Vertigo
Design Contest
ME72 Engineering Design Laboratory
Fall Term, 2000
Rules and Details

Version 1.6 (6:30 pm, November 3, 2000)
Final Contest to be held: November 30th, 2000
in: Beckman Auditorium
Vertigo
Design Contest
ME72 Engineering Design Laboratory
Fall Term, 2000
Rules and Details
Version 1.6 (6:30 pm, November 3, 2000)
Final Contest to be held: November 30th, 2000
in: Beckman Auditorium

1 Object

The object is to design and build a device which, in collaboration with a teammate’s device, will magnetically attach scorable items (SI’s) to one side of a vertical steel wall to win a series of contests. Each team’s score at the end of the contest is based on the number and location of the SI’s in its scoring zones on the wall. In each contest, each device will strive to combine speed, strength, finesse, guile, strategy, etc., to complement and assist its teammate’s device in out-performing the opposing team’s devices.

The “contest arena” is a rectangular volume 1.22 m (4 ft) wide, 1.22 m (4 ft) high, and 4.88 m (16 ft) long. The arena is partially closed on the front and ends with clear plexiglass walls, the bottom surface is solid with padding and carpeting, the back is solid and covered with a brown porcelain coated sheet metal (chalkboard surface), and the top is predominantly open with a set of 2.5 cm (1 in) wide steel “U”-channels spanning the width from front to back. The interior of the arena contains two shelves and ramps to connect them. Each side of the back wall contains two scoring zones:

- the upper zone (3-zone) is 30.5 cm high by 61.0 cm wide (12 in high by 24 in wide) and is positioned at the outer edge of the upper shelf; it carries a multiplicative value of three (3).
- the lower zone (1-zone) is 22.9 cm high by 61.0 cm wide (9 in high by 24 in wide) and is positioned directly below the upper zone and 10.2 cm (4 in) from the carpet surface; it carries a multiplicative value of one (1).

Four views of the arena are shown in Figures 1 through 3 on Pages 13 and 15. Each team’s devices begin the contest on one (assigned) side of the upper shelf of the arena, within a painted rectangle.

At the start of the contest, four cubic and four cylindrical scorable items will be positioned on the floor of the arena.

Each device is operated via radio control from a joystick tower containing a radio transmitter. Electrical power will be supplied to each contestant’s transmitter for 60 seconds. The receiver/control module, carried by the contestant’s device, contains four channels of control. Two channels are continuously modulated by use of a two-axis joystick and two channels are switched by a trigger and thumb switch on the joystick. The polarity of switched channels is determined by the positions of two toggle switches on the joystick baseplate.
2 Evaluation

An overall winner will be determined in a modified round-robin tournament, followed by a single-elimination “playoff” tournament among the top four teams.

The winner of each contest will be determined at the end of 65 seconds (60 seconds of power followed by 5 seconds without power), based on the number and location of the scorable items (SI’s) attached to the wall.

The score for each SI is determined by multiplying the value of the SI itself by the value of the scoring zone to which it is attached.

- Each cube has a value of one (1).
- Each cylinder has a value of two (2).

Therefore, a cylindrical SI in the upper zone (3-zone) produces +6 points, and the cubic SI in the lower zone (1-zone) produces +1 points. The score for each team is calculated by adding up the points for each SI in the scoring zones on its side of the wall. The team that has the highest score at the end of 65 seconds wins.

In all cases (particularly those requiring judgement) the judges will decide the winner.

3 Individual Work

While you will be working in teams of two, it is expected that each individual will design and fabricate a functional device.

It is acknowledged that interaction between teams in the class is highly beneficial. To that end, any conversations, calculations, analyses, ideas and tests may be shared among the teams, but the device design and fabrication must be an individual effort. Note that this collaboration policy does not extend to replicating others’ ideas. Occasionally two people will arrive at a very similar solution independently, sometimes one person will see a great idea in someone else’s device, and finding no superior alternative will want to incorporate it. This duplication is permissible, however, not encouraged. Competitors usually maintain a high level of secrecy around their device, and blindly copying an idea or strategy may be risky.

