UNIVERSITY OF MARYLAND EXTENSION

2025 4-H LEGO Robotics Challenge

Protecting the Environmental

Protecting the environment involves actions and policies aimed at preserving the natural world, mitigating human impact, and ensuring the health of ecosystems for current and future generations. Some key issues include:

1. Pollution: Air, water, and soil pollution from industrial, agricultural, and urban activity harms human health, wildlife, and natural habitats. Reducing emissions, regulating waste disposal, and adopting cleaner technologies are critical to addressing pollution.

2. Trash and Waste Management: Improper waste disposal leads to littering, overflowing landfills, and ocean pollution. Implementing recycling programs, reducing single-use plastics, and encouraging composting are essential steps to manage waste sustainably.

3. Water Quality: Contamination of water sources due to industrial discharge, agricultural runoff, and untreated sewage threatens drinking water, aquatic life, and ecosystem health. Protecting water quality requires stricter regulations, improved wastewater treatment, and conservation practices.

4. Invasive Species: Non-native species introduced to ecosystems can outcompete native organisms, disrupt food chains, and cause ecological imbalance. Managing invasive species involves prevention, monitoring, and removal strategies to protect biodiversity.

5. Clean Energy: Transitioning from fossil fuels to renewable energy sources like wind, solar, and hydropower reduces greenhouse gas emissions and helps combat climate change. Promoting clean energy also fosters sustainable economic growth and minimizes air pollution.

Collectively, addressing these issues demands global cooperation, community involvement, and the adoption of sustainable practices to ensure a healthy planet.

Contents

Manual Revisions

D.0 Original Draft Release:
D.0.1 Formatting: Phil Malone
D.0.2 Photos: Willie Lantz
D.0.3 Review: Phil Malone.

1.0.0 Initial Public Release: 3/20/2025

Protecting the Environmental

The goal of the 4-H LEGO Robotics Challenge is to provide a simple LEGO Robotic game for entry level participants. This is done through a mission-based activity where youth design, build and program LEGO robots to solve defined tasks. The activity is performed on a 4' x 4' game mat, using pre-defined mission pieces. Each mission has points assigned, based on achieving a set goal. Although the missions are predefined, the solutions for achieving those missions are very open-ended, and depend on the creativity and skill of the participants. This document defines the rules and operating procedures for the 2025 game. If you have any questions, contact Willie Lantz at the Garrett County Extension office at 301-334-6960 or wlantz@umd.edu.

1 Teams and Coaches

Teams will consist of 3 to 8 members. The age range of team members may be defined by the local event organizers, but all teams must consist of 4-H youth who are Juniors, Intermediates, or Seniors. Coaches of teams need to be official UME volunteers. If you are not a UME volunteer, contact your local extension office or the Maryland State 4-H Office at 301-314-9070 for information on becoming an official volunteer. Coaches also need to register through 4-H Online. A link is provided on the Maryland 4-H Robotics Page at:

https://extension.umd.edu/programs/4-h-youth-development/program-areas/stem

Coaches who are registered will receive updates on the game and competitions. Each team can register multiple coaches. Coaches should not register youth team members. There will be a later registration date for the Maryland State 4-H Robotics Challenge.

2 The Game

Team members will construct a robot, using ONLY LEGO parts. The robot will be controlled by a LEGO Mindstorm or Spike Prime Brick. The robot will autonomously perform specific tasks. The team will have 2 minutes and 30 seconds to perform as many tasks as possible.

2.1 Competition kit

The competition kit comprises the playing field "mat" and the Mission Models. The mission models are constructed from a LEGO Spike Prime accessory kit of parts. Competition kits can be shared among multiple teams. Use the link in section 1 above to locate a playlist of mission model build videos.

2.2 Field Mat

The field mat is a 48” x 48” vinyl banner which is mounted inside a wooden “playing field” for stability. The mat defines the various mission regions of the game and provides registration marks for positioning mission pieces.

