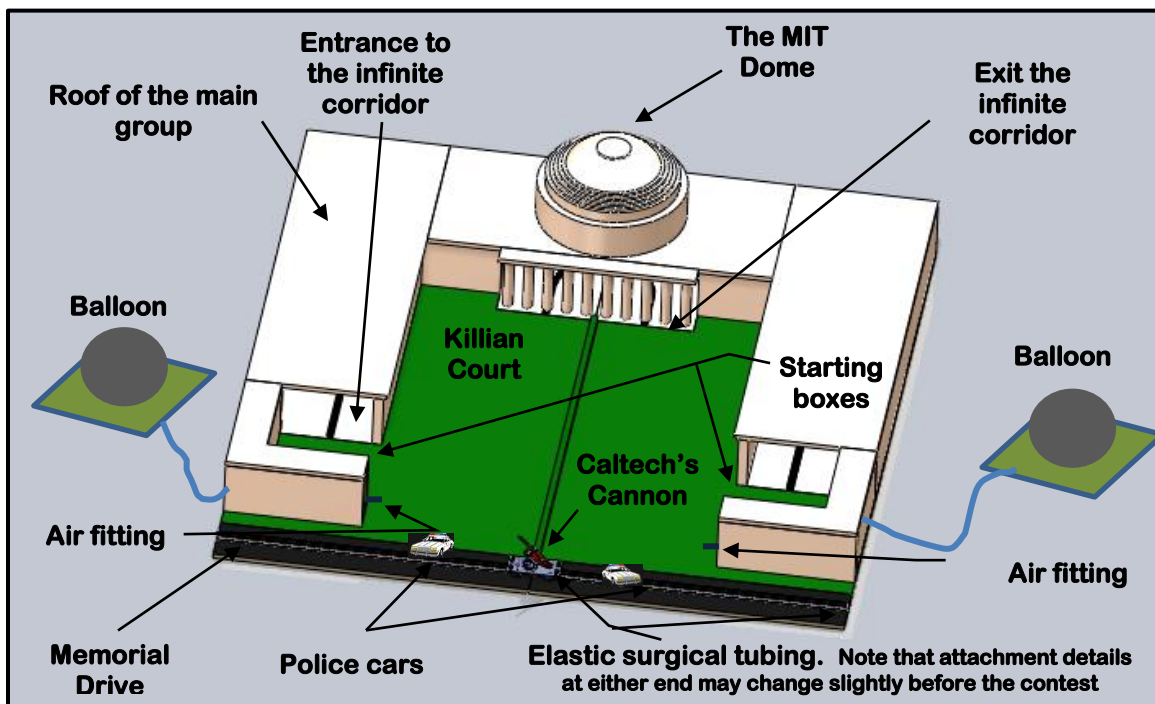


Table Description & Contest Rules

RoboHacks: Mechanizing MIT's Best Practical Jokes

Table Description & Objectives



Your mission: At MIT, the word “hack” refers to a practical joke on a large scale. You will design and build robots to reproduce -- some of the greatest hacks of all time.

You seek to score by putting police cars on the dome, by inflating a balloon under the Harvard vs Yale football game, by dumping superballs in Killian Court, and by stealing the Caltech cannon. Robots begin inside their respective starting boxes. Once time starts, your robot(s) may leave the box, but your robot may not cross to the opposite side until one of your robots has passed through the infinite corridor. For the first 20 seconds, your robot operates autonomously and in the subsequent 100 seconds under radio control.

Scoring

There are four types of scoring items in this game: *police car*, *balloon*, *superball* and the *cannon*.

The details related to these possible scoring tasks are listed below:

- You score 30 points for putting your police car on the very top of the dome and 15 points for putting your police car on any lower part of the dome.
- You earn one point for each of up to 5 super-balls you dump from the roof onto Killian court.
- You score one point for each liter of air you fill into your balloon
- You can multiply your score earned in other tasks by up to a factor of four by moving the cannon along Memorial drive toward your side of the table. The farther the cannon has moved toward your side, the higher your multiplier.

