OFFICIAL COMPETITION MANUAL

Challenge Information, Rules, and Awards

Oklahoma State University
Stillwater, Oklahoma
Last Revised: September 30, 2015

Mercury Robotics
http://mercury.okstate.edu

Competition Overview

The Mercury Remote Robot Challenge is an international, interscholastic competition of robotics. The challenge is to design and build a robot capable of completing a remote mission. The operator of the robot must be located at least 50 miles (80 kilometers) from the robot. The robot must be operated using only the communications channel defined by the Mercury rules (see section 4.4). The mission includes navigation of a dark tunnel, capturing a bean bag, climbing and descending 30 degree inclines, and Delivering the Payload to a target. In addition to these actions, the robot must also demonstrate speed sprinting toward the finish line.

The objective of the challenge is to maximize your teams score as defined in section 3.2. In addition, the robot must be in compliance with all rules and be able to recognize Loss of Signal (LOS) in order to be declared the 2016 Mercury Remote Robotics Challenge Champion. LOS is the condition that prevents the robot from receiving commands from the operator due to a network problem (not related to the robot system). Robots which fail the LOS test may at best place second. All robots will take the LOS test during the morning of the day of the competition.

Revision History

This section is included to keep track of changes made to the document in the case that it is revised after publication. Additional material added to the document is denoted by the icon within the text.

Revision	Date	Notes
2	9/30/2015	Changed 2015 to 2016 on final page.
1	8/31/2015	Fixed spelling and wording corrections w/ track update
0	8/17/2015	Original Publication

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1.0 Game Overview

This year's game is the Transit of Mercury, celebrating the transit of mercury between the sun and the earth. This transit occurs approximately 14 times a century with mercury appearing as a black dot against the sun. It will take place on the ninth of May 2016 following this competition. The Track this year is 24 inch (61 cm) wide and will be surrounded by 3 in (7.6 cm) tall foam board walls. The robot will need to be small enough to traverse the course while avoiding contact with walls. Each game begins with a five minute setup time followed by ten minutes in which the robot may complete a maximum of three runs.

This year's track will have several obstacles that each team will have to navigate in order to earn points. Obstacles consist of a variable radius serpentine road, a straight tunnel, acquiring a bean bag, traversing a see-saw with no guard walls, delivering the bean bag at a target and sprinting to the finish. All of this must be accomplished while driving from no less than 50 miles away. Each team will have to be diligent and design their robot with these factors in mind.

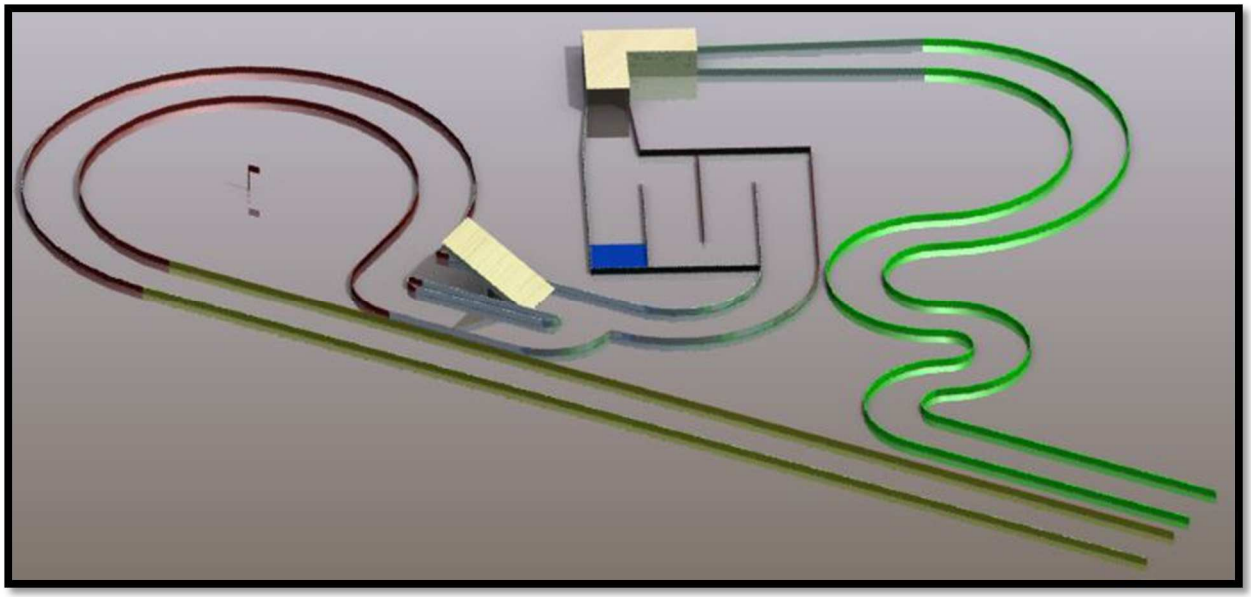
The robot must follow a predefined path from "Start" to "Finish" and perform the Pickup, Transport and Delivery of the Payload in minimum time while attempting to avoid wall contacts. Striking and/or knocking over walls will carry penalties (see section 3.2). Nothing may be dropped on the course during a fun besides the payload and any robot that is likely to cause damage to persons or property will be deemed ineligible to compete. It is understood that minor damage due to robots bumping the track walls may occur. The robot must be guided by the actions of the Operator at the remote location but it may have on board intelligence. The Operator may only receive information provided by the robot. This means that any live streaming video that is available from anything that is not mounted on the robot cannot be used for reference.