In many respects, you should treat this design project as similar to an ordinary homework set. It is permissible to collaborate with your classmates and seek the advice of the instructor, TA’s, M.E. Shop staff, other class participants, other students, however, the final product must be your own work.

At the end of the term, for grading purposes, you must be able to indicate the boundary of the functional device that you designed and fabricated, and in particular to distinguish it from the device that your teammate designed and fabricated.

Additionally, it is vital to acknowledge the contributions of others to your ideas, by a suitable notation in your design notebook. If you are concerned about the acceptable limits to collaboration, discuss the situation with the instructor(s).

Do your own work, and as always, it is best if you use your own ideas and concepts.
### Milestones:

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Day</th>
<th>Time</th>
<th>Milestone</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>26-Sep</td>
<td>Tue</td>
<td>10:00 am</td>
<td>Zeroth Assignment given.</td>
</tr>
<tr>
<td></td>
<td>28-Sep</td>
<td>Thur</td>
<td>10:00 am</td>
<td>Objectives, Requirements and Functions Assignment;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 Alternatives Assignment;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mockup Assignment given.</td>
</tr>
<tr>
<td></td>
<td>28-Sep</td>
<td>Thur</td>
<td>2:00 pm</td>
<td>Written Contest Materials distributed. Pick up “Bag of Junk”.</td>
</tr>
<tr>
<td>2</td>
<td>3-Oct</td>
<td>Tue</td>
<td>10:00 am</td>
<td>Zeroth Assignment Due.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Objectives, Requirements and Functions Due [5%].</td>
</tr>
<tr>
<td>3</td>
<td>10-Oct</td>
<td>Tue</td>
<td>10:00 am</td>
<td>Engineering Analysis Assignment given.</td>
</tr>
<tr>
<td></td>
<td>10-Oct</td>
<td>Tue</td>
<td>7:00 pm</td>
<td>Preliminary Design Review.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 Design Alternatives Due [5%].</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mockups Due [5%].</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Begin building Prototypes of key elements.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Begin Fabrication of Device.</td>
</tr>
<tr>
<td>4</td>
<td>17-Oct</td>
<td>Tue</td>
<td>10:00 am</td>
<td>Engineering Analysis Assignment Due [5%].</td>
</tr>
<tr>
<td></td>
<td>19-Oct</td>
<td>Thur</td>
<td>2:00 pm</td>
<td>Prototype of 1 key (working) element Due [5%].</td>
</tr>
<tr>
<td>5</td>
<td>26-Oct</td>
<td>Thur</td>
<td>2:00 pm</td>
<td>Continue Fabrication.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Begin Testing and De-Bugging.</td>
</tr>
<tr>
<td>6</td>
<td>1-Nov</td>
<td>Wed</td>
<td>7:00 pm</td>
<td>Critical Design Review.</td>
</tr>
<tr>
<td></td>
<td>2-Nov</td>
<td>Thur</td>
<td>2:00 pm</td>
<td>Demonstration of 1 key function. Due [5%].</td>
</tr>
<tr>
<td>7</td>
<td>9-Nov</td>
<td>Thur</td>
<td>2:00 pm</td>
<td>First Complete Device Prototype Due [5%].</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>First version fabrication complete.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Continue Refinement.</td>
</tr>
<tr>
<td>8</td>
<td>16-Nov</td>
<td>Thur</td>
<td>2:00 pm</td>
<td>Device Scoring Function Test [5%].</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Size and Weight Test.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Continue Refinement.</td>
</tr>
<tr>
<td>9</td>
<td>22-Nov</td>
<td>Wed</td>
<td>5:00 pm</td>
<td>Devices Impounded for Thanksgiving Break.</td>
</tr>
<tr>
<td>10</td>
<td>27-Nov</td>
<td>Mon</td>
<td>8:00 am</td>
<td>Impounded Devices Returned.</td>
</tr>
<tr>
<td></td>
<td>28-Nov</td>
<td>Tue</td>
<td>10:00 am</td>
<td>Preliminary Contest: Beckman Auditorium. 45 Second Set-up Time Test.</td>
</tr>
<tr>
<td></td>
<td>30-Nov</td>
<td>Thur</td>
<td>10:00 am</td>
<td>Device Size and Weight Test: Beckman Auditorium. Devices Considered</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Complete. Device Construction to Cease.</td>
</tr>
<tr>
<td>11</td>
<td>5-Dec</td>
<td>Tue</td>
<td>5:00 pm</td>
<td>Contest Evaluations Due.</td>
</tr>
<tr>
<td></td>
<td>7-Dec</td>
<td>Thur</td>
<td></td>
<td>Device Grading. [40%]</td>
</tr>
</tbody>
</table>
5 Rules