Based on the above description, the scoring formula is:

$$\text{Score} = (p + s + b) * c$$

p – The police car. If you put your police car on the top of the dome, $p=30$, if you put your police car on the lower part of the dome, $p=15$, otherwise $p=0$.

b – The largest volume of the balloon that you attained during the match (in liters) up to a maximum of 35 liters.

s – The number of your superballs (up to 5) that you dumped into Killian court from the roof of Building 10.

c – The position of the cannon, specifically, how far the cannon moved toward your side of the table. This scores a multiplier up to a maximum of 4. The distance moved is divided by 9 inches and rounded up to the nearest integer to give the multiplier. Marks will show what score was attained.

Scoring Example:

Blue has scored his police car on the top area of the dome, pumped the balloon to 3 liters, did not dump the superballs, and moved the cannon 17 inches from the center toward the blue side.

Blue's score $(30 + 0 + 3) * 2 = 66$

Red did not score her police car, pumped the balloon to 19 liters, dumped all five of her superballs, and had moved the cannon 19 inches from the center toward the red side before blue moved it back onto the blue side.

Red's score $(15 * 0 + 5 + 19) * 3 = 72$

Red has a higher score and therefore wins.

Robocon International Design Contest -- Summer 2011

Scoring in General: Referees are empowered to make all scoring judgments and interpretation of rules. Defensive actions are generally allowed to prevent or to make scoring more difficult but strictly subject to the rules described below. For example, pushing, pulling, or lifting an opponent are acceptable. Damaging an opponent or the table is not allowed.

Scoring with the police car: A police car scores 30 points if it has been placed on the top of the dome and is supported exclusively by it. The top of the dome is defined as the raised circular section whose diameter is about 5 inches (13 cm). A police car scores 15 points if it has been placed on the dome including areas other than the top of the dome and is supported exclusively by the dome. The police car must be resting stably on the dome, at least momentarily, and not additionally supported by or touching your robot in any way. The car scores for the robot on whose side it was originally parked. Each police car can score only once. A police car, once positioned on the dome scores points even if it's knocked down later on. The car is about 5 inches long, 2 inches wide, 1.5 inches tall, and weighs about 1 N. The car will be initially positioned on Memorial drive, on the marked locations North of the partition in the road, inboard of building 1 or 2, and facing outboard, and one car will be on each side of the table.

Scoring with the balloon: You earn points for pumping up the balloon. The largest volume of the balloon during the regulation time of the round determines your score. One point is awarded per liter of volume, rounding down to the nearest integer. If the balloon bursts (due to inflation, not due to robots puncturing it), you earn the maximum score of 35. To fill the balloon, you must use the access point provided on the table. To deliver air to that access point, you can incorporate into your robot a pump of your own design or a source of compressed air of up to 60 psi gauge pressure. Your opponent could interfere with your pumping operations as long as it is not via damaging your robot. For example, they could push you off of the pneumatic fitting.

Scoring with the superballs: You score one point for each superball you deploy from the roof of building 10 into Killian court. Each side has its own set of 5 balls. At the start of the round, the superballs must be within the starting box and can be contained or held by the robot in any way you choose. Each ball counts only if the robot that releases it is supported exclusively by the roof when it releases the ball and the ball is at the roof level or higher and is above building 10 when it is released and the ball lands within the green area of Killian court.

Scoring with the cannon: A cannon is firmly attached to a truck on Memorial Drive. The truck is firmly attached to a rail. Forces may be applied to the truck and/or the elastic surgical tubing, but not to the cannon itself. The value of the multiplier is determined by the displacement of the center of the cannon (and the truck to which it's fixed). Moving the cannon by between 9 to 18 inches toward your side earns a 2X multiplier, moving it by 18 to 27 inches earns a 3X multiplier, and so on up to a maximum of a 4X multiplier. Scoring a 4X multiplier requires overcoming about 7 pounds of tension in an elastic band. Defensive actions are generally allowed. Something can be placed to block the truck or the cannon as long as it does not damage the table or its parts. The multiplier for each side is determined by the maximum displacement toward each side during the official timing of the round.