2.0 The Field

The field this year is played on the same carpet as in previous years along with returning to the 24 inch (61 cm) wide track. The walls will remain ¼ inch thick foam board 3 inches (7.6 cm) high, colored soft white. The curved pieces are made by making cuts about every 1 to 2 inches, perpendicular to the length of the foam core board that go about halfway through the board. This allows the board to bend into a curve made up of small straight sections. We encourage you take this tolerance of the track into consideration and design accordingly.

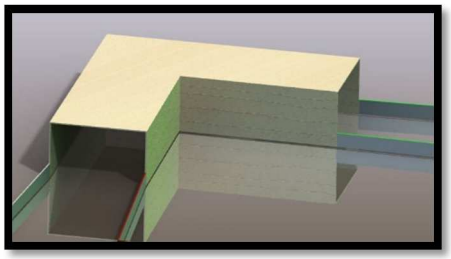
We assemble the track with tape (painters tape is suggested because it leaves behind no residue). Tape the wall pieces to the carpeted floor of the competition space and to each other to form the 3D track.

If you want to use other materials to build the track you may. The purpose of the walls is to make it easy to judge when a robot should receive a penalty for going outside the bounds of track and to prevent the robot from sustaining damage if a wall contact is made. So long as the walls, tunnel, and bridge hold true to the dimensions of the track and fulfill their purpose you can use what materials you have available. The direction of travel through the obstacles will match the order of the obstacles as they appear in this section.



2.1 Serpentine

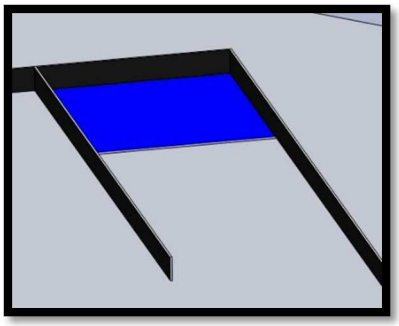
A series of winding semicircle turns with internal radii varying from 5 feet (152.4 cm) to a single foot (30.48) that the robot must navigate while trying to avoid wall contacts. The Serpentine will be the first obstacle faced but will not directly award any points.



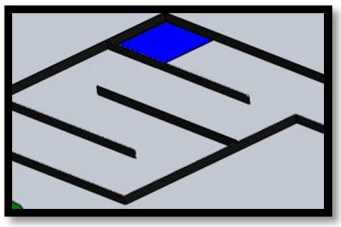
2.2 The Tunnel

The Tunnel is a dark 90 degree closed tunnel 12 inches (30.5 cm) high by 18 inches (46 cm) wide and 6 feet (182.9 cm) long. Notice the tunnel is narrower than the remainder of the track. Successfully traveling through the tunnel without incurring a wall contact will award 25 points.