THE FOLLOWING MISSION OBJECTS BEGIN IN BASE (HANDS):

Oyster Cage (5.1)
Cover Crops (5.2)
Pollinators (4 pcs) (5.3)

2.3 Playing Field base and perimeter.

The field will be constructed of a ½” thick sheet of plywood (48” X 48”) with 2” X 4” (1 ½” X 3 ½” actual measurements) on edge to create a playing area of 45” X 45” (inside the 2x4 frame). The mat (48” X 48”) will be installed between the 2” x 4” edge and the plywood. The playing field will be laid on a table or supported by two sawhorses 28” to 32” tall.

3 The Robot

3.1 Allowed Materials

Robots must be constructed using a single MINDSTORMS Brick (RCX, NXT, EV3 or Spike Prime) and any additional official LEGO parts. Non-LEGO parts will not be allowed. The robot must be programmed with LEGO supplied software to perform the tasks autonomously.

A maximum of the following motors and sensors may be attached to the robot during a run. This does not include "extra" robot manipulators brought to the table but not currently attached to the robot:

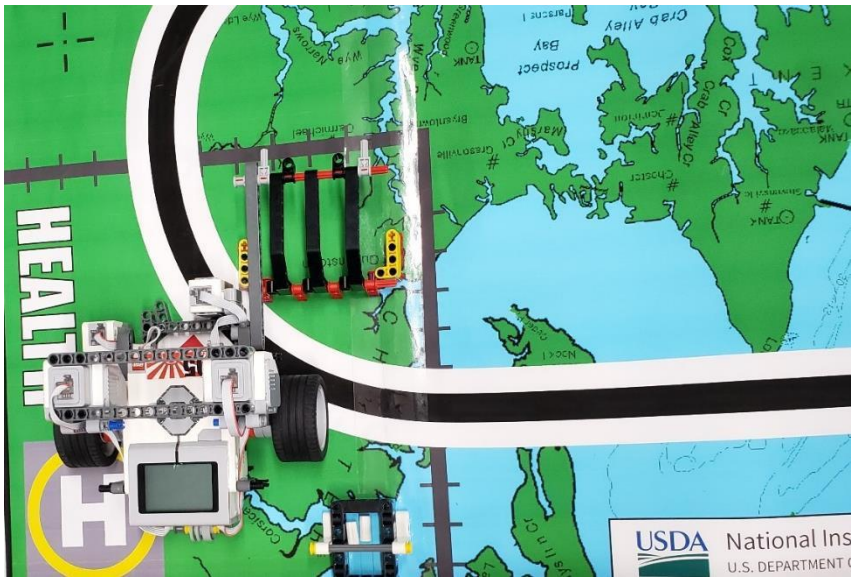
a. 2 x touch sensors
b. 2 x light sensors
c. 1 x ultrasonic sensor
d. 1 x LED lamp
e. 1 x gyro sensor
f. 3 x motors

The following may not be used:

a. Paint, tape, glue, and oil
b. Non – LEGO stickers
c. Remote controls of any type

3.2 Robot Size

The robot and any attachments must start completely inside of the Base area of the board which measures 12" X 12" and must not be taller than 12". After the robot leaves the Base area it may expand to any dimension. For the 2024 LEGO Robotics Challenge, the Base Area is in the South-West Corner of the mat (**Heart H corner**). The actual base area includes the THICK perimeter line, but not the thin lines that extend beyond the THICK line.



Note: this photo is a photo of a previous year's game for illustration purposes only.

3.3 Robot Operation

3.3.1 Robot in Base

While in Base, members may change programs or change parts on the robot. The robot will be considered in Base if any part of the robot is within the Base Area perimeter once the match starts.

3.3.2 Handling the Robot

The robot may only be handled by the team members while the robot is in the Base Area. Once the robot completely leaves the Base area, or it contacts a Mission Model, then the mission is considered to be "under way". The member cannot touch, or in any way influence the movement of, the robot or Mission Model until it comes back to Base (any part of the robot breaks the plane of the base) without a penalty. See section 6 for more about Robot Touch Penalties.

