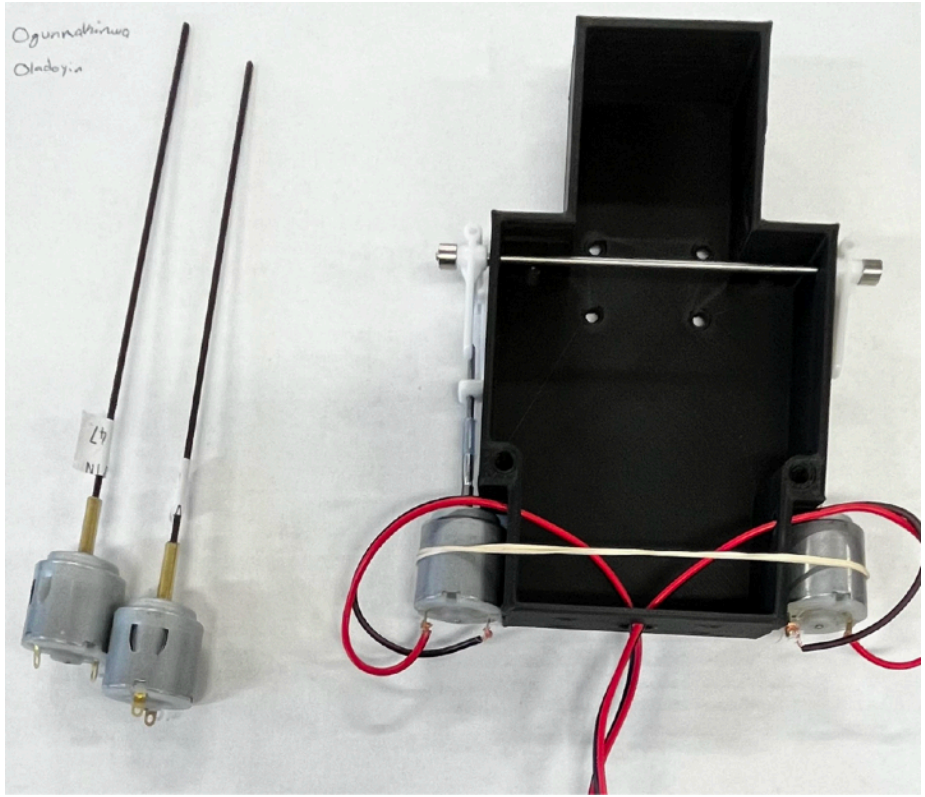


- Students are given a set of drawings and must build a robot either from wood blocks or using 3D CAD & 3D printing.
- Onshape is used by many teams. Any CAD program that will produce 3D printing files is allowable.

Not your typical robot

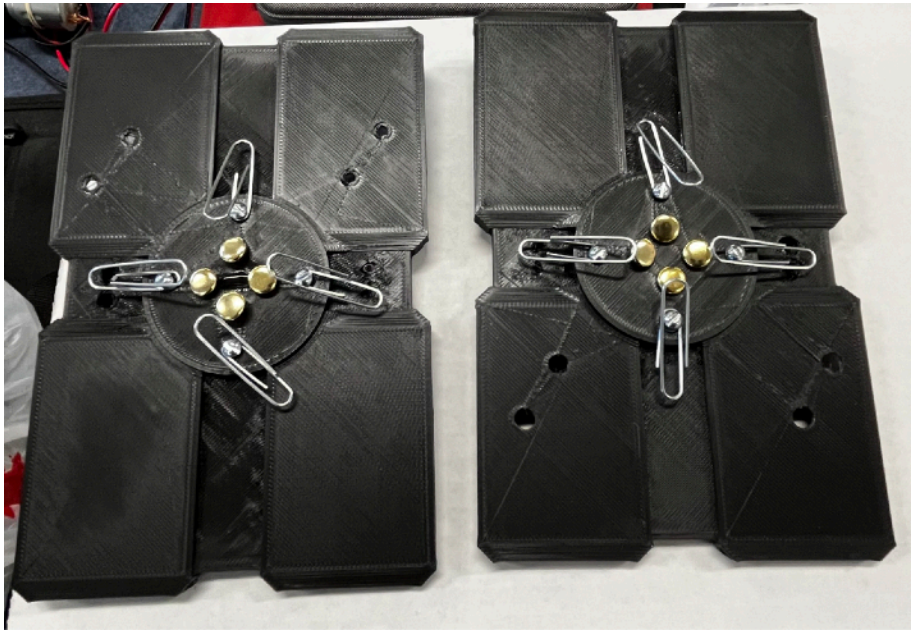
- A 2 leg robot has two controllers, one for each leg. Switches are made from paperclips.
- Themes are required, here the basic unit has been turned into a tank.
- The controllers move the motors, two per leg. One for forward/back, one for up/down.
- One student operates each leg.
- Requires two team members for a 2 leg robot. Four for a 4 leg robot.

