Team Foosketball

Design Contest

ME72 Engineering Design Laboratory

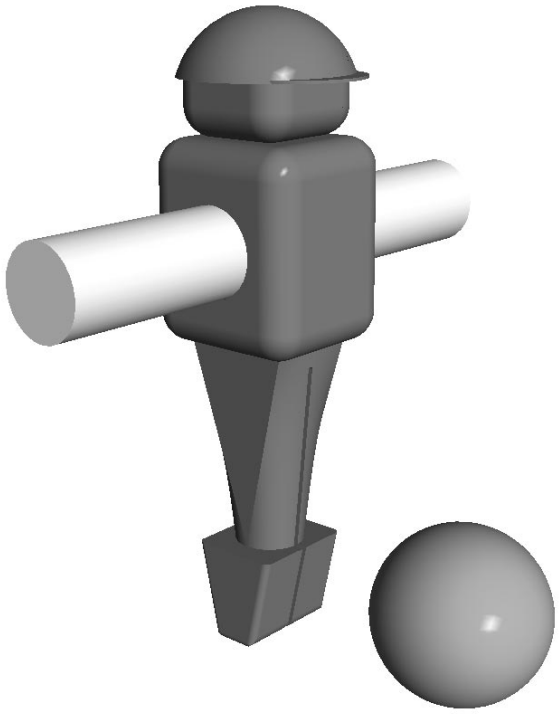
Fall Term, 1998

Rules and Details

Version 1.2, (5:25 am) November 30, 1998

Final Contest to be held: December 3rd, 1998

in: Beckman Auditorium



Team Foosketball

Design Contest

ME72 Engineering Design Laboratory

Fall Term, 1998

Rules and Details

Version 1.2, (5:25 am) November 30, 1998

Final Contest to be held: December 3rd, 1998

in: Beckman Auditorium

1 Object

The object is to design and build a device which, in collaboration with a teammate's device, wins a series of contests. In each contest, your device will strive to combine speed, strength, finesse, guile, strategy, *etc.*, to complement and assist your teammate's device in out-performing the opposing team's devices.

The basic contest is for your team's devices to deliver ping-pong balls into a goal at the opposite end of the "arena" from your team's starting position. The "contest arena" is a flat rectangular table 1.22 m (4 ft) wide and 2.44 m (8 ft) long. The table is surrounded by a clear plexiglass border extending 0.55 m (22 in) above the table top. A raised bar divides the table into two sides. The bar is 5.1 cm (2.0 in) in diameter and is mounted 5.72 cm (2.25 in) above the surface of the table. The bar is supported at the table edges. Three views of the arena are shown in Figures 1 through 3 on Pages 10 and 11. At each end of the table there is a plexiglass goal box with two scorable regions divided by a sloping plexiglass wall. The top of the sloping wall is 15.24 cm (6 in) above the surface of the table. The width of the opening is 101 cm (40 in). Each team's devices begin the contest on one (assigned) side of the arena, within a set of painted start-lines. At the start of the contest, 15 ping-pong balls will sit on top of the center bar. The ping-pong balls will be evenly spaced with 6.35 cm (2.5 in) between their centers. At the start, and during the contest, the balls will not be constrained on the table top in any way.

The score at the end of the contest is based on the number of ping-pong balls in each of the regions of the goals. Ping-pong balls in the front region of the goal are worth one (1) point. Ping-pong balls in the back region (over the sloping wall) of the goal are worth three (3) points. The team with the highest score at the end of 35 seconds wins.

Electrical power will be supplied to each contestant's device for 30 seconds. (Two channels of ± 24 volts DC power can be (continuously) modulated separately to each device by use of a two-axis joystick, there are also two additional independent channels of (switched) ± 12 volts DC.)

2 Evaluation

⇐ *NEW!*

An overall winner will be determined in a triple-elimination tournament. This is just like a single-elimination tournament, except a device must lose thrice (instead of once) to be eliminated from the competition. Pairing of devices to compete will be chosen randomly.