Rules & Regulations

1. General Principles

- a. These rules are intended to create opportunities to learn engineering.
- b. Those things not specifically forbidden are allowed.

2. Timing

- a. Each round of the contest is two minutes (120 seconds) long.
- b. For the first 20 seconds, no control signals may be sent to the robot. So that your robot can sense the start of the round, an LED will light. The LED will be positioned in the building and at the center of the outboard face of your starting box.
- c. If both players agree to not use the first 20 seconds, then the match will last 100 seconds.

3. Winning & Advancing

- a. There will be a single elimination tournament with 16 slots in the bracket.
- b. In the tournament, the highest scoring robot in each match advances to the next round. In general, only one machine may advance. If there is a tie, it will be broken by weighing the two systems. The lighter machine prevails. Only the parts of the machine fielded in that round will be weighed.

4. Control

- a. Team members must control their own machines. Two team members at a maximum can be actively involved in manipulating the controls.
- b. All control must be accomplished without contacting the robot.
- c. Control may be achieved via radios and, in addition, any another wireless device approved by the referees (e.g. a TV remote control, a laser pointer, a cell phone, Xbee, Bluetooth, etc).
- d. A contestant may use up to eight channels of radio control. Contestants may add more degrees of control by using means in addition to radios such as a TV remote control or laser pointer.
- e. A contestant may not deliberately interfere with the radio or other remote control of the opposing player.
- f. Robot drivers must wear safety glasses when in the vicinity of the table. Some prescription glasses are acceptable.

5. Robot Configuration

- a. Your entire robot must fit in the *Starting Box* at the time of impounding and at the beginning of each match when set up on the table. The starting box is defined by the limits of the court on the actual tables with 1mm of buffer all around. They are about 15.5" by 15.5", but there is some variation. Make sure your robot fits in every starting box on every table. In addition, the robots are limited to 18" height with lateral constraints extending up from the court below. Note that the "starting box" is a bit more than twice the height of the buildings surrounding the starting box. The box is "virtual" and has no actual walls or a door. The robot may not touch the buildings at the start. There must be a small gap between the starting box and the adjacent building.
- b. Your entire robot must be made from the kit materials and components, a specified list of approved items (fasteners and items in the stock cabinet), approved batteries, and electronic components authorized by the referees. A restricted list of recycled items is allowed including soda bottles (up to 2 liters volume total) made of PETE (a clear plastic), VHS tapes, and corrugated cardboard. Items that primarily serve to make robots look cool generally will be allowed including LEDs, seven-segment displays, and such items. There are no chemicals in the kit or supply cabinet aside from epoxy, cyanoacrylate adhesive, grease, and such things. For example, baking soda and vinegar would make a great balloon inflation means, but they are not in the kit and can't be in your robot. Electric motors (or other actuators) taken from appliances (or other household or industrial equipment) are not considered recycled items.
- c. Your "kit" includes up to 12 cubic inches of 3D printed parts. You are also limited to consuming up to 5 cubic inches of support material.
- d. Your "kit" also includes services to process materials in your kit. You have, at your disposal, one hour of waterjet or laser cutting and four hours of machining services from the Central Machine Shop.

Robocon International Design Contest -- Summer 2011

- a. Your kit includes some actuators literally in your bin when it is issued to you (two SpringRC Continuous Rotation, one VS-2, one VS-11, and one motor with planetary gear either a BO-P5 40:1 or BO-P6 120:1). Your "kit" also can be augmented with some actuators from a menu. The menu includes alternatives from two columns as shown below. There can be repeats from column A (for example, you could get 2 VS-11s or 4 VS-2As). You must show your design and justify your selection to get these items.