1. Safety:

   (a) Any device which is judged to be a risk of injury to any participant or spectator will be disqualified.

   (b) Any device that causes a non-scorable item to leave the boundaries of the contest arena will be disqualified.

   (c) It is mandatory that safety glasses be worn at all times while competing and testing. This requirement will be relaxed during the final tournament. It is, of course, also mandatory that safety glasses be worn at all times while in the M.E. Shop.

2. Scorable Items:

   (a) The 4 wooden cubes and the 4 wooden cylinders are the only scorable items.

   (b) The score for each scorable item (SI) is determined by multiplying the value of the SI itself by the value of the scoring zone to which it is attached.

   - Each cube has a value of one (1).
   - Each cylinder has a value of two (2).

   See Rule 6a on Page 9 and Rules 2(c)i and 6i on Page 4. The two scoring zones on each side of the back wall have multiplicative values of one (1) (lower zone) and three (3) (upper zone), as shown in Figure 2 on Page 14.

   (c) In order for a SI to be counted in your team’s favor it must:

      i. be attached by means of magnetic force to your team’s side of the back wall within a scoring zone, and

      ii. not be touching any part of your team’s devices.

   (d) i. Each cubic SI is 50.8 mm [2.0 in] long on each edge, with a mass of 107 g [3.8 ounces].

      ii. Each cylindrical SI is 47.6 mm [1.9 in] in diameter and 50.8 mm (2.0 in) long, with a mass of 76 g [2.7 ounces].

   (e) i. The cubic SI’s have four (4) magnets that are each flush-mounted to the center of a face of the cube. A 3.0 cm (1.2 in) hole cuts through the cube between the two remaining faces.

      ii. The cylindrical SI’s have two magnets that are each flush-mounted to the center of the two ends of the cylinder. A 1.1 cm (0.45 in) hole cuts through the cylinder from one end to the other along the cylinder axis.

      iii. All magnets used in the SI’s are Alnico 8 ring magnets with a reported 3.89 N (0.875 lbs) of pull with an OD of 2.3 cm (0.9 in), an ID of 1.2 cm (0.48 in), and a thickness of 0.7 cm (0.27 in). The magnets are arranged so that opposite ends of the cylinders have opposite magnetic poles, and adjacent faces of the cubes have opposite poles. Magnetic faces of the SI’s are painted red and blue to indicate pole sense. Neutral SI surfaces, those without magnets, are painted yellow.
3. Energy Sources:

(a) The energy used by each contestant's device is limited to the following:

i. A change in the altitude of the center of gravity of the device.

ii. Electrical power supplied by a maximum of eight (8) AA size alkaline batteries. Several contest-sanctioned AA batteries are provided in the kit for device development and testing. Additional batteries may be purchased by team members; however, only contest-sanctioned batteries will be allowed for the competition. Eight (8) new AA batteries, drawn randomly from an available stock, will be supplied to each contestant at the beginning of the tournament. No battery replacement will be permitted during the tournament.

A. A joystick and a pair of switches (finger trigger and thumb switch on stick) are interfaced to a radio transmitter to provide 2 channels that are individually continuously controllable and 2 channels that are on/off controllable, respectively. Additionally, the polarity of the on/off channels is determined by the positions of two toggle switches on the joystick baseplate.

B. Reception and execution of transmitted control signals to each device is achieved via a receiver/control module that is 4.1 cm x 5.1 cm x 12.7 cm (1.6 in x 2.0 in x 5.0 in) and has a mass of 198 g (6.84 oz). This module contains a receiver and four (4) reversible motor controllers and has an allowable nominal input voltage range of 7.2 V to 12 V.