Any Mission Objects that are to be brought back to Base must cross into the Base before a member touches the robot. Any mission that was in progress will be terminated if a member touches or in any way interferes with the robot while the Mission Object is still outside of Base**. If scoring pieces are in the control of the robot and have not crossed into base the points will not count and the pieces cannot be used for further missions.**

Teams may re-run the mission, but Mission Models will remain where they are when the robot was touched. The robot may leave Base and return as many times as time allows. Unless given explicit permission by the referee, team members may not touch any Mission Models or field components outside of the Base.

3.3.3 Mission Objects in Base

Some Mission Objects start the challenge within the Base Area. These may be loaded onto the robot or its attachments by hand. Only the robot may move them out of, or back into base. Once they have left the base with the robot, they may not be manipulated by hand until they return back to base. (*See 2.2 for mission objects in base at the start of the match*). The team may place the in-base objects pieces on a table outside of the playing field during the match.

4 Game Rules

4.1 Mission Objects

All Mission Objects are constructed from a standard LEGO Education Spike Prime Accessory Kit. Instructions for construction of mission objects will be provided on the State 4-H Robotics Challenge web site at https://extension.umd.edu/programs/4-h-youth-development/program-areas/stem/. Build instructions are provided in the form of assembly videos. As these videos may be updated to provide last minute changes, the Objects shown in the videos supersede images shown in this document. Teams should make every effort to construct Mission Objects according to the videos. A YouTube Video playlist can also be found here:

4.2 Robot Rounds

Each robot will play three rounds with the average of the three rounds contributing to the final score. Each robot round will last for 2 minutes 30 seconds. The round will be started at the referees call and the robot will be turned off by the referee at the end of the round. Teams will be given a minimum of 10 minutes between rounds.

4.3 Robot Operators

Two members will be allowed at the table during the robot rounds. Additional team members must stand in the designated area and may tag in and out during the round.

4.4 Scoring of Mission Objects

All scoring of robot missions is Based on the location of items **at the end of the match**. If an item is placed in scoring position and then moved by the robot, the item will receive the points for the final resting spot at the end of the match.

5 Missions

"Missions" are the definition of what the robot must do to gain points. Missions may be performed individually, or grouped together within a single program. Mission may have several different point values depending on the degree to which the mission is completed. Missions are defined in the following sections:

5.1 Oyster Cage Deployment

Place the oyster cage in the correct lease (X-Y-Z). The correct lease will be indicated by having "Yellow paper" covering the mat. The mission will be randomized before the start of the match. The robot must use a sensor to determine the correct lease in which to deploy the cage. To get FULL points, this mission must be the first mission the team attempts during the round. The referee will ask if they are ready, after which time they may not interact with the robot in ANY way until it returns to base, except as described below. The referee will role a dice to determine the location of the lease. When the referee starts the match, the team may only press the start button on the robot to begin the first mission. The cage must be fully inside lease for full credit. If only some part of the cage is in the correct lease the team will receive half credit for the mission. The team may perform the mission later in the round for 10 points.

Score: 40 points max

- **First Mission – Cage fully in the selected (yellow) lease – 40 points**
- **First Mission – Cage in (partly) the selected (yellow) lease – 20 points**
- **Later Mission – Cage fully in the selected (yellow) lease – 10 points**
- **Later Mission – Cage in (partly) the selected (yellow) lease – 5 points**

The picture on the left shows starting position of the oyster lease indicator (Lego) yellow color paper). If the team selects this mission first it will be randomized between the XY&Z area. If the team is not doing the mission as the first mission the yellow paper will remain in the Y position. The picture on the right shows the oyster cage in (partly) inside of the selected lease. The frame of the oyster lease area will be dura-locked to the field.