The winner of each contest will be determined at the end of 35 seconds (30 seconds of power followed by 5 seconds without power), by counting and scoring the ping pong balls in each goal. Ping pong balls in the portion of the goal nearest to the table top (in front of the sloping plexiglass wall) count as one (1) point. Ping pong balls in the portion of the goal farthest from the table top (behind the sloping plexiglass wall) count as three (3) points. The team that has the highest score wins. Ties are possible, but a team must transfer at least one ping pong ball into its opponent team's goal or the round will count as a loss for that team.

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 also 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. If you are concerned about the acceptable limits to collaboration, discuss the situation with the instructor.

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

4 Important Dates:

Week	Date	Day	Time	Milestone
1	**29-Sep**	**Tue**	**10:00 am**	Zeroth Assignment given.
	1-Oct	**Thur**	**10:00 am**	Written Contest Materials distributed. FR's and C's Assignment given.
	1-Oct	**Thur**	**2:00 pm**	Pick up "Bag of Junk".
2	**6-Oct**	**Tue**	**10:00 am**	
	8-Oct	**Thur**	**10:00 am**	3 Alternatives Assignment given. Mockup Assignment given.
	8-Oct	**Thur**	**2:00 pm**	Zeroth Assignment **Due**. FR's and C's **Due**.
3	**13-Oct**	**Tue**	**10:00 am**	
	15-Oct	**Thur**	**10:00 am**	**Design Review** (bring Notebook and Mockup).
	15-Oct	**Thur**	**2:00 pm**	**Design Review** (bring Notebook and Mockup). 3 Alternatives **Due** [5%]. Mockups **Due** [5%]. Begin building Prototypes of key elements. Begin Fabrication of Device.
4	**20-Oct**	**Tue**	**10:00 am**	Engineering Analysis Assignment given.
	22-Oct	**Thur**	**2:00 pm**	Prototype of 1 key (working) element **Due** [10%]. Continue Fabrication.
5	**27-Oct**	**Tue**	**10:00 am**	Engineering Analysis Assignment **Due** [5%]
	29-Oct	**Thur**	**2:00 pm**	Continue Fabrication. Begin Testing and De-Bugging.
6	**5-Nov**	**Thur**	**10:00 am**	**Design Review** (bring Notebook and Device).
	5-Nov	**Thur**	**2:00 pm**	**Design Review** (bring Notebook and Device). Continue Refinement, Testing and De-Bugging.
7	**12-Nov**	**Thur**	**2:00 pm**	First Complete Device Prototype **Due** [7%]. First version fabrication complete. Continue Refinement.
8	**19-Nov**	**Thur**	**2:00 pm**	Device Function **Test** [8%]. Size and Weight **Test**. Continue Refinement.
9	**25-Nov**	**Wed**	**5:00 pm**	Devices **Impounded** for Thanksgiving Break.
10	**30-Nov**	**Mon**	**8:00 am**	Impounded Devices Returned.
	1-Dec	**Tue**	**10:00 am**	**Preliminary Contest:** M.E. Shop. 45 Second Set-up Time **Test**.
	3-Dec	**Thur**	**10:00 am**	Device Size and Weight **Test** in Beckman Auditorium. Devices Considered Complete. Device Construction to Cease.
	3-Dec	**Thur**	**1:30 pm**	Contestants Assemble in Beckman Auditorium.
	3-Dec	**Thur**	**2:00 pm**	**Final Contest:** Beckman Auditorium.
11	**8-Dec**	**Tue**	**5:00 pm**	Contest Evaluations **Due**.
	10-Dec	**Thur**		Device Grading. [40%]

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 contest. It is, of course, also mandatory that safety glasses be worn at all times while in the M.E. Shop.

2. **Energy Sources:**

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

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

      ii. Electrical Power supplied by the umbilical cord:

         A. 2 channels of $\approx \pm 24$ VDC at $\approx$3.0 amps (max) for 30 seconds. These 2 channels are individually, continuously, controllable by use of a 2 axis joystick. This power can only be converted to useful work by the two (2) large (24 volt, HP) DC electric motor(s) supplied in the "bag of junk".

         B. 2 channels of $\approx \pm 12$ VDC at $\approx$3.0 amps (max) for 30 seconds. The voltage for these channels is controlled by a three position switch (center position: off; with return-to-center springs). This power normally will be converted to useful work by any of the (12 volt) DC electric motors supplied in the "bag of junk".

