4-H$_2$O

Water in our Daily Lives

2016 Maryland State 4-H
LEGO Robotic Challenge

Through 4-H$_2$O, 4-H members involved in robotics will create LEGO robots that complete tasks related to water use on a 4 ‘ X 4’ board. LEGO robots will collect water samples, irrigate crops, fix water lines, deliver shadow balls and deliver hydrogen cells. Teams will also complete a service project which deals with water use.

1.0 Teams

1.1 Teams will consist of 3 to 8 4-H members.

1.2 Teams will register through the county extension offices with the State 4-H Robotics Committee from February 1$^{st}$ to July 31$^{st}$. Once a team is registered through the county, the county can order game pieces ($30 per set). Team coaches will also be added to a list to receive information and updates about the game and state contest. The registration form is found on the Maryland State 4-H Robotics Challenge web page at https://extension.umd.edu/4-h/4-h-program-areas/robotics-0

1.5 State Fair Competition

1.5.1 County or Unit Extension Offices may submit up to three teams per age division to participate in the state competition during the Maryland State Fair on Sunday, August 30$^{th}$, 2015.
1.5.2 County Extension educators will enter the teams into the State Fair Competition by July 31st.

1.5.3 There will be a $20 registration fee per team for the State Fair Competition. Checks should be made to the “Maryland 4-H Foundation”.

1.5.4 The State 4-H Competition will be held on the first Sunday of the Maryland State Fair (8/28/16). Teams will be provided with a schedule for their project and technical presentations.

1.5.5 Each team will be provided with a 6’ or 8’ pit table space. The team should use the table to present their service project.

1.5.6 Teams will be divided into one of three divisions according to the three 4-H age divisions (Jr. 8-10 yrs old as of 1/1/16, Inter. 11-13 yrs old as of 1/1/16, Sr. 14-18 yrs old as of 1/1/16). Mixed age division members will compete in the age division of the oldest member. All age divisions will compete in the same contest with awards given in each age division.

2.0 The Game
Team members will construct a robot out of LEGO’s that is controlled by a RCX, NXT, or EV3 controller. 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 mat will be the Race Against Time Mat (NX990974) available from LEGO Education. LEGO parts and instructions to construct field mission models will be available once the team is registered through the county. Competition
kits can be shared among multiple teams and remain the property of the local UME 4-H Youth Development Program.

2.2 Playing Field
The field will be constructed of a ½” thick sheet of plywood with 2”X4”s 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 2x4 edge and the plywood. The field includes the 12” X 12” base area. The playing field will be on a table or sawhorses 28” to 32” tall.

3.0 Robots
3.1 Allowed Materials
Robots must be constructed using the LEGO RCX, NXT, or EV3 controllers and any additional official LEGO parts. Non-LEGO parts will not be allowed. The robot must be programmed with LEGO Mindstorms, RoboLab or NXT (any version) software to perform the tasks autonomously. A maximum of the following motors and sensors may be used:
   a. 2 – touch sensors
   b. 2 – light sensors
   c. 1 – ultrasonic sensor
   d. 1 - lamp
   e. 3 - rotation sensors (RCX only)
   f. 3 – motors
The following may not be used:
   a. Paint, tape, glue, and oil
   b. Stickers are not allowed
   c. Remote controls of any type

3.2 Robot Size
The robot and any attachments must fit 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.

3.2.1 Robot in the base area (South corner of the mat)

3.3 Robot Operation

3.3.1 Handling the Robot
The robot may only be handled by the members while the robot is in the base area. Once the robot leaves the base area, the member cannot touch or in any way influence the movement of the robot until it comes back to base without a penalty.

3.3.2 Robot in Base
While in base, members may change programs or change parts on the robot. The robot will be considered in base as soon as any part of the robot crosses into the base.

3.3.3 Mission Objects in Base
Any 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 or LEGO model. Teams may
re-run the mission, but game pieces will remain where they are when the robot was touched. The robot may leave base and return as many times as time allows.

3.3.4 Touch Penalties
If the robot is touched outside of the base area it must be brought back to base immediately and will be assessed a touch penalty (see 5.8 for details on touch penalties).