Column A (choose 2)

VS-11
VS-2A or SpringRC
(set of two)
BO-P5 40:1
BO-P6 120:1

Column B

(choose 1, limited supplies)

VS-10
Pneumatics Kit
Alternative pneumatic cylinders
Bare motor (Tamiya or Micro-motion)

- b. Crossing to the other side of the table is permitted, but only after your robot has successfully travelled through the infinite corridor. Crossing to the other side is defined by breaking the plane that extends vertically through the middle of the table. Reaching across (e.g., to grasp an object or block your opponent) is NOT allowed until your robot has navigated the infinite corridor. Violation of this rule will be penalized by reducing your score to zero for deliberate or major violations or else one point penalties for each inadvertent or minor violation. Being forced to the opposite side by your opponent is not a violation. If one of your robots traverses the infinite corridor, it has "punched your ticket" for the entire system and then any one of your robots can break the mid-plane.
- c. Successfully travelling through the infinite corridor is defined as entering through the opening within the starting box and exiting through any opening on your opponent's side. The opening by building 10 has a vertical plexi-glass partition so that the referees can more easily ensure that you entered fully on the opponent's side. The robot that traverses the corridor has to be a machine that is substantially complete and substantially under control by radio or software. For example, a projectile fired through the corridor is not "substantially under control" but a simple wall following robot is. The robot must fully emerge from its exit, at least momentarily.
- d. There is no limit on machine weight, but you should generally still attend to the weight of your machine as excess weight may lead to poor performance. Also, weight of your system will be used as a tie breaker.
- e. Energy may be stored in batteries, compressed air, elastic strain, and gravitational potential energy. Total stored energy may not exceed 30kJ. This limit will be enforced by the referees based on calculations the team must provide. Compressed air may not exceed 60 psi gauge pressure. Mechanisms using large amounts of rubber or springs must have adequate safety locks to reduce the chance of accidents. These locks may be removed once all contestants and onlookers are safely away from the

Robocon International Design Contest -- Summer 2011

- device. Safety of all forms of energy storage will be at the discretion of the faculty and judges.
- f. Contestants will be responsible for charging their own batteries, compressed air containers, springs, rubber bands, etc.
 - g. Your machine may be reconfigured between rounds. One reason to reconfigure is to accommodate the differences between the right and left sides of the field. You will know at least 5 minutes before you compete which side your machine will be assigned.
 - h. You will have access to set up your machine within the starting box prior to each round. You should be able to complete your set-up fully in less than three minutes.

6. Sporting Conduct & Safety

- a. Damaging or overturning an opponent's robot is not allowed (although blocking and push and lifting are allowed).
- b. Once scoring is accomplished, it cannot be reversed by defensive actions, but additional scoring can be prevented.
- c. Damaging the contest table and or control equipment is strictly forbidden.
- d. In the case of destruction deemed by the judges to be accidental, the judges may permit repairs and a rematch.
- e. Contestants and spectators (i.e. any human beings) may not directly affect the motion of the machines or anything else on the table.
- f. Any robot components or table items that depart the table cannot be manually re-introduced to the table during a round. It is permissible to drive a robot off the table during a round. It is permissible for a robot to reach outside the boundaries of the table during a round.
- g. Nets or entanglement devices are not permitted, but other defensive devices generally are permitted.
- h. **NO DANGEROUS MACHINES. THE JUDGES' DECISIONS ON SAFETY MUST BE RESPECTED AND OBEYED PROMPTLY.**

General questions may be asked of all participating faculty, graduate students, undergrad assistants, and staff of Robocon. However, all officially sanctioned rule interpretations will be made by the referees. The key rulings will be discussed every morning at the opening meeting. The questions and answers will also be archives at the Robocon Stellar site. This archive represents the official position of the Robocon leadership and has legal standing similar to precedent and case law in the US legal system.