      Note: Only one (1) motor may be powered by each channel of electrical power.

      iii. Spring Energy stored by deforming any element or elements of your "bag of junk", including the springs and eight (8) Number 33 Plymouth (brand) pure rubber bands **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 Number 33 Plymouth (brand) pure rubber bands supplied in the "bag of junk". ⇐ *V1.2*
      Note: Ping-pong balls are not considered projectiles.
      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: You may have 8 rubber bands 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, your 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, as desired, for any other function other than projectile launching.

3. **Contest Kit Materials:**

   (a) Each contestant's device(s) must be constructed entirely from materials supplied in the "bag of junk". No other materials (either from the shop, or elsewhere) can be used or substituted, with two additions described immediately below:

      i. In addition to the "bag of junk" a maximum of 113.4 grams [4.0 ounces] (dry cured weight) of RTV silicone casting compound may be used. 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. In addition to the "bag of junk" 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. In addition to the contents of the "bag of junk", twenty (20) additional machine screws can be selected from a set of specially marked bins (in the M.E. Shop).

   (b) The black plastic housings of the ITT/GM door lock actuators are *not* legal parts of the kit and *cannot* be used in your device. The parts inside the housings (motors, gears, *etc*.) *are* legal parts of the kit and *can* be used in your device.

   (c) 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.
   Remember: Each contestant's final device(s) must be able to be fabricated from **one (1)** complete "bag of junk".

   (d) 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.

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

   (f) These materials may be modified in any way (disassembled, cut, machined, ground, *etc*.).

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

(h) Soldering and brazing are permitted.

(i) Welding is not permitted.

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

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

(l) Each DC electric motor must have at least one (1) power lead connected to ground. It is illegal to "bridge" the motors across both power supplies (by connecting one motor lead to one power supply, and the other lead from the same motor to the other power supply). A pin-out of the power umbilical will be distributed with the connectors.

(m) 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.

(n) Paint or Shellac may be used to insulate the strands of wire, if desired.

4. **Contest Device:**

(a) **Size:**

i. When each contest begins, each team's devices must simultaneously fit together into a 20 cm by 40 cm by 20 cm (inside dimensions) [7.874 inches by 7.874 inches by 15.748 inches] plexiglass box.
This rule requires your team's devices to actually fit inside a 20 by 20 by 40 cm box 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 by 20 by 40 cm volume at the start. Note that a 20 by 40 cm box will be painted on each side of the contest arena. At the start of the contest, your devices must be positioned within the box on the side of the table to which your team has been assigned.
A 20 cm by 40 cm by 20 cm (inside dimensions) plexiglass box is available in the M.E. Shop to test the size of your device.

ii. While all parts of a modular or multi-part device must be able to be constructed from no more than one (1) kit, only those parts that are competing in any particular competition are required to meet the 20 cm by 40 cm by 20 cm size constraint.

(b) **Mass:**

i. The upper limit of the devices' mass is 4.00 kg [8.818 lb, 8 lb 13.10 oz]. This refers to the combined mass of your team's devices. Devices will be weighed before the contest.

ii. While all parts of a modular or multi-part device must be able to be constructed from no more than one (1) kit, only those parts that are competing in any particular competition are required to meet the 4.00 kg [8.818 lb, 8 lb 13.10 oz] mass constraint.

(c) After each device's initial competition (on December 3rd), no major design changes will be allowed.

(d) No manipulation of, or interaction with, a device will be allowed while it is competing, other than by modulating the electrical power supplied to your device by use of your joystick and switches.

(e) 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.

(f) Make an effort to make your device look good, after all, we want this to be a class act.

(g) 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 on your devices.

(h) *Non-functional* decorations are encouraged.

5. **Spatial Rules:**

(a) Ping pong balls are the only scorable items. In order to count as a 1-point goal, a ping pong ball must have completely passed the vertical plane defined by the edge of the table. In order to count as a 3-point goal, a ping pong ball must have completely passed the vertical plane defined by the top edge of the sloping wall in the goal box.

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

(c) Any ping-pong ball ejected from the arena will be considered to be out of play.