Not your typical robot



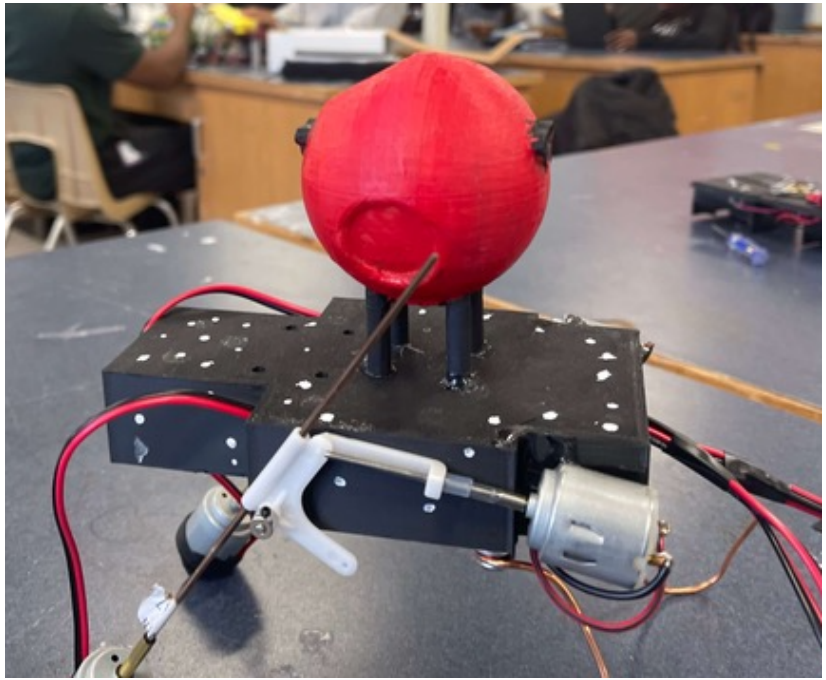
- Starting with the body, motors and legs.

Not your typical robot



- Controllers are built.
- This team used creativity with their CAD model.
- It must be functionally the original concept, but here the model was modified and can be made with a printer with smaller size capacity.

Not your typical robot



- The concept starts taking form.

Not your typical robot

- And It Comes Together
- Add significant effort to make this happen.
- Time must be spent on both building the robot and also practicing walking.
- It is much harder than it seems!