C. A battery pack, with eight (8) AA size alkaline batteries has a mass of 207 g (7.30 oz).

D. In order to limit maximum current to safe levels, the electrical impedance across the terminals of any channel of the power control module must be greater than or equal to 3 Ohms.

E. Only eight (8) AA-sized alkaline batteries at a time may be used in your device (for any purpose), and they cannot be permanently installed.

F. Batteries may not be modified in any way at any time (mechanically, chemically, thermally, electrically, etc.); they must be stored and operated at room temperature.

G. Used batteries must be recycled when depleted of electrical energy. A container for this purpose will be available in the M.E. Shop.

iii. Spring Energy stored by deforming any element or elements of the “bag of junk”, including the springs and rubber bands, up to 40.0 Joules (approximately the amount of spring energy stored by deforming twelve (12) of the rubber bands supplied in the “bag of junk”), with the following exception: Any projectile that is launched can only use the amount of spring energy stored by deforming at most two (2) of the rubber bands supplied in the “bag of junk”.

Note: Scorables items (described in Section 2 on Page 4) are not considered projectiles. Anything other than scorables that is caused to fly through the air, without a rigid link or 2-link linkage in contact with the arena, is considered to be a projectile. A chain of three (3) or more links is not a rigid link or 2-link linkage.
A flexible tether is not a rigid link or 2-link linkage. This rule means that any energy stored in springs that is used to launch one or more projectiles is limited to that which can be stored in two (2) of the rubber bands in the kit. It is permissible to use more spring energy to launch projectiles, so long as by the end of the contest all materials used to launch projectiles (other than the two rubber bands specifically described above) must return to the same stored potential spring energy state that they had at the beginning of the contest. For example: 8 rubber bands may have been stretched at the start of the contest. Immediately after the start of the contest, all 8 rubber bands are released to launch a projectile. Then, the device must re-stretch 6 of those rubber bands to their originally stretched state by the end of the contest. The same applies to deforming any contest kit materials. This restriction of two rubber band’s worth of spring energy only applies to projectile launching. Any element or elements in the kit can be used to store and release spring energy, (up to 40.0 Joules), as desired, for functions other than projectile launching. 

4. Contest Kit Materials:  

(a) Each contestant’s device(s) must be constructed entirely from materials supplied in the contest kit “bag of junk”. No other materials (either from the M.E. Shop, or elsewhere) can be used or substituted, with additions described immediately below. In addition to the contents of the “bag of junk” each contestant may also use:

i. A maximum of 113.4 grams [4.0 ounces] (dry cured mass) of RTV silicone casting compound. This casting compound is supplied in bulk. See the Staff in the M.E. Shop if you wish to cast one or more parts out of silicone. The intended purpose of this casting compound is for sealing, however, it may be used for molding tires or tracks or other components.

ii. A maximum of 3 meters [118.1 inches] of 2.38 mm [3/32 inch] diameter “Orange-Go” belt material may be used. See the Staff in the M.E. Shop to join the ends of a segment of this material into a continuous belt. The intended purpose of the “Orange-Go” is for power transmission as a belt, however, it may be used as a tire or track material, or for other (non-decorative) purposes.

iii. A maximum of 1 meter (39.4 inches) of 25.4 mm (1.0 in) wide self-adhesive Velcro hook and loop.

iv. A maximum of 2 meters (78.8 in) of 25.4 mm (1.0 in) wide by 1.6 mm (0.06 in) thick flexible magnetic stripping. This magnetic stripping is rated at 4.44 N (1.0 lb) pull per 6.5 cm² (1.0 in²).

v. A maximum of 6 meters (236.25 inches) of braided Dacron fishing line.

vi. A maximum of twenty (20) additional machine screws can be selected from a set of specially marked bins (in the M.E. Shop).

vii. A maximum of 1 meter (39.4 inches) of Belden 8 conductor cable. 

viii. A maximum of 4 meters (157.6 inches) of 30-gauge shellac coated wire.
ix. A maximum of 2 meters (78.8 inches) each of red, black and green insulated stranded wire.