2.3 The Pickup Zone



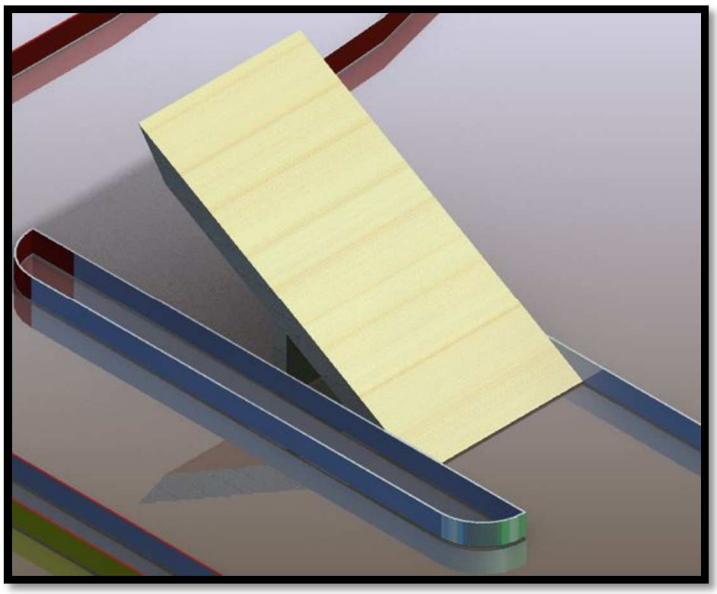
This is defined as a 24 inch square dead end section of track that will hold the Payload for pickup. The Payload will be resting on the floor unconstrained in the center of the Pickup Zone. This Payload is a bean bag measuring 2 inches on a side and weighing about **two ounces.** The robot must be capable of locating the payload, capturing it and securing it in the robot unaided. Securing the payload is defined as being attached so that if you picked up the robot the payload would not fall on the ground. Successful Pickup unaided by the robot handler will award 15 points.



2.4 Slalom

Three U-turns that will require the robot to make sharp turns while holding on to its payload. The Slalom does not directly award any points.

2.5 Transit

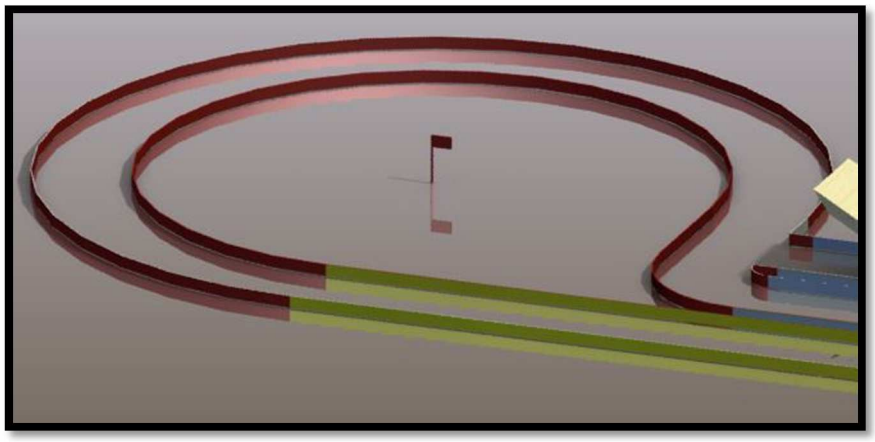


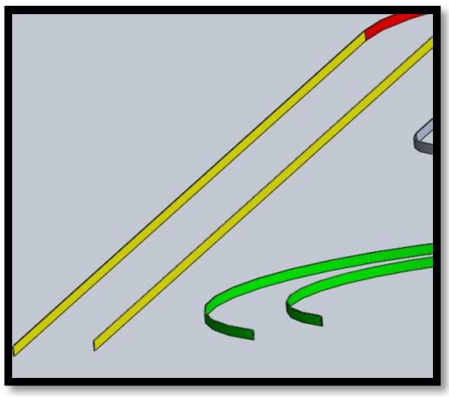
This year's climbing obstacle is a smooth wood surface See-Saw that will be slightly weighted toward the incoming side of the track. The See-Saw will be 48 inches (122 cm) long and 24 inches (61 cm) wide with **no walls** on either side. When Level the see –saw sits at 12 inches (30.48 cm) off the ground. Robots will have to be very careful while on the See-Saw as the fall could be very damaging to the robot. The incline made relative to the ground will be 30 degrees. Successful Transit will award 25 points if the payload is not dropped. Dropping the payload is defined as losing

contact with the robot, so as long as the robot is in contact with the payload until the robot successfully completes the transit the full points can still be achieved. If the robot does fall off, the robot handler may reset it in front of the obstacle by taking a 10 point reset penalty.