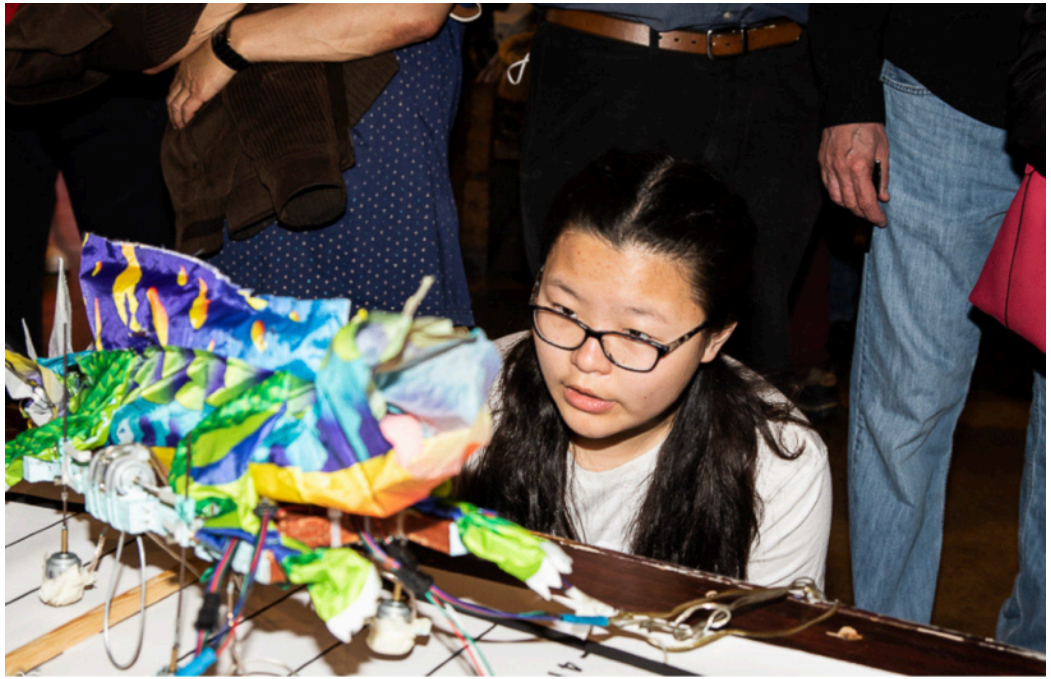
Not your typical robot

- And It Comes Together
- The start of the track run, here 4 team members work together for a 4 leg robot.

Not your typical robot

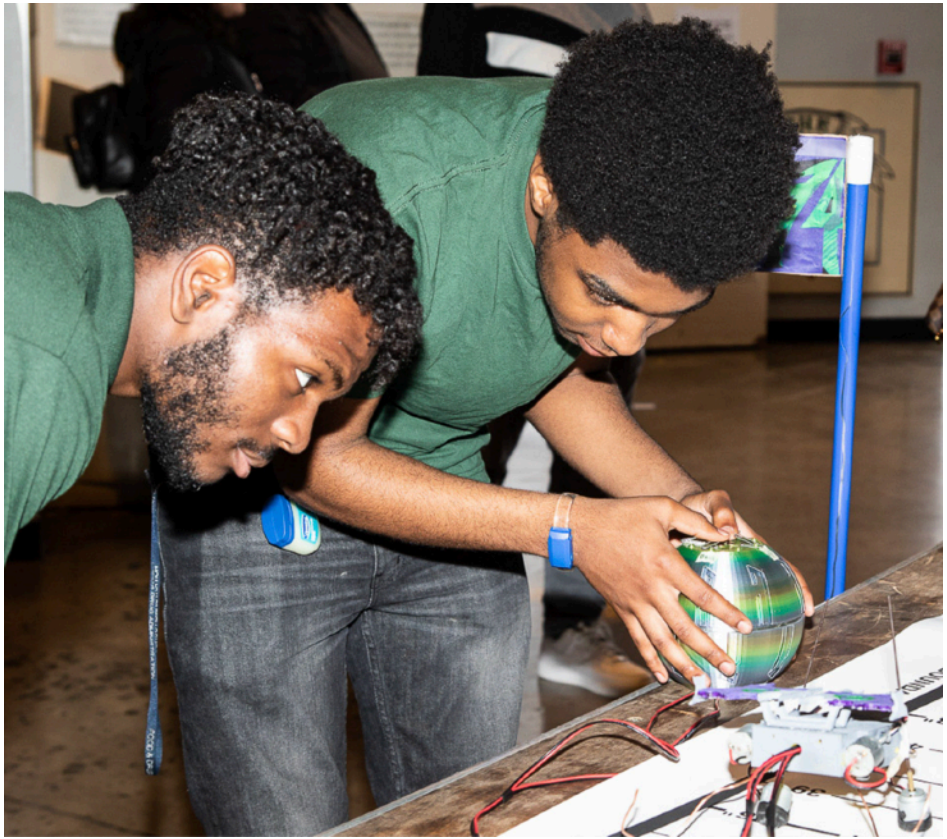
- And It Comes Together
- Imaginative artwork transformed this into a dragon.

Not your typical robot



- And It Comes Together
- Other team members can encourage the operators. Cheering is encouraged.

Not your typical robot



- And It Comes Together
- The colored ball is a controller showing creativity.

The Robot Challenge - Options

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 or you may build your own controller from scratch.	Manual control operation must be completed first and then a 2nd run for automation. 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.	

The Robot Challenge - Cost

- Time & Effort - 21 hours for a typical 2 leg manual robot, strongly recommended for 1st time.
  - 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, so the time taken will probably be about the same.

- Automation -
  - You must build the manual robot first and then add the automation control.
  - Automation requires C++ programming, recommended double the planned time to 42 hours to assemble and run additional testing.
    - C code sample is in the manual that must be adjusted for your robot.
  - Controllers are reusable for future projects.

The Robot Challenge - Cost

- Each Robot starts with one or two basic kits.
  - 2 leg requires one kit - $69.75
  - 4 leg requires two kits - $139.50 for both

Each Kit contains 4 motors (two per leg), all thread for legs, and the wires, solder, glue, and connecting parts to build a manually controlled two legged ROBOT.