(d) The **boundary** of the contest arena is: the planes extending vertically from the long edges of the rectangular table; the planes extending vertically from the inside faces of the goal box, and the *top* surface of the table. This leaves the air above the contest table free range!

(e) Each device must be designed to functionally interact with nothing other than: the table top the inside vertical surfaces of the plexiglass sides of the table; the central bar; ping-pong balls; a competing device; and the air.

(f) Devices may not interact with the outside vertical edges of the contest arena in any way, at any time. This means (among other things) that your device may not "hook" over the edge of the table or the plexiglass sides of the goal, in any way, at any time.

(g)

(h) Devices **may not** interact with either power umbilical in any way, at any time.

(i) Devices **may not** interact with the power umbilical support in any way, at any time.

(j) At the start, before electrical power is applied, each team's devices must rest entirely within the start box.

(k) 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.

6. **Contest Arena:**

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

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

(c) Intentional damage to the power umbilical will result in disqualification. It is your responsibility to avoid damage to the power umbilical, both during testing, and during the contest. If you have any doubt about the strategy you plan to adopt: See the instructor(s).

(d) Strategies aimed specifically at interference with, destruction of, or damage to, a power umbilical cord or connector (either your own, or an opponent's) are not in the spirit of the contest, and will not be allowed.

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

(f) The ping-pong balls will 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.

(g) A ping-pong ball is 37.9 mm [1.49 inches] in diameter, and has a mass of 2.3 grams [0.81 ounces].

(h) There are two practice tables. Both will remain in the sub-basement of Spalding Lab (in room 04 Spalding, near the Mechanical Engineering Shop) for the duration of the term. We expect to be able to provide 24 hour access to the contest tables for testing purposes. One will be moved to Beckman Auditorium two days before the contest (by **10:00 am** on **Tue 1-Dec**); the other will be moved to Beckman Auditorium on the day before contest day.

(i) If there is sufficient sentiment to do so, and a suitable room can be found, one table may be moved to the SAC for 24 hour testing during the last few weeks of the term.

7. **Time:**

(a) During the competition, 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 allowed will result in one ball begin moved from the bar to your team's goal for each 15 seconds, or portion thereof, over 45 seconds your team uses to set up. To help in this regard, a set up time test will be conducted prior to the contest. Satisfactory completion of the time test is a *pre-requisite* to competing in the final contest. ⇐ *V1.2* ⇐ *V1.2*

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

(c) Electrical power will be provided for 30 seconds.

(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.

8. **Miscellaneous:**

(a) Teams will be chosen at random (during the contest) to compete against each other in each round.

(b) Table assignment (East or West) and start side (Left or Right) for each team will be made randomly during the contest. You and your teammate are free to choose which of the joysticks (on your assigned side of the table) you will each use.

(c) During the competition, if your team gets a *bye*, or your opponent(s) do not show, your team will be expected to compete against a placebo. To advance in the competition, your team must legally deposit at least one (1) ping-pong ball in to the opposite goal during the competition against the placebo.

(d) Be sure to test your device(s) under the most realistic contest conditions possible. Note that there are some unavoidable variations between the two contest arenas, both of which will be used during the final contest. If there are conditions that you know will be different during the contest, you may be tuning/debugging your device for non-contest conditions.

(e) Remember, if you can't win the contest, losing with style counts.