5.2 Increasing Pollination

The robot will move from base the two flowers and two bee hives to Kent Island area of the board. The pollinators must remain upright and each must be touching land (green). The pieces much be touching the mat and the team can not leave behind any sort of devise that is used to deliver the pieces.

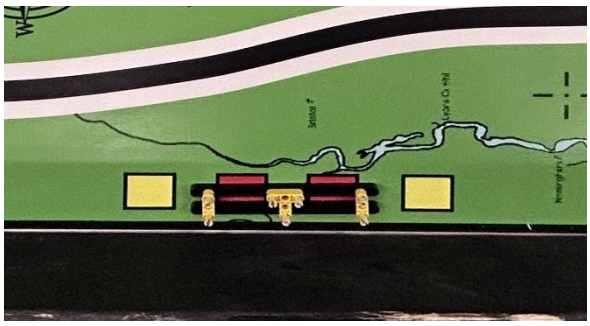
Score: 5 points for each pollinator piece touch Kent Island land (green)

The picture at left shows the 4 pollinator pieces touching the land area of Kent Island. The picture below shows the area of Kent Island in the yellow circle

5.3 Planting Cover Crops

The robot must deliver the cover crops to the land on the west side of the field. The cover crops must be upright and touching both the red boxes.

Score: 15 points if cover crop is touching both red boxes



Cover Crops in scoring position

5.4 Fish Selection

The robot must collect the yellow fish and bring back to base or place in the restaurant area. The restaurant area is defined as the inside corner of the HEALTH corner and the heavy back line. If the red fish are moved they must remain in (touching) water (blue) outside of the base area for 5 points each. Red fish in base are worth 2 points each.

Score:

- **Yellow Fish in Base – 5 points per fish**
- **Yellow Fish in Restaurant area – 10 points per fish**
- **Red Fish in water (blue) outside of base – 5 points per fish**
- **Red Fish in base – 2 points per fish**

The picture at right shows the starting position of the fish. The picture at left shows the scoring position of the yellow fish at the restaurant area.

5.5 Collecting Trash

The Robot needs to collect the trash that are located at the red hash marks on the back line around the mat and deliver the trash to base

Score: 5 points per trash piece in base at end of match

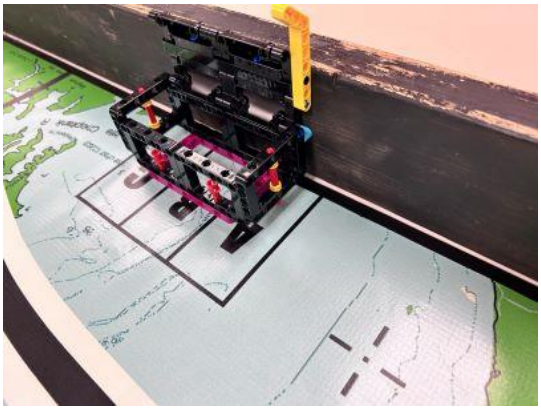
The picture above shows the location of each trash at the red hash mark. The picture to the right shows the location of all 4 trash (yellow circles).

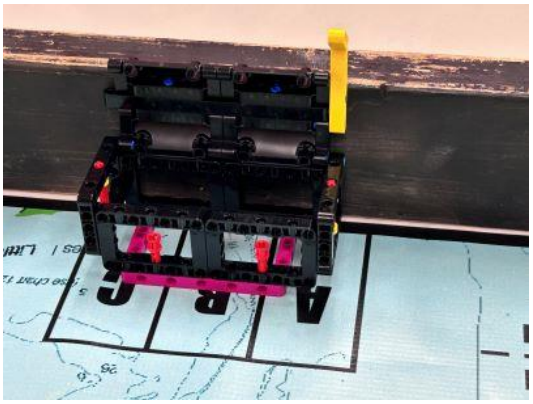
5.6 Trash Disposal

The robot may place the trash collected in the trash bin on the south border of the field. The team can earn extra points for closing the trash bin lid. The lid may be closed independent of trash being placed in the bin.