(b) Each contestant’s final device(s) must be able to have been fabricated from parts contained in one (1) complete contest kit “bag of junk”.

(c) Exact replacement parts or modules for your contest device may use materials from more than one kit, but dissimilar parts or modules must all be built from one kit.

(d) Replacement supplies and materials are available on a limited basis. If you damage something, or cut it up and then want to do something different with it, see the M.E. Shop staff or one of the TAs. We will do our best to supply replacements, but we cannot guarantee unlimited supplies of all materials. We also cannot guarantee that replacements will be identical to the original. You may want to check availability of replacements prior to conducting a risky experiment with a rare part.

(e) The black plastic housings of the four (4) door lock actuators are not legal parts of the kit and cannot be used in a device. The parts inside the housings (motors, gears, etc.) are legal parts of the kit and can be used in a device.

(f) Glues and epoxies may be used only for bonding. Among the prohibited uses of glues is the creation of a composite material using a glue as the matrix.

(g) Contestants are responsible for providing their own glues and epoxies. Some glues and epoxies will be available in the M.E. Shop, but to ensure an un-interrupted supply, go to a (hardware) store, and buy your own.

(h) The contest materials may be mechanically modified in any way (disassembled, cut, machined, turned, ground, etc.).

(i) The contest materials may not be altered chemically (except locally by glues, for bonding).

(j) Soldering and brazing are permitted.

(k) Welding is not permitted, except spot-welding of the sheet steel.

(l) Use of Numerically Controlled (N.C.) machining is not permitted.

(m) The plastic bags included with the materials may be used as part of the device.

(n) No modifications to the DC electric motors are permitted. Specifically, re-winding of the motors is prohibited.

(o) It is illegal to “bridge” the motors across two control channels (by connecting one motor lead to one channel, and the other lead from the same motor to another channel). An engineering drawing of the power connector is shown in Figure 5, and a layout of the pins is shown in Figure 6 on page 17.

(p) Light machine oil, mineral oil, or vegetable oil (depending on the competitor’s preference) can be used SPARINGLY to lubricate. Do not contaminate the contest arena. Oil contamination of the surface of the arena will have a profound influence on the traction of your device, and others. For many traction materials, including tires made of silicone, once they are contaminated with oil it is nearly impossible to effectively clean them.

(q) Paint or Shellac may be used to insulate the strands of wire, if desired.
(r) The toothed-belt pulley on the shaft of the 24 volt motor may be removed. Use great care in removing this pulley to avoid damage to the motor. See the M.E. Shop staff to borrow a tool that has been built specifically to remove this pulley. Note that this toothed-belt pulley is not a gear, and should not be used as one. It will quickly destroy any plastic gear that it meshes with.

(s) The centrifugal clutch on the shaft of one type of the 12 volt motors may be removed. Use great care in removing this clutch to avoid damage to the motor. See the M.E. Shop staff to borrow a tool that has been built specifically to remove this clutch.

(t) A plastic battery holder is provided to contain up to eight AA size alkaline batteries.

5. Contest Device:

(a) Size:

i. Prior to the start of the tournament, each team must demonstrate that their combined devices can simultaneously fit into a 20 x 40 x 20 cm (inside dimensions) [7.87 x 7.87 x 15.75 inches] plexiglas box. The plexiglass box is available in the M.E. Shop to check this constraint.

ii. At the start of the each contest \((t=0)\), each team’s combined devices must be positioned within the painted 20 x 40 cm rectangle on the side of the arena to which it has been assigned. Each team’s devices must fit within a 20 x 40 x 20 cm volume at \(t=0\), when electrical power is applied, at the start of the contest. This requires that a team’s multi-part or multi-component device(s) must have all parts inside a 20 x 40 x 20 cm volume at the start.

iii. While all parts of a modular or multi-part device must be constructed from the parts contained in one (1) kit, only those parts that are used in any particular contest are required to meet the 20 x 40 x 20 cm volume constraint.