4.0 Game Rules
4.1 Mission Models
Mission models will be provided as part of the competition kit. Instructions for construction of mission models will be provided. It is the team’s responsibility to construct mission models correctly. The field(s) at the state competition may not be altered (consideration will be given if discussed with the referee). Mission models will be provided at the competitions; therefore teams should not bring mission models to the competition table.

4.1.1 Starting Field Set Up
4.2 Robot Rounds
Each robot will play three rounds with the highest score of the three rounds counting toward the final awards. 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 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 point for the final resting spot at the end of the match.

5.0 Missions
Missions are described as the following:

5.1 Collect the water sample carts.
Robot must bring the water sample carts back to the base area. The water sample carts in base will be worth 10 points each.
5.1.1 Water sample starting location.

5.2 Deliver Truck and Water Samples to 4-H Clover
The robot will transport the truck with or without the water sample carts to the 4-H clover circle in the north corner of the mat. If the truck is completely inside the circle (outside of the red circle) with the water samples in the bed of the truck the team earns 50 points. If the truck is completely inside the circle but the water samples are not inside the truck the truck is worth 20 points. If the truck is partly inside the circle the team will receive 10 points.

5.2.1 Truck inside the Clover Circle with water samples inside the truck. (inside the outside edge of the circle)
5.3 Delivering the Shadow Balls to the Water Reservoir
The robot delivers the eight shadow balls to the water reservoir. Each shadow ball will be worth 4 points in base and 10 points in the water reservoir. Any shadow ball that is not in base or in the reservoir will be assessed a 5 point penalty.

5.3.1 Shadow Ball Reservoir with ball inside the reservoir.

5.4 Irrigating Crops

The robot must push down on the handle to release the two balls to the crops. The team will receive 40 points for releasing the water.
5.4.1 Location of Irrigation Model

5.4.2 Irrigation with water balls released

5.5 Installing the Dam
The robot must place the dam wall between the two sides of the Dam. The dam wall must be installed upright with some part of the key under the breast of the dam. The mission is worth 40 points.
5.5.1 Dam Location

5.5.2 – Dam Wall in scoring positon

5.6 Hydrogen Cells Collection and Delivery
The robot collects the four hydrogen cells. The hydrogen cells in base are worth 5 points each. If the hydrogen cells are delivered to the hydrogen cell base station they are worth 10 points each.
5.6.1 Location Hydrogen Cells

5.6.2 Hydrogen Cell Delivery Zone with Hydrogen Cells in Delivery Zone.

5.7 Fixing the water pipeline

The robot must push the center part of the pipeline to line it up with the other parts of the pipeline. The water pipeline will be fastened to the table with duralock. If any part of the pipeline is broken loose from the mat, no points will be awarded. If the pipeline is fixed the team receives 50 points.
5.7.1 Water Pipeline in Starting Position

5.7.2 Pipeline in the fixed position

5.8 Robot Touch Penalties

Each time a touch penalty is assessed a shadow ball will be removed from the table by the referee. Shadow Balls in base will be removed first and then shadow balls delivered to the water reservoir. Any shadow balls in a penalty position will not be removed.
5.9 Technical Presentation
Each team will be assigned a 15 minute time period prior to the robot rounds to explain their robot’s design. The presentation should include information on the teams design features, game strategies and programming. 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). The team will be assigned a numerical score between 0 and 100.

6.0 Service Project

6.1 Project Overview - Through the service project, the team should learn more about water use. Topics to be considered are conservation, agriculture, drinking water, power creation, etc. It is suggested that the team meet with professionals involved with water use. The team should then identify a service project that will assist with some issue involved with water.

6.2 Project Display – The teams should create a table top display that will explain the service project. The board will be displayed during the competition on the team’s pit table.

6.3 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.