Score:

- **10 points per trash piece inside of the trash bin**
- **20 points for closing trash bin lid**



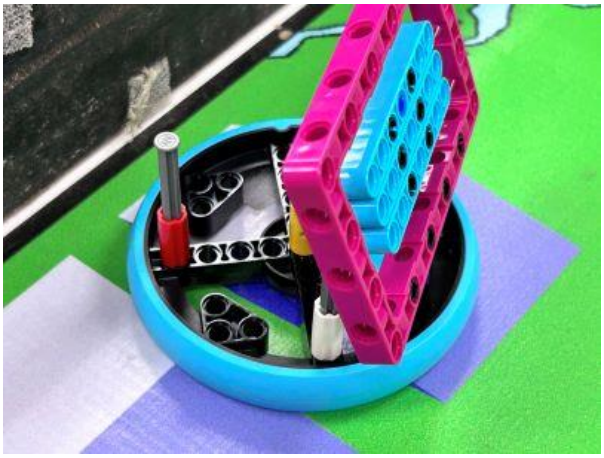


The left picture above shows the trash bin in the open position and the picture at right shows the trash bin in the closed position. The trash bin will be dura-locked to the field.

5.7 Solar Panel Alignment

The robot must turn the solar panel until the right side is touching the white peg.

Score: 25 points if solar panel is touching the white peg

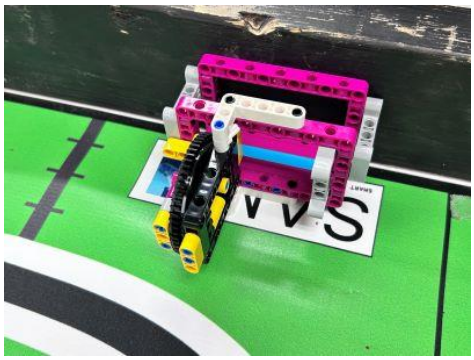


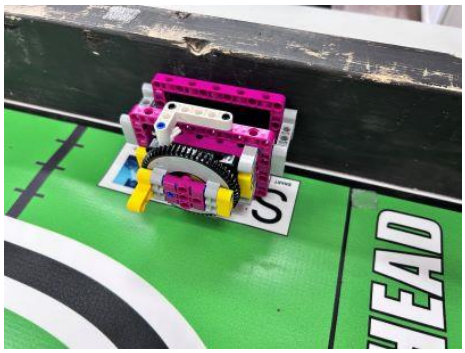
Left picture shows base position of the solar panel and the starting position of the solar panel. The right picture shows the scoring position of the solar panel (base not correct on right picture) Note – The solar panel will be dura-locked to the field. If the solar panel is dislodged no points will be earned.

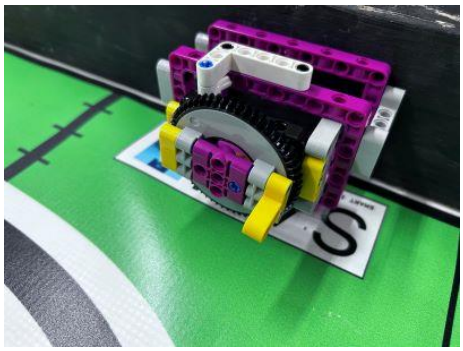
5.8 Tire Recycling

The robot must close the hatch on the **tire pyrolysis machine** (tire digester).