2.6 Delivery Zone

The Delivery Zone is a very special zone of the track where the robot may deliver its payload to the target denoted by a 12 inch zero gravity flag located in the center. This Zone consists of a 6 foot radius circle and the surrounding track. The robot may deliver the payload from anywhere in the Delivery Zone denoted by the red walls in the picture below. The robot may not make contact with any of the ground inside the zone or it will incur a contact penalty. The payloads distance will be measured from the closest corner rounded to the nearest inch. The distance will determine the multiplier for the team's score for example, a distance of zero inches from the center results in a maximum multiplier of 1.5. The distance from the Payload to the Zero G flag is measured at the conclusion of the match and provided it is greater than 72 inches (182.88) away (in the Pickup Zone for example) will just be scored as 72 inches away.





2.7 The Sprint

The final straight run of the track which is 45 feet (13.72 m) long timed by an infrared tripwire. This portion of the challenge will test the speed and straight line control of the robot. The points for this section will be based on the amount of time it takes to complete the run for a maximum of 35 pts.

3.0 The Game

The run order will be determined by lottery and may be reordered at the discretion of the event organizers. The day will start with an organized practice run where teams will also be called upon to demonstrate their LOS handling. Due to a large number of teams that will need to practice each team will be restricted to a maximum of two members on the track during the practice runs.

3.1 Run Times

Each team will be allowed a maximum of 15 minutes of operating time during the competition. The 15 minutes is divided into two sections; 5 minutes for setup and 10 minutes to run the track. The setup time ends when the robot begins operating. If the team uses more than 5 minutes for setup, it will cut into the 10 minutes of run time.

The teams may make up to 3 runs as the 10 minute time window will allow. At any time during the 10 minute run time, a team may choose to terminate the run and restart the track. A team may not restart after terminating its third and final run. When the final run is started, it must be completed before the 10 minute window expires.

In the event that a loss of signal (LOS) occurs (exceeding 5 seconds) due to the communications link and not the robot or other equipment, the expended LOS time will be deducted from the total run. This lost time will be added to the team's 10 minute window.

3.2 Scoring

$$Score = \left(Tunnel + Pickup + Transit + \frac{70}{\sqrt{Sprint}}\right) * \left(\frac{72 - Dist}{144} + 1\right) - 3 * WC - 10 * RP$$

Where the following are possible scores for each action:

$$Tunnel = \begin{cases} 25, Successfully\ navigates\ the\ Tunnel\ without\ a\ wall\ contact \\ 0, otherwise \end{cases}$$

$$Pickup = \begin{cases} 15, Successfully\ Acquires\ Payload\ without\ any\ outside\ assistance \\ 0, otherwise \end{cases}$$

$$Transit = \begin{cases} 25, Successfully\ transports\ Payload\ over\ See-Saw \\ 15, Robot\ crosses\ the\ Seesaw\ but\ loses\ control\ of\ the\ Payload\ during\ the\ attempt \\ 0, Bypasses\ Transit \end{cases}$$

$$Sprint = \{Time\ it\ takes\ to\ complete\ the\ sprint\ in\ seconds\ to\ two\ decimal\ places\}$$

$$WC = \{Number\ of\ Wall\ Contacts\ incurred(3\ points\ each)\}$$

$$RP = \{Number\ of\ Reset\ Penalties\ incurred(10\ points)\}$$

3.3 Penalties

In the following cases the described penalties will be applied.

- **Touching the robot** – If the Robot Handler has to right the robot during the run it will result in a score penalty of 10 points and the robot will be put where it left the track or anywhere prior to that point. If any other team member touches the robot during the run, the current run will be disqualified and therefore not scored.
- **Excessive Communication** – If the judge rules that any team member at the competition site is providing directions to the Operator during the run, the team may be issued a warning, penalty or be disqualified depending on the extent of the infraction. The only communications recommended between the two individuals during a run is "Start when ready" and "Terminate this run?"
- **Touching track boundaries** – If the robot comes into contact with the track walls or crosses over the area above taped track boundaries a penalty of 3 points will be deducted from the final score. The penalty will be assessed each time the robot comes into contact with the boundaries. Extended contact can be assessed multiple penalties if it lasts longer than three seconds and the robot remains in motion, if a robot continues to drive over the walls as to gain an advantage the judge will assess a 5 wall penalty for each occurrence . For example, a robot that stops while touching the boundary will only receive one penalty but one that drives while touching the wall might receive more than one at the judge's discretion.