(b) Mass:

i. The upper limit of the combined mass of each team’s devices’ is 4.50 kg [9.921 lb, 9 lb 14.73 oz]. Devices will be weighed before the final tournament.

ii. While all parts of a modular or multi-part device must be able to have been constructed from parts contained in one (1) kit, only those parts that are used in any particular contest are required to meet the 4.50 kg [9.921 lb, 9 lb 14.73 oz] mass constraint.

(c) After each device’s initial competition (on November 30\(^{th}\)), no major design changes will be allowed.

(d) Exchange of modules of a multi-part device between rounds of the tournament is permitted. See rules 4b and 4c on Page 7.

(e) No manipulation of, or interaction with, a device will be allowed while it is competing, other than by modulating the control signals supplied to each device by use of the joystick and switches.

(f) Strategies aimed only at destruction of, or damage to, an opponent’s device are not in the spirit of the contest, and will not be allowed.
(g) Make an effort to design and build a good-looking device, after all, we want this to be a class act.

(h) Choose a 2-digit integer number for your team. (Number 00 is reserved for the placebo). Check with the instructor(s) to avoid duplicate numbers. Be sure to display your number prominently (numbers at least 50 mm (2 inches) tall) on the surface(s) of your team’s devices facing up (towards the overhead video cameras).

(i) Non-functional decorations are encouraged.

6. Spatial Rules:

(a) A SI must be attached to the vertical back wall completely within a scoring zone to have its value multiplied by the value of the zone. Each 25.4 mm (1 inch) wide boundary is considered part of the zone. Thus an attached SI that partially extends beyond the boundary would not be considered to be in the zone.

(b) All parts of each device must remain within the boundaries of the contest arena before, during, and after the contest.

(c) Any scorable item ejected from the arena will be considered out of play.

(d) The boundary of the contest arena is the open rectangular volume defined by the top of the carpeted surface of the base plane and the inside planes of the vertical walls.

(e) Each device must be designed to functionally interact with nothing other than: the top surface of the carpet, the inside vertical surfaces of the plexiglass side walls and rear wall, all surfaces of the ramps and their supporting structures, the horizontal “U”-channels on the top of the arena (all surfaces of these bars), the scorable items, other devices, and the air within and above the contest arena.

(f) Devices may not interact with the outside vertical boundaries of the contest arena or aluminum exo-skeleton in any way, at any time. This means (among other things) that a device may not “hook” over the edge of the rear wall, or the plexiglass sides, or the aluminum support structure in any way, at any time.

(g) At the start, before electrical power is applied, each team’s devices must rest entirely within the start volume.

(h) Interaction of your team’s devices with the opposing team’s devices (after the start of the contest) is encouraged, however, certain limitations do apply:

i. You may not intentionally (or knowingly) damage your opponent’s device(s). Accidental damage is bound to occur. Intentional damage is prohibited.

ii. You may not intentionally (or knowingly) eject your opponent’s device(s), or any portion thereof, from the contest arena in any way.

iii. You may not interact with, modify, or intentionally block the radio control signals from the opposing teams’ transmitters.

(i) The initial locations of the SI’s are shown in Figure 2 on Page 14. The initial orientation of the cubes will be with the axis of the central hole horizontal and pointed toward the audience. The cylinders will initially be oriented vertically. All SI’s will initially be oriented with a Red magnetic pole facing upwards.
7. Contest Arena:

(a) There will be no mechanical constraint supplied as part of the start area.

(b) Intentional damage to the contest arena will result in disqualification.

(c) Intentional damage to any RC receiver or speed control module will result in disqualification. It is your responsibility to avoid damage to the receiver/control module, both during testing, and during the contest. Competitors should make efforts in the design and fabrication of their device to avoid placement of the receiver/control module in a vulnerable position, such as the front bumper of the device. Module positioning that puts it at obvious risk for damage will not be permitted. If you have any doubt about the strategy you plan to adopt, see the instructor(s).

(d) The structure of the contest arena may not be violated (spearing the surface will draw a judge’s wrath, and disqualification.)

(e) The scorable items will be used and shared by all participants, and therefore are considered to be part of the contest arena, and therefore cannot be permanently altered or damaged in any way at any time.