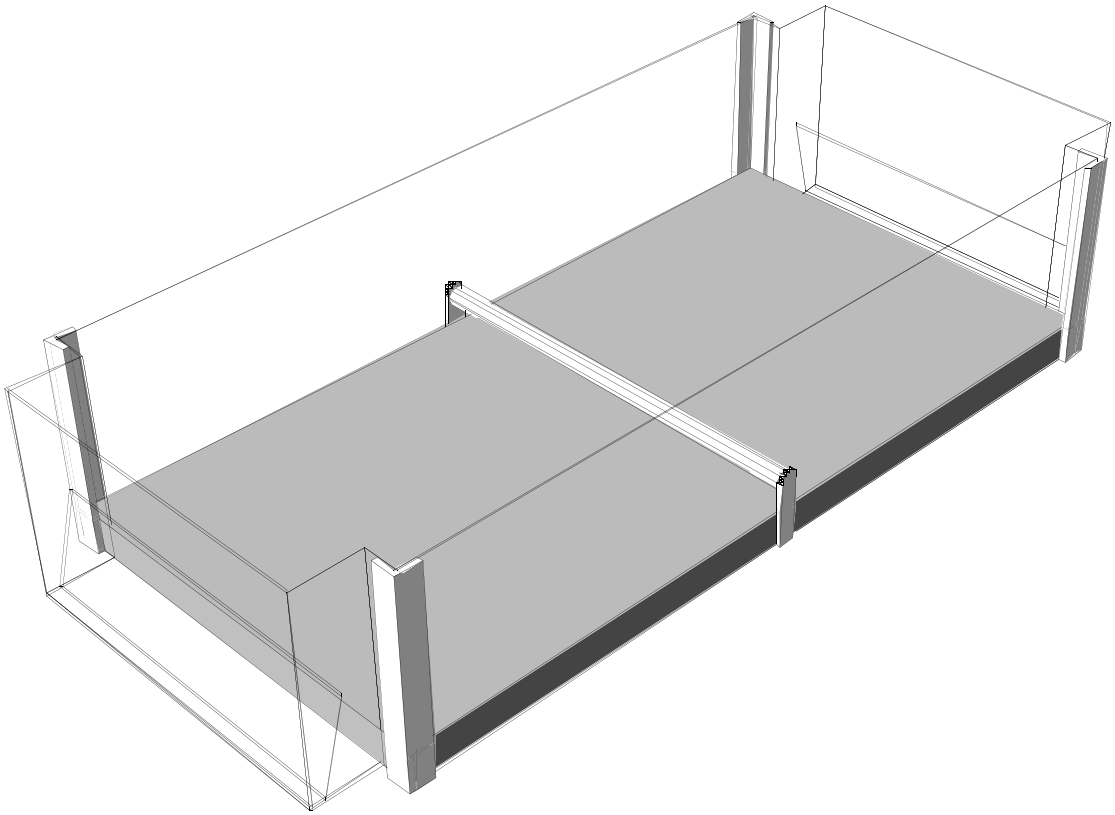


Figure 1: Isometric View of the Contest Arena.

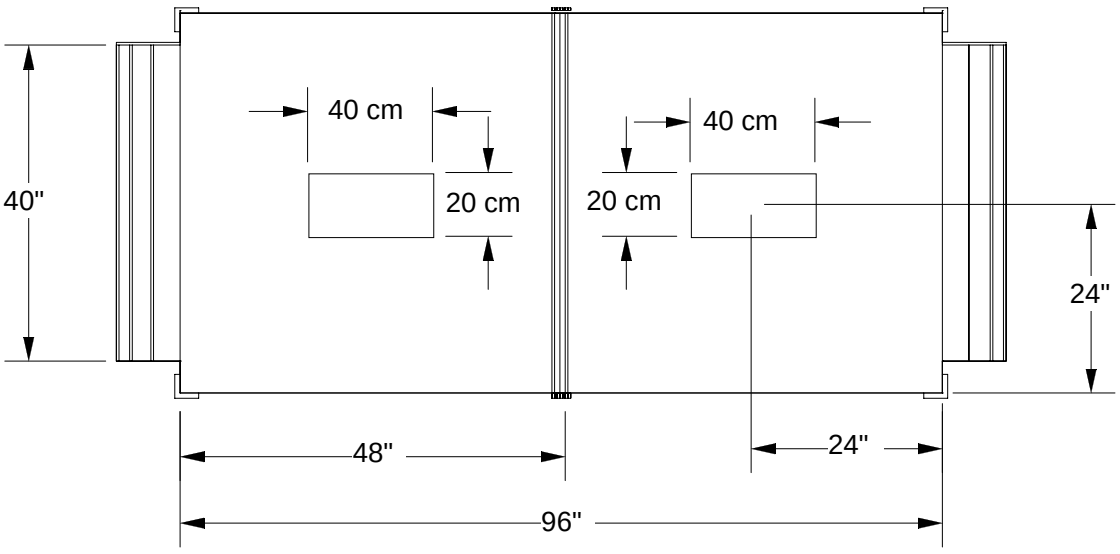


Figure 2: Top View of the Contest Arena.