3.4 Scoring Example

Robot 1 Travels through the Tunnel but needs help getting loaded. Gets over the See-Saw but drops the payload mid crossing. Shoots the payload 3 feet away from the target and finishes the sprint in 15 seconds racking up 3 wall contacts. Total Score = 78.5 points

Robot 2 Travels through the Tunnel picks up the payload and delivers it safely across the see-saw but its launching mechanism jams flipping the robot over. The team decides to right the robot and try to launch again but cannot, so they race to the finish in 75 seconds incurring one wall contact. Total Score = 62 pts

Robot 3 Travels through the tunnel, picks up the payload makes it over the see-saw and launches making it just 14 inches from the target. Finally the robot sprints to the finish in 55 seconds having incurred 15 penalties during its run. Total Score = 39 points

Tunnel (0, 25)	Pickup (0, 15)	Transit (0, 15, 25)	Sprint (70/sqrt(t))+5	Distance (72-D/144)+1	N (3pts)	RP (10pts)	Score
25	0	15	30	1.25	3	0	78.5
25	15	25	10	1	1	1	62
25	15	0	20	1.4	15	0	39

4.0 The Robot

4.1 General Robot Requirements

At the time of the beginning of the match the robot shall fit into an 18 in (46 cm) by 18 in square with a vertical limit of 12in (30.5 cm) in size volume but may expand to larger once the run has begun.

4.2 Safety

We encourage all the participants to consider the safety regulation required by the robots to protect other participants, public and the venue. There are some standard components that are used for the robot design that are regulated for safety purposes. We reserve the right to disqualify (or allow to participate) any team that does not meet the standards of safety considered by the Jury. Consider the following:

- Batteries: You may use NiCad, NiMH, SLA batteries or other "safe" batteries. Li+ batteries may be used only if the team *can demonstrate that proper charging and low cut-off systems have been implemented*.
- Rocket motors, Medieval flails, Nuclear devices (that includes both fusion and fission) and any components that have a tendency to combust, explode, or jumpstart the apocalypse.

Components that may cause damage to persons or property should be avoided.

4.3 Communications

The competition provides an 802.11b/g/n Wi-Fi network on the venue. All communications between the driver and the robot **must** use this network. The driver must establish a two-way communication with the robot. At the very least, the robot must send a heartbeat signal back to the driver.

The following are the details of the wireless network and regulations of its use during the competition:

1. The competition Wi-Fi network will have the ESSID “MERCURY” and no security protection. This ESSID will ***not*** be broadcast. Please ensure that your system can connect to a Wi-Fi network without the ESSID broadcast.
2. The Wi-Fi router providing this network will have a public IP address that will be disclosed to the team on the day of the competition.
3. Each team is allowed to have at most **two** networked hosts using the Wi-Fi network. For example, an IP camera and a Wi-Fi device will count as two hosts. A Wi-Fi device with a non-IP camera attached only counts as one host (for example, a smartphone providing video feed and control channel will only count as one host, but it must use the Wi-Fi network).
4. The team will have to provide information about their networked devices on the online registration form. The team may change this information on the form *any number* of times up until the week before the competition. This information includes a brief description of each device, the MAC addresses, and the ports each device will use if an inbound connection is required.

5. The networked devices will have to use DHCP to obtain an IP address. Static IP addresses are not allowed and will result in the team's disqualification if used. IP addresses are assigned based on the MAC addresses of the networked devices provided by the team on the registration form.
6. If the team requires an inbound connection to a networked device, the team is allowed to have at most **three** forwarded ports. The information provided on the registration form will be used and the team will be notified of the external ports assigned to the team a week before the competition.
7. During the team's run, only the team's robot will have access to the Wi-Fi network. All other robots will be completely turned off.
8. A base station to provide non-Wi-Fi wireless link between the robot and the official router is allowed to be used on-site. This wireless link must not use the 802.11 standard. The base station must use the competition Wi-Fi network to gain Internet access and the base station will count towards the two maximum networked devices.
9. Independent Wi-Fi repeaters, bridges, ad-hoc Wi-Fi networks, and access points are not allowed. The only 802.11b/g network each device may use is the official wireless network.

The team must also pass the “Loss-of-Signal” test that will be performed in the morning of the competition to be eligible as the competition winner. The test will be performed as follows:

1. The team clearly demonstrates that the driver can control the robot,
2. The official router technician will then shut down the router and the robot must be able to clearly indicate that it is now experiencing a loss-of-signal situation and stop,
3. After the official router is restarted, the team must be able to demonstrate that the driver can re-establish connection to the robot without the team personnel manipulating the robot. The robot must show that connection is re-established by turning off the Loss-of-Signal indicator, and resume normal operation as in point 1.