7.0 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.
<table>
<thead>
<tr>
<th>Mission</th>
<th>Description</th>
<th>Point Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 Collecting Water Sample Carts</td>
<td>Robot must bring the water sample carts back to base.</td>
<td>Carts in base 10 points each Total 20 points</td>
</tr>
<tr>
<td>5.2 Deliver Truck and Water Samples</td>
<td>The robot will transport the truck with or without the water sample carts to the 4-H clover circle in the north corner of the mat. <em>(If the water samples are transported to the 4-H clover and are not in base at the end of the match the team will not receive the points in 5.1)</em></td>
<td>Truck completely inside the red circle around the 4-H Clover with the two water carts inside the truck 50 points Or Truck completely inside the red circle around the 4-H Clover 20 points Or Truck partly inside the red circle around the 4-H Clover 10 points</td>
</tr>
<tr>
<td>5.3 Shadow Balls</td>
<td>The robot delivers the eight shadow balls to the water reservoir.</td>
<td>Shadow Balls in Base 4 points each Total 32 points Or Shadow Balls in Reservoir 10 points each Total 80 points</td>
</tr>
<tr>
<td>5.4 Irrigating Crops</td>
<td>The robot must push down on the handle to release the two balls to the crops.</td>
<td>Water balls released 40 points</td>
</tr>
<tr>
<td>5.5 Installing Dam</td>
<td>The robot must place the dam wall between the two sides of the Dam. The dam wall must be installed upright with some part of the key under the breast of the dam.</td>
<td>Dam wall installed 40 points</td>
</tr>
<tr>
<td>5.6 Collecting and Delivering Hydrogen Cells</td>
<td>The robot collects the four hydrogen cells and delivers to the Hydrogen Cell delivery zone.</td>
<td>Hydrogen Cells in Base 5 points each Total – 20 points Or Hydrogen Cells in Delivery Zone 10 points each Total – 40 points</td>
</tr>
<tr>
<td>5.7 Fixing Water Pipeline</td>
<td>The robot must push the center part of the pipeline to line it up with the other parts of the pipeline.</td>
<td>Water Pipeline Fixed 50 points</td>
</tr>
<tr>
<td>Penalties</td>
<td>A penalty will be assessed for each shadow ball that is not in base or in the water reservoir.</td>
<td>-5 points for each shadow ball not in base or the reservoir.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total Possible 300 points</td>
</tr>
</tbody>
</table>
### Appendix A - Maryland 4-H Lego Robotic Challenge – Robot Technical Presentation Rubric

#### Robot Design

<table>
<thead>
<tr>
<th>Evidence of structural integrity, constructed in a manner to allow for multiple tasks appropriate for the game, efficient use of parts.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beginning</strong> (1 point each)</td>
</tr>
<tr>
<td>O Quite fragile &amp; breaks a lot</td>
</tr>
<tr>
<td>O Repairs and adding attachments take considerable time</td>
</tr>
<tr>
<td>O Little use of manipulators</td>
</tr>
<tr>
<td>O No sensors used for positioning</td>
</tr>
<tr>
<td>O Very basic robot design</td>
</tr>
</tbody>
</table>

#### Strategy & Innovation

<table>
<thead>
<tr>
<th>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.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beginning</strong> (1 point each)</td>
</tr>
<tr>
<td>O Organization AND explanation of the team needs improvement</td>
</tr>
<tr>
<td>O No clear goals</td>
</tr>
<tr>
<td>O No clear strategy for accomplishing the mission</td>
</tr>
<tr>
<td>O Robot has typical features and operates as expected</td>
</tr>
</tbody>
</table>

#### Programming

<table>
<thead>
<tr>
<th>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).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beginning</strong> (1 point each)</td>
</tr>
<tr>
<td>O Program is very basic relying on no feedback from the field</td>
</tr>
<tr>
<td>O Program is not documented</td>
</tr>
<tr>
<td>O Program is difficult to understand</td>
</tr>
<tr>
<td>O Excessive driver interaction needed to aim/set robot before each mission</td>
</tr>
<tr>
<td>O Robot completes missions infrequently or only after multiple attempts.</td>
</tr>
<tr>
<td>O Robot completes missions nearly every time and regardless of field conditions.</td>
</tr>
</tbody>
</table>

**Over for Comments**  
**Total Score**