

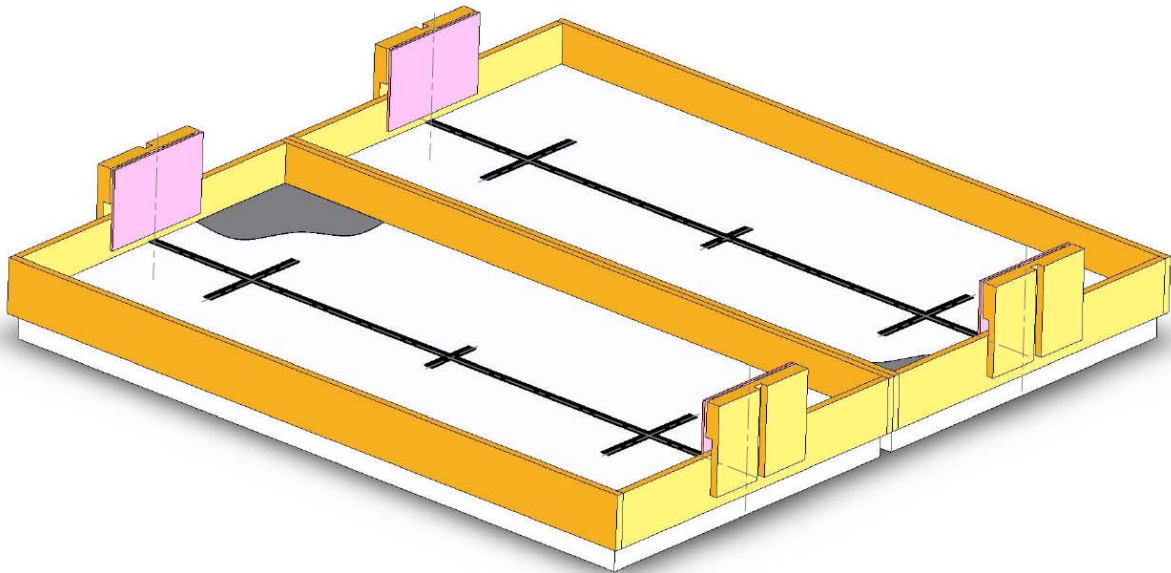
Dodgeball

ME210 Project Specifications

Winter, 2009

Purpose:

The purpose of this project is to provide an opportunity to apply all that you have learned so far in ME210 to solve an open-ended mechatronics design problem. The task is to design an autonomous machine that will compete against an opponent in a game of that most venerable and respected of contests: Dodgeball!



Motivation:

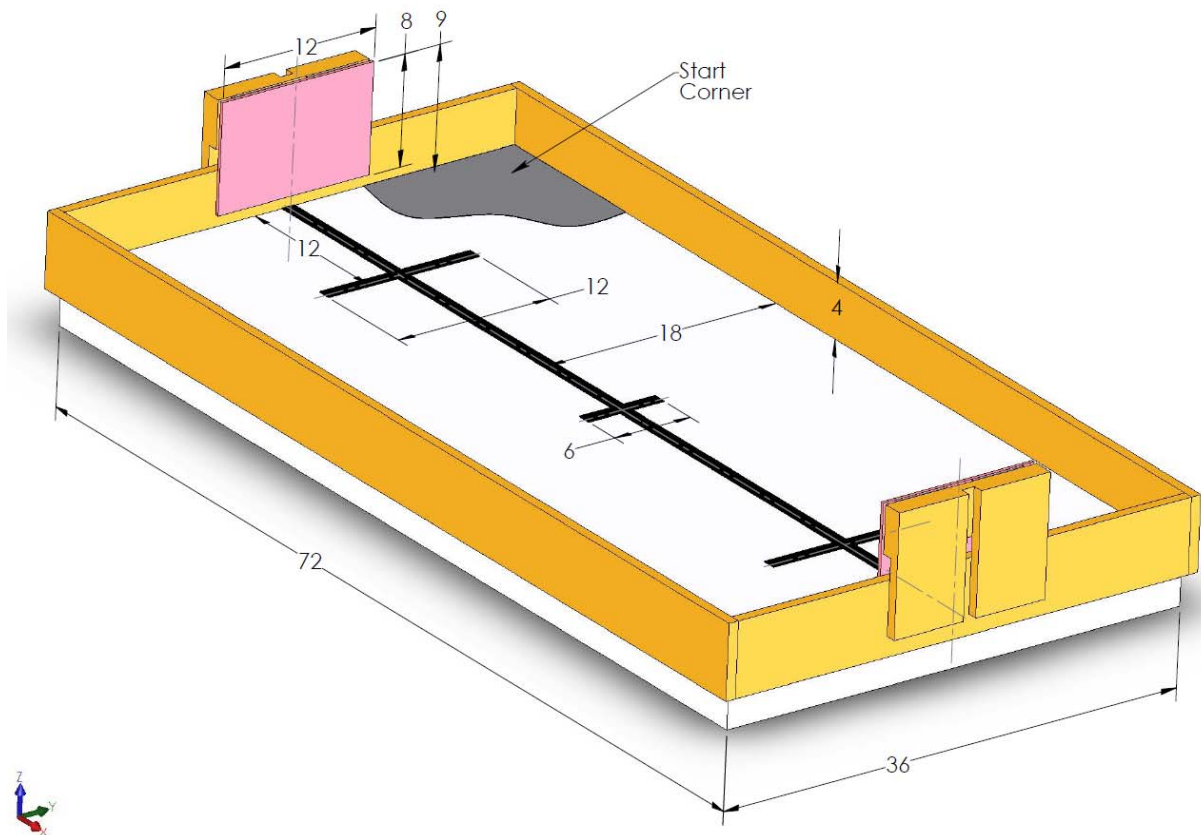
Since the dawn of time, man has hurled hurlable objects in order to more easily bring down prey, scale the food chain and expand his (or her) territory. With any available leisure time, he honed these skills practicing the delicate art of throwing things in contests of sport. Discus, shot put, javelin, hammer, the caber toss – the list is long indeed. Over millennia, highly structured, complex and ritualistic social expressions of tossing have evolved as well, and surely the pinnacle of achievement resulting from this integral of the collective effort of all of mankind is Dodgeball.