5.0 The Tournament

5.1 Registration

Registration forms can be found online at mercury.okstate.edu under the Mercury Challenge Tab. Registration should be submitted no later than **Saturday February 27, 2016 at 11:59:59PM CST.** The registration forms provide information that is needed to organize the competition, generate name tags, and for preparing refreshments. Please contact us if you have special dietary needs.

The competition is open to teams of any size though only four members may hold active positions at the competition. The active positions and their responsibilities are:

- **Team Leader** – The team leader is the contact point between the competition organizers and the team. The team leader is encouraged to be at the venue or to have a representative standing in during the day of the competition and may act as the robot handler or a technical assistant.
- **Operator** – During the competition only the Operator may guide the robot. Note that the Operator must be at least 50 miles (80km) away from the competition site at all times during the teams run.
- **Robot Handler** – During the competition only the Robot Handler may touch the robot during a "run". Permitted contact includes any technical support or maintenance.
- **Technical Assistant –** During the competition the technical assistant may only handle the robot whenever a "run" is not in progress. The technical assistant is to provide aid with technical issues that may arise with the robot.

Teams are encouraged to come up with a unique team name that will be used for keeping score and for announcements at the competition. This section describes all submission items that the team will have to submit in order to participate in the competition.

5.2 Technical Document

Each team is required to submit a technical document describing the robot and the design decisions that go into the robot, this document is **Due MARCH 18th.** There is a 10 page limit to this document ***NOT*** including appendices. This document will be used by the competition officials to survey the technology and engineering methods used by the team to improve subsequent competitions. At the minimum, please ensure that the document describes the following topics:

- A high-level block diagram of the robot
- Communication systems used (TCP or UDP sockets, applications, etc.)
- The main controller used for the robot (single-board computers, Arduino, custom made, etc.)

- Video feedback system (if the robot has it)
- The driver interface of the robot
- The robot's drive configuration (number of motors, wheels, etc.)
- Sensors and other intelligent subsystems used on the robot
- Power subsystem

This document is also a factor for the "Best Design" award. Please submit this document by e-mailing the document in PDF format to: okstate.mercury.robotics@gmail.com.

5.3 Video Presentation

The team is required to submit a *2 to 5 minute* video for the competition, **Due MARCH 18th**. This video will be used for promotional materials for the competition and will be played during the competition itself for the audience, so please tailor the contents of the video accordingly and ensure that the robot is actually featured! The video is a factor for the "Best Presentation" award. Please submit the video by uploading your video to a video site preferably *YouTube* or *Vimeo*, and provide us the link by e-mailing it to: okstate.mercury.robotics@gmail.com.

5.4 Robot and Team Picture

The team is required to submit a reasonably high-resolution picture of the robot (300 dpi) and a smaller picture of the team personnel, **Due MARCH 18th**. These pictures will be featured in promotional materials and miscellaneous items in the competition such as team member badges, posters, displays, etc. The picture must be in JPEG or PNG format. Please submit the picture by e-mailing it to: okstate.mercury.robotics@gmail.com.

5.5 Judging

The Jury consists of professors from OSU. The head judge will be responsible for judging the performance of the robot during the competition (penalties, starting time, etc.). The remaining judges will be in charge of scoring the video presentation, the robot design, and interview the participants to determine the winners for Judges' Choice awards.

Any subject not considered in this document will be left to the discretion of the Judges.

5.6 Awards

The awards will be given to the three highest scores computed during the competition, resulting in the 1st, 2nd, and 3rd place respectively. Other Awards will include: the "Best Presentation" (submitted video presentation), "Best Design" and "Judge's Choice". Note that it is possible for one team to win multiple awards.

Awards, except the ones based on the team's score, will be given at the discretion of the Judges. They may base awards on personal preference or by examining the general consensus of teams, volunteers, and spectators.

Appendix

Contact Information

If you have any questions regarding the information shown in this document or about the event, please post online your inquiry at mercury.okstate.edu under the "Contact Us" tab, or contact the Mercury Robotics advisor Dr. Carl D. Latino at carl.latino@okstate.edu or by phone: (405) 744–5151.

Dr. Carl D. Latino

We are looking forward to see you in the

2016 Mercury Remote Robot Challenge