Score: 15 points for closing the hatch and additional 20 points for turning the door hatch





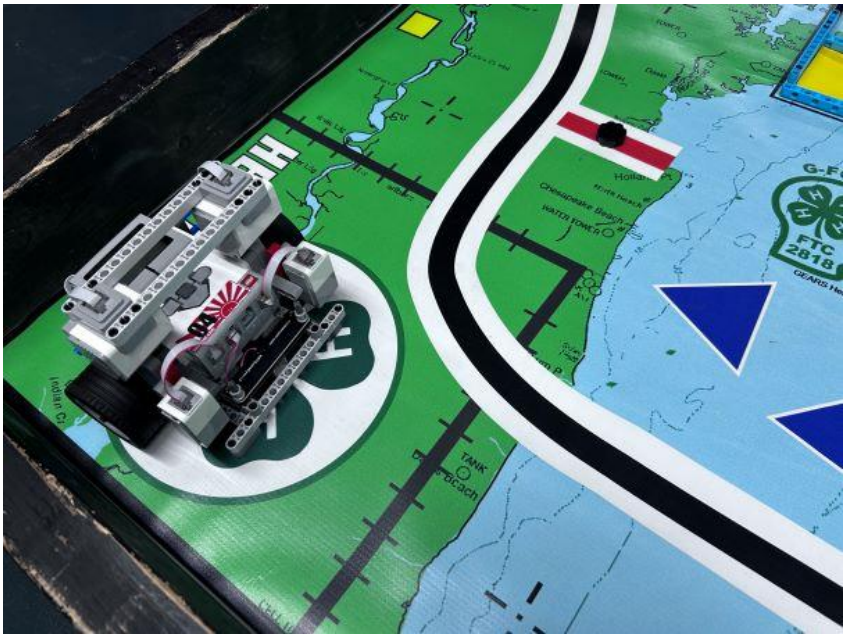


The picture on the left shows the hatch in the starting open position. The picture in the middle shows the hatch in the closed scoring position. The picture on the right shows the hatch locked (turned 90 degrees). The tire pyrolysis machine will be dura-locked to the field.

5.9 Parking Robot

The robot parked completely inside of the HEART area on the mat.

Score: 10 points for robot completely in the HEART area.



6. Touch Penalties

During the robot round, if the robot is touched while it is completely outside of the Base area it must be brought back to Base immediately and the team will be assessed a touch penalty.

For example, if a robot goes off course during a mission and does not return to base, the team may pick up the robot and return it to base, but the action will be assessed a touch penalty. Any game pieces that are in the robot at the time of the touch penalty that have been collected from the field will not be counted as returned to base or be allowed to otherwise be scored.

If the robot is taking a game piece to a delivery location which started the game in base and remains with the robot, the team may retry to deliver the game piece from base. Any game pieces that are touching the field outside of base or mission models that get moved may not be reset or recovered by the team.

To assess the touch penalty, the referee will take (remove from the field) one red fish for each touch penalty, starting with red fish outside of base.

7 Team Notebook

Each team should document the building of their robot in a journal. Each day that the team meets: record plans for the day, pictures and diagrams of robot building process, and ending reflections. The notebook will be shared with the judges during the technical presentation.

8 Technical Presentation

Each team will be assigned a 10-minute time period prior to the robot rounds to present to a panel of judges their robot's design. The presentation should include information on the team's design features, game strategies and programming. A print out of at least one program should be presented to the judges. A game table with mission models will be provided. The team may utilize the game table to demonstrate the robot completing missions. A panel of 2-4 judges will rate the team's technical presentation based on the Technical Rubric (Appendix A).

9 Service Project

Through the service project, the team should conduct a service project related to environmental awareness. The team should share their project with a community organization or in an appropriate manner to help educate the public about the environment. If a robotic program has multiple teams doing the same or a similar community service projects, be clear in explaining the roles of the team members in conducting the project.

9.1 Project Display

The teams should create a tabletop display that will explain their service project. The board should be displayed during the competition on the team's pit table and can be used during their presentation.

9.2 Project Presentation

The team will present a 3–5-minute presentation about their project to a panel of judges. The judges have 5 minutes to ask questions.