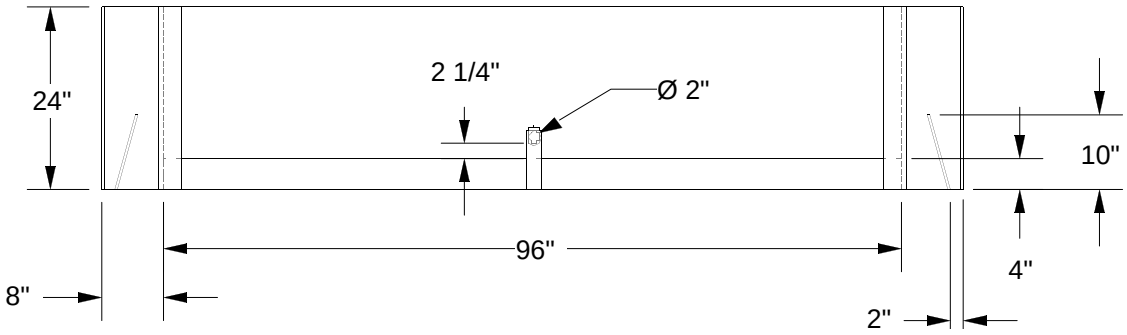
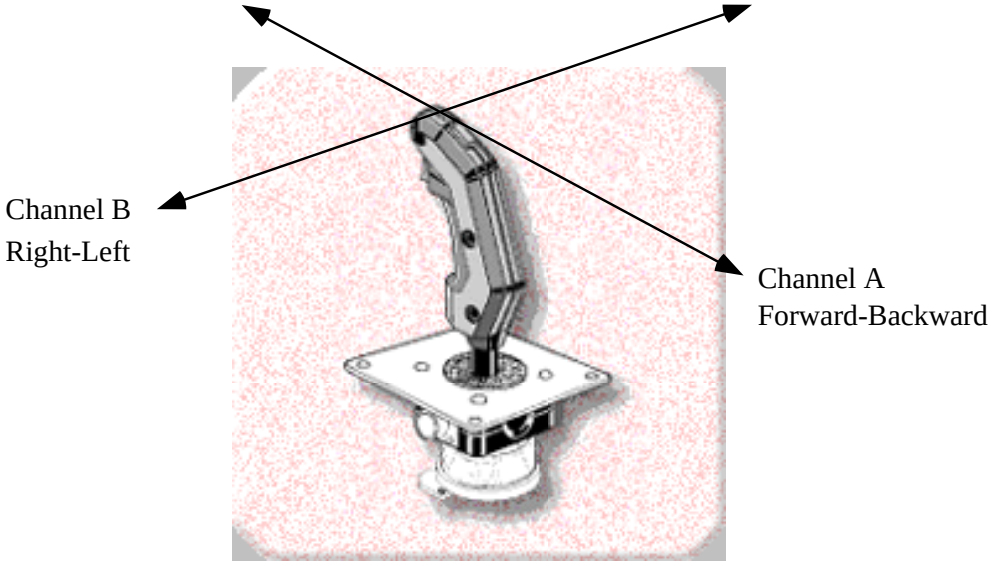
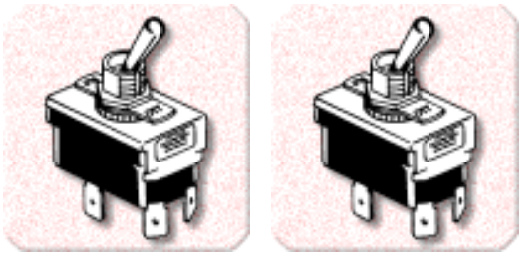


Figure 3: Side View of the Contest Arena.





Channel C
Left Toggle

Channel D
Right Toggle

±24V Chan A	Chan A Return	±24V Chan B	Chan B Return
±12 V Chan C	Chan C Return	±12 V Chan D	Chan D Return

Figure 4: Power Connector Pin Layout (front view of power umbilical with connector tab up). This corresponds to the back view of the panel-mount connector supplied to the students.