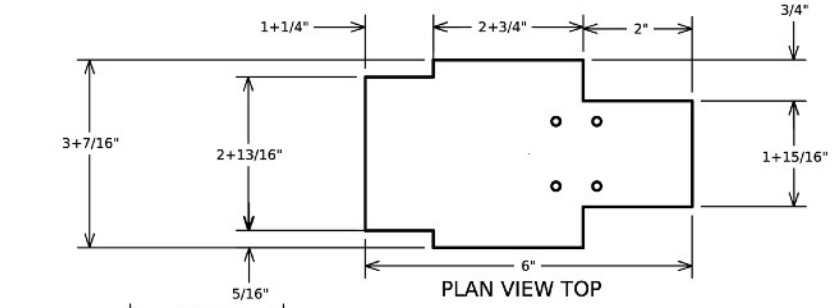
- If wood is specified, a block for the body and boards for the controllers are supplied. Shaping the block and boards into the body and controllers require shop tools.
- Most teams use CAD programs to print a 3D body or controllers as alternate to the wooden parts.
- The instruction manual provides instructions for both wooden and 3D printed bodies and controllers.

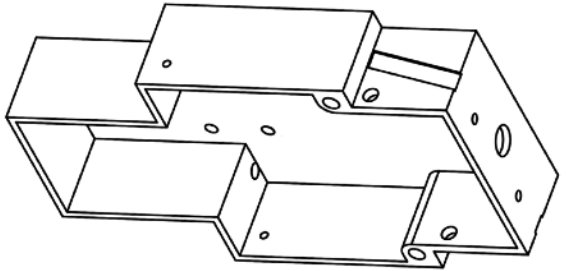
Shipping Costs vary but may be avoided by picking up at BMI or Ellicott City.
You will be charged the actual UPS shipping cost. Estimate $12.50 for a single kit.

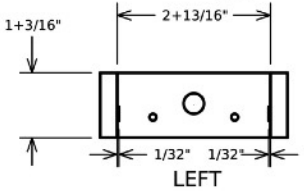
The Robot Challenge - Cost

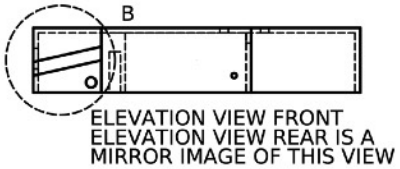
Automation: Two Legs: $85.00 Four Legs: $90.00 + shipping	**Automation Boards** consist of a central processor and electronics necessary to operate the motors associated with each leg. The two-legged Automation board controls 4 motors and the four-legged board controls 8 motors. Automation boards require additional wiring. The automation board can be programmed to operate the legs in a timed sequence. Automation uses an Arduino UNO R4 Minima that plugs into the automation board. If you supply that, deduct $20 from the cost. Programming is C++ using the Arduino IDE, which is open source and will run on Linux, Mac or Windows. https://www.arduino.cc/en/software The team must supply a cable to connect from their computer to the USB-C input.

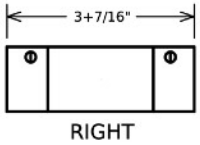
The Robot Challenge - Typical Drawing the students use to create a model

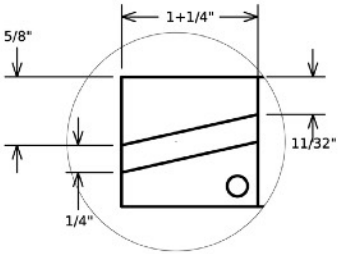


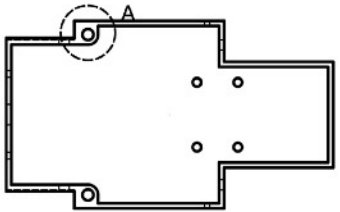


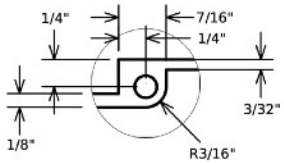












ROBOT BODY
RCB001 REV B
SHEET 3 OF 7
SCALE 1:2

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

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 1.3

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

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 1.5

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

The Robot Challenge - More Information

- Don Herres - IEEE Baltimore d.herres@ieee.org
  - Contact Don to obtain kits
- Jessica Celmer - Education Manager, Baltimore Museum of Industry challenges@thebmi.org
- https://ewh.ieee.org/r2/baltimore/robot/
- https://www.thebmi.org/visit/plan-your-school-group-experience/maryland-engineering-challenges/
- IEEE and Baltimore Museum of Industry are both 501(c)(3) not for profit educational organizations.