10 Mission Point Scoring summary

Mission	Description	Point Value
5.1 Oyster Cage Deployment	The scoring will be as follows: - 1st Mission – Cage fully in black lease – 40pts - 1st Mission – Cage in black lease – 20 pts - Later Mission – Cage fully in black lease – 10 pts - Later Mission – Cage in black lease – 5 pts	**40 points max**
5.2 Increasing Pollination	Pollinators touching land (green) in the Kent Island area of the field. Must be upright - 5 points for each pollinator	**20 points max**
5.3 Planting Cover Crops	Cover crops must be touching both red squares.	**15 points**
5.4 Fish Selection	Yellow fish collected if in: - Base – 5 points per fish - Restaurant Area – 10 points per fish Red Fish - In water at end of round – 5 points - In base at end of mission – 2 points	**60 points max**
5.5 Collecting Trash	Collect trash and take to base area - 5 points per piece of trash	**20 points max** **-unless trash is moved to the trash bin**
5.6 Trash Disposal	Trash pieces placed inside of the trash bin - 10 points each Trash Lid Closed - 20 points	**60 points max**
5.7 Solar Panel Alignment	Turning the solar panel till it touches the white peg - 25 points	**25 points**
5.8 Tire Recycling	Closing the Door - 15 points - Additional 20 points if hatch is locked	**35 points**
5.9 Parking Robot	Robot parked completely inside the HEART area of the field.	**10 points**
	Max Points	**265 Points**

Robot Design	Evidence of structural integrity, constructed in a manner to allow for multiple tasks appropriate for the game, efficient use of parts.				
	Beginning (2-points)	Developing (3 points)	Accomplished (4 points)	Exemplary (5 points)	Score
	Repairs and adding attachments take considerable time Very basic robot design	Parts of the robot do not fit well together Basic robot design with good balance	Parts of the robot fit and function well together Robot design is sound and functions well with game	Robot is streamlined and functions as a unit Robot design is well thought out and performs task every time	
Strategy	Ability to develop and explain improvement to robot design that happened throughout the season including methods for making decisions and testing. Ability to clearly define and describe team goals and strategies for accomplishing goals. Creation of new, unique or unexpected features that are beneficial in performing the specific tasks.				
	Beginning (2 points)	Developing (3 points)	Accomplished (4 points)	Exemplary (5 points)	Score
	Organization AND explanation of the team needs improvement No clear goals No clear strategy for accomplishing the missions	Team organization OR explanation of the team needs improvement Goals setting is ambiguous Strategy is unclear	Organization of the team is systematic and well explained Team has good goals Team has a clear strategy to accomplish tasks	Organization is systematic, well explained and well documented Team has document goals Team has clear strategy to accomplish most/all game missions	
Innovation	Robot has typical features and operates as expected No sensors used for positioning or missions	Robot has minimal features that are innovative Limited or no use of sensors	Robot has features that are innovative that allow it to accomplish goals and strategies Use of sensors for basic positioning	Robot has many innovative features which allows the team to accomplish most/all game missions with Accuracy Use of sensors for accurate positioning	
Programing	Programs are appropriate for the intended purpose and would achieve consistent results, assuming no mechanical faults. Programs are modular, streamlined and understandable with documentation. Ability of the robot to move or act as intended using mechanical and/or sensor feedback (with minimal reliance on driver intervention and/or program timing).				
	Beginning (2 points)	Developing (3 points)	Accomplished (4 points)	Exemplary (5 points)	Score
	Program is very basic relying on no feedback from the field Program is not documented Robot completes missions infrequently or only after multiple attempts.	Program is basic relying on little feedback from the field for positioning. Program documentation is not complete Robot completes missions inconsistently or only after a few attempts.	Program uses field or sensors to determine robot position on the field. Program is documented and easy to understand Robot completes missions consistently most of the time.	Program uses complex code and sensors to determine position on the field. Program is well documented and is easy for anyone to understand Robot completes missions nearly every time and regardless of field conditions.	
				Maximum Total Score = 20 pts	Total Score

Appendix A - Maryland 4-H Lego Robotic Challenge - Robot Technical Presentation Rubric