(f) There is one contest arena. It will remain in the sub-basement of Spalding Lab (room 04 Spalding, near the M.E. Shop) for the duration of the term. We expect to be able to provide 24 hour access to the contest arena for testing purposes. The arena will be moved to Beckman Auditorium prior to the contest. Class participants will have access to the arena in Beckman Auditorium for testing purposes.

8. Time:

(a) During the tournament, after a contestant is called to start, a maximum set-up time of 45 seconds will be allowed. This rule will be very carefully enforced. Exceeding the 45 second set-up time will result in one scorable item being moved from the table to your opponent’s lower zone for each 15 seconds, or portion thereof, of overtime, up to a maximum of 60 seconds of overtime. The cubes on your side of the arena followed by the cylinders on your side of the arena will be moved to the wall. Exceeding 60 seconds of set-up overtime will result in a loss for that round for the offending team, and the placebo will be substituted for the offending team’s devices for that round. A test of each team’s set-up time will be conducted prior to the final tournament. Satisfactory completion of the time test is a pre-requisite to competing in the final tournament.

(b) No action of either team’s competing device(s) is permitted prior to the application of electrical power.

(c) Electrical power to the joysticks will be provided for 60 seconds for each contest.

(d) Any “settling” of any device must occur within 5 seconds after the electrical power is shut off. The winner of each round will be judged at the end of this 5 second settling period.

(e) A maximum pick-up time of 45 seconds will be allowed for removing all of your device(s) after a contest.
9. Tournament:

(a) Teams will compete in a modified round-robin tournament, where each team will compete against 5 randomly selected teams.

(b) The pairing of competitors will be chosen randomly.

(c) Ties are possible, however, for any round in the tournament not to count as a loss, your team must score at least one (1) point.

(d) The tournament score will be determined by awarding each team:

- one (1) point for each win,
- one-half (1/2) point for each tie, and
- zero (0) points for each loss.

(e) At the end of the tournament, the four (4) teams with the highest number of tournament points will compete in a single-elimination “playoff” tournament to determine the winning team.

(f) In the event of a tie in tournament points at the end of the modified round-robin tournament, the tie will be resolved based on the total number of points scored by each team.

(g) In the event of a tie among the top four (4) teams in both tournament points and total points scored, the tie will be resolved by a single-elimination “pre-playoff” round.

(h) The pairing of teams for the “playoff” tournament will be based on position after the modified round-robin tournament: #1 vs. #4, #2 vs. #3.

(i) In the event of a tie during the single-elimination playoff tournament, up to a maximum of two additional periods of 60 seconds of electrical power will be provided to resolve the tie.

(j) In the event that additional time fails to resolve a tie during the single-elimination playoff tournament, an audible poll of the audience will be used.

(k) Arena start side (Left or Right) will be distributed as equally as possible throughout the tournament for each team. You and your teammate are free to choose which of the joysticks (on your assigned side of the arena) each of you will use.

(l) During the tournament, if your opponent(s) do not show, your team will be expected to compete against a placebo.

(m) Your team may be (randomly) assigned to compete against the placebo.

(n) For any round against the placebo not to count as a loss, your team must score at least one (1) point.

10. Miscellaneous:

(a) Be sure to test your device(s) under the most realistic contest conditions possible.

If there are conditions that you know will be different during the contest, you may be tuning/debugging your device for non-contest conditions. (Remember that your device will perform differently as the batteries discharge, so it is important to test with both fresh and partially discharged batteries.)
(b) Remember, if you can’t win the contest, losing with style counts.
Figure 1: Oblique Views of the Contest Arena.
Figure 2: Top and Front Views of the Contest Arena. Dimensions in inches.
Figure 3: Side View of the Contest Arena. Dimensions in inches.
Figure 4: Joystick (with trigger and thumb switches) and Toggle Switches.
Figure 5: Power Connector: Berg “Latch-N-Lok” 8-Pin Receptacle 78064-101.

Figure 6: Power Connector Pin Layout. This corresponds to the rear view of the connector supplied to the students, with the latching slot up, shown in the lower-right view in Figure 5 above.