And so it can come as no surprise that, as mankind moves further into the age of robotics, we take our first tentative steps exploring new games involving *autonomous robots* beaming each other with projectiles while striving to avoid being beamed. Though it seems as frivolous as the innocent games of Dodgeball enjoyed in PE classes across the continent, in fact this game serves no less a purpose than inspiring this new generation of mechatronic designers to push the envelope of their knowledge and the state of the art to design machines and strategies that compete to see which will dominate. In the end, everyone wins because the experience is inherently valuable. But, of course, there can be only one *champion* – and we mean to find out who that will be!

The ME210 version of mechatronic Dodgeball pits two robots (“Bots”) against each other in head-to-head competition. Competitors strive to traverse a Dodgeball Arena as many times as possible, hit their opponent with as many hurled Nerf Ballistic foam balls as possible and avoid being hit themselves to achieve the highest point score in a 2-minute game. The winner of each head-to-head competition advances to the next round of the Dodgeball Tournament until a single Champion is crowned.

Project Specifications:

Each Bot must be a stand-alone entity, capable of meeting all specifications. Power must be supplied by batteries, which are to be carried on board each Bot. Each team will be supplied with 2 7.2V NiCad rechargeable battery packs. Each Bot must operate completely un-tethered during grading and competition. The Bot's control software must execute from the flash memory of the C32. Workstations will not be available in the room where the competition takes place (though the ME210 lab is just around the corner).



Dimensioned Perspective View of One Side of the Dodgeball Arena

The object of the game is simply to score more points than the opponent. There are two ways to score points: one point is awarded each time a Bot crosses the width of the playing surface and tags a bumper on the side wall, and one point is awarded each time a Bot beans its opponent with a ball. Each round of Dodgeball lasts 2 minutes. A single-elimination Dodgeball Tournament will be held in Terman 556 on the evening of Monday, March 9 to determine which Bot will be crowned the ME210 Dodgeball Champion. The public is invited to attend the event.

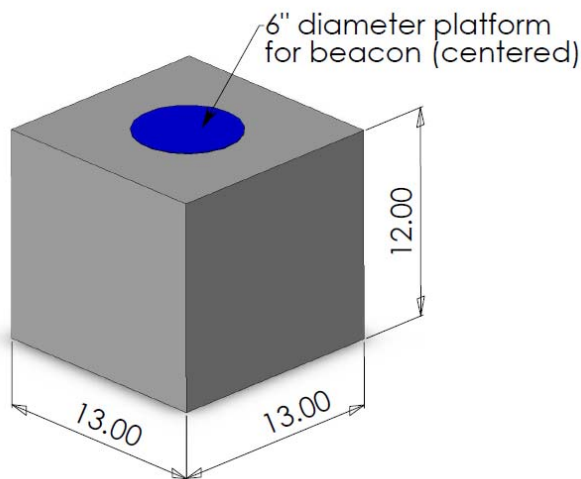
The ME210 Dodgeball Arena will be constructed from particle board, the playing surface of which will be uniformly covered with white melamine. The court will be divided at the half-court line, and each half will have dimensions of 6' x 3' (L x W). The dimensions of the entire court will be 6' long by 6' wide. Around the perimeter of each side of the Arena (including the half-court line), a protective border will be installed. This