

UBER-BOTS!



UBER has finally switched to self-driving cars, and the result has been mayhem! Passengers are being ignored, missed, dropped off in the wrong location, even run over by the automated vehicles. Random people that are not passengers are being whisked off the streets and delivered to random destinations in the city. Occasionally stray animals are being picked up instead of passengers, and then dropped off rather angry on top of passengers!

In the midst of this of this disaster, you and your engineering team has been asked to submit a bid to design a better autonomous vehicle. You are asked to submit a written proposal to compete for the project, and will build a working model of your automated car to demonstrate to UBER your design and your ability to operate successfully as an engineering firm. You and competing bidders from other firms will enter a competition to see whose UBER-bot works best.

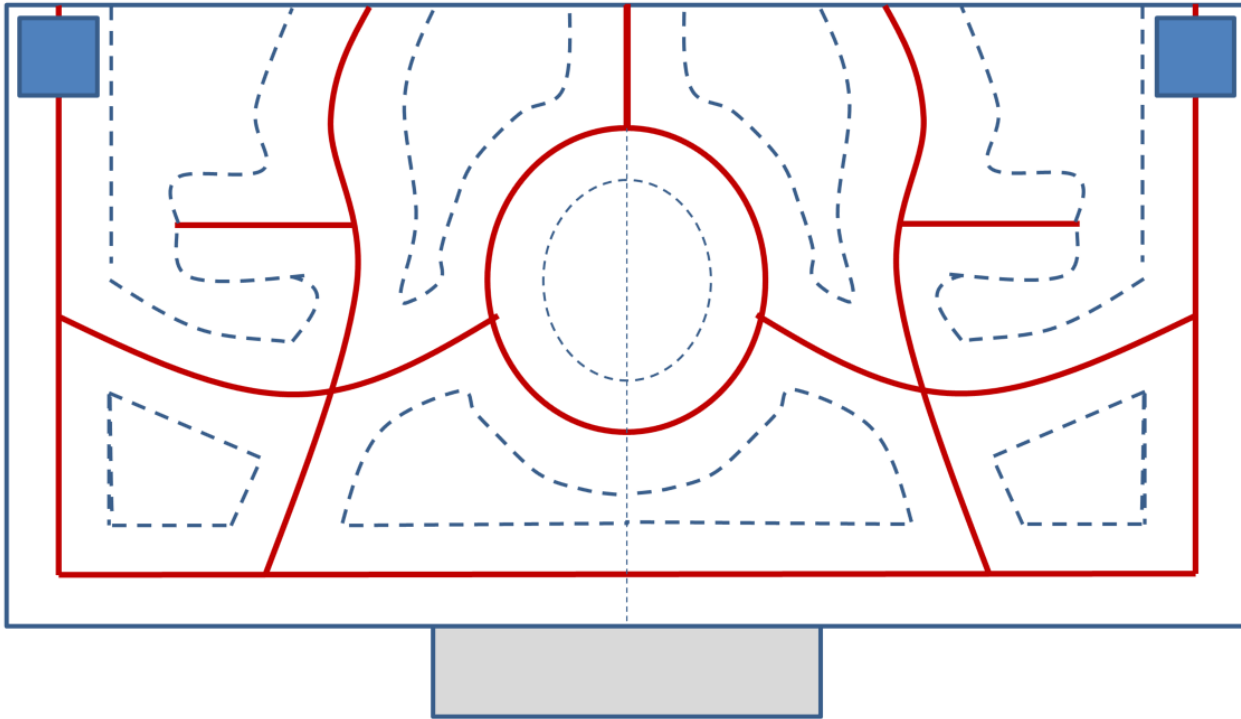
You'll have to navigate a model city, find passengers whose beacons indicate that they are looking for a ride, pick them up and drop them off at a location marked by a destination beacon. The city has numerous stray animals – do NOT pick them up and give them rides – they tend to get rather upset.

Ride quality, of course, counts.

Revision History

2.0	June 27 2016	JN rule updates (1 kHz / sidewalks / doll placement / bumper). Edits in red.
1.7	May 9 2016	AM release to class
1.5	May 4 2016	JN Edits
1.0	April 13, 2016	AM first draft

Figure 1 – Playing Surface



The competition surface is 8' x 16'

Roads are a minimum of 16" wide, and are marked with black electrical tape (shown in red above)
City blocks are shown in dotted outlines and will consist of buildings ranging from 2" to 8" in height.
There are two robot starting areas at the back corners of the surface – marked in blue above.
There will be a 4' x 1' drop-off area at the front of the surface, marked in grey above.

There will be a 2" tall wall along the back centre of the surface, which prevents robots from the edge of the surface along the 3 centre paths.

Although the topology will be kept the same as in the figure above, changes in angles, path lengths, and curvature may occur during course construction.

COMPETITION RULES

1. **City scape playing surface** - The Playing Surface is approximately 8 feet x 16 feet plus an additional 4' by 1' drop-off area as shown in the diagram above. The Playing Surface is made of wood and will have some warp and slight bumps at the joints. Robots must be designed to accommodate for imperfections and irregularities in the surface. Buildings on the surface will range from 2" to 8" in height. The diagram above is one possible representation of the surface. The final surface may not be identical to the diagram.
2. **Start Areas** – The Start Areas are 12" by 12" zones at the back corners of the Playing Surface. The Robots will begin entirely inside of the Start Areas. Left vs right start areas will be assigned to the robots by the competition stewards just prior to each heat.
3. **Drop Off Area** – The Drop Off Area is a region 1' x 4' at the front of the city surface. It is located 1" below the main surface. The Drop Off Area will have 8" clear walls or netting surrounding its three outer walls, to help prevent items from falling off the edges.
4. **Roads and Sidewalks** - The roads are a minimum of 16" wide and are marked by black electrical tape running down the middle of the road. The tape is not guaranteed to be straight at any point, may have small gaps and joints, and there is no minimum radius of curvature. The roads start inside the Start Area. The Sidewalks line all sides of the roads, and are 1 inch 2.5 inches above the surface. **Buildings upto 9 inches tall (total height 10 inches above surface) will be placed throughout the surface. Buildings may reach to the edge of the sidewalk.** ~~EXCEPT for the cutouts for the Bases for the Passengers and Passerbys (see below)~~
5. **Destination marker** – The Destination Marker is an IR beacon placed at the front of the Drop Off Area, pointing toward the city. It will be located **12 inches** 40" above the playing surface and will emit at **1 kHz** 40kHz.
6. **Passengers** – The Passengers will be fabric dolls placed on **1.5 inch** tall IR Bases that will emit infrared in all directions (approximately) at **1 kHz** 40kHz. The dolls will be held upright with internal rods, and are approximately 6" tall. **The Passengers and IR Bases will be placed at the edge of the sidewalk, resulting in centre of the Passengers and the centre of the Road a distance of 10 inches +/- 2 inches apart. The IR Bases emitting over a 180 degree range into the Road area. All potential Passenger areas on the Sidewalk will be marked, and will have a minimum of 6inches wide and 5 inches deep which do not contain any other structures.**
7. **Passerbys** – The Passerbys will be fabric dolls placed on **1.5 inch** tall dummy bases that do not emit any IR. The dolls will be held upright with internal rods, and are approximately 6" tall. The Passerbys will be marked visually different than the Passengers, strictly for the purpose of audience viewing to tell the difference between Passengers and Passerbys, and likely not distinguishable by the robots themselves. **The Passerbys will be placed in the same potential area on the Sidewalk as the Passengers.**

8. **Rule no longer applies. Areas for the Passenger/Passerby Bases**—The Sidewalk will have a number of Cutouts throughout the surface for the Bases for both Passengers and Passerbys. ~~The Cutouts may extend up to 1” below the top surface of the sidewalk (upto 1.5” above the ground), and will be left empty if there are no Passengers or Passerbys in the area.~~
9. **Stray Animals** - Stray Animals will also be present on city streets though will not be marked with IR emitting bases. Some Stray Animals will occasionally be placed next to a passenger, spaced by no less than 2” away. **There MAY be Mobile Stray Animals placed on the surface as well. These Mobile Stray Animals will be programmed to travel exclusively along the roads; if they collide with any other vehicles on the front side, they will be programmed to pause for 5 seconds then proceed forward.**
10. **Number of Passengers and Passerbys** - There will initially be a total of 4 Passengers and 4 Passerbys on the playing surface at the start of the competition. A random number of Stray Animals will also be placed on the surface.
11. **Replacing Passengers, Passerbys and Stray Animals** A computer code will determine Passenger, Passerby and Stray Animal positions randomly, while ensuring that Passengers and Passerbys placement is equally divided on the left- and right-hand sides of the surface at all times. Every time a Passenger or Passerby is picked up, a new Passenger or Passerby will be placed on the surface. Stray Animals will be placed at the beginning of the heat and will remain stationary for the duration of the heat
12. **Passengers must be within the 1inch tall Bumper** During transport, the Passengers must be fully within the boundary of the vehicle set by the 1 inch Bumper. **If any portion of the Passenger is outside of the Bumper during transport, the Passenger will not be counted for scoring, and the Robot may be stopped and restarted to avoid collisions with the other Robot.**
13. **Scoring** - Scoring is as follows:
- +2 points for every passenger transported to the Drop Off Area,
 - -1 point for any Stray Animal transported to the drop off area,
 - -1 point for any Passerby transported to the Drop Off Area
 - -1 point for any passenger dropped off outside the city limits (off the playing surface).
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- In addition, Robots will gain a 1-5 star rating based on the “quality of the ride” as determined by the judges. This rating will be used to break ties, and to determine a special “Best ride” prize to be provided at the end of the competition.
14. **Robot interactions** - Two opposing robots will operate on the same surface at the same time and may interact. Robots may NOT be malicious in their interactions with the other robot, though they may compete for passenger pick ups. Judges will disqualify malicious robots at their discretion. Robots must be able to avoid, tolerate and recover from collisions. Robots may choose to stand their ground in a collision for a maximum of 2 seconds but must take action to take them away from the perceived direction of the collision. Robots unable to do this will be penalized 5 points at the end of the heat.

15. Multiple Runs During One Heat, and Restarting Robots - A Robot which successfully completes a run for a score can be restarted to attempt a higher score. Scoring is not cumulative during the Heat, only the single-highest scoring run during the Heat will count.

Robots may also be rescued by the team and restarted as many times as desired during the heat, including:

1. Falling off the Playing Surface.
2. Getting lost or stuck on the Playing Surface.

Time during the Heat does not stop during a restart. Each restart counts as a separate attempt and only the top score achieved within one attempt will be counted.

16. Time Limit – Heats are a maximum of 2 minutes. Additional time may be allowed in the finals to resolve heats that are tied at the end of two minutes. Judges may choose to end a heat early if there is a clear winner during the heat.

GENERAL RULES

- A. **Autonomy:** Robots must be completely autonomous – no form of remote control is allowed.
- B. **Size:**
- At the start of the run, the Robot must fit inside a 12" by 12" base with a 16" height, defined by a box given to the team.
 - Once the race begins, Robots may extend a pickup mechanisms to the side reaching out a maximum of 10" to either side. Any such mechanisms must be retracted while the robot is in motion except for small motion adjustments (less than 1") for adjusting to pick up the items.
 - The Robot may not intentionally leave any part of itself on the surface or break into multiple robots.
 - If the robot cannot meet these size restrictions, the Judges may choose to allow the Robot to run individual Rounds but not compete in the overall competition.
 - Each robot MUST have a 1" tall smooth metal bumper without sharp corners that fully surrounds the robot and fits within the 12" x 12" size limit. No part of the robot may extend past the bumper except as described above. The bumper does not have to touch the surface, but instead must be raised ¼" above the surface (i.e. it must at least cover the area from ¼" above the surface up to 1-¼" above the surface).**
 - The Bumper must enclose the entire vehicle, including the wheels. Passengers must also be enclosed inside the Bumper during transport.**
- C. **Power:** Robots may only be powered by one large battery pack (nominally 16V) provided, plus two low-voltage (nominally 9V) batteries intended for use for sensor circuits. The large battery pack is the only electrical power which may be used to drive any motors (DC or servo) on the Robot (cannot use the low-voltage packs in series).
- D. **Components:** All components outside of those provided by the course instructors or listed at the end of this document must be approved by course instructors. Teams that choose to purchase their own items will not be reimbursed, and are limited to a maximum of \$100 per team.
- E. **Damage to Surface:** Robots may not permanently modify or damage to the competition surface or any individual playing piece.
- F. **Start Mechanism:** Robots will initiate motion only when the START button on their controller is pressed by a team member at the start of the match (signalled by a Judge).
- G. **Playing Surface Variations:** The surface is made of wood and will have some warp and slight bumps at the joints. Robots must be designed to accommodate for imperfections and irregularities in the surface and variation between practice and final surfaces.
- H. **Rules Finalization:** Rules and dimensions will change slightly between now and the competition. Finalized rules will be issued after completion of the competition surface construction in Hebb 42. Qualifying heats (with no opponent) will take place 2 weeks prior to the competition in Hebb 42.
- I. **Sportsmanship Rule:** Strategies or designs that obviate the design elements of the course or that do not follow the intent of the competition will be disallowed whether or not they explicitly break these rules. All strategies which have been designed specifically to come as "close to" violating any of the

posted rules as possible must be presented to the course instructors during the design stage of robot building. **All decisions are at the discretion of the course instructors.**

ALLOWED AND RESTRICTED MATERIALS

Approved:

1. Solenoids (when used with mechanical constraints)
2. Elastic bands
3. Wheels and hubs from existing RC or other small vehicles.

Must be Reviewed By Course Instructors

1. Springs are generally allowed, but must be reviewed individually for safety.
2. Compressed air may be allowed, but all valves and fittings must be reviewed for safety and a maximum pressure limit will be imposed.

Restricted or Banned:

1. Discrete H-bridge driver chips.
2. Any components other than wheels from existing RC or other small vehicle chassis, including (but not limited to) suspensions, differentials, steering mechanisms.
3. Alternate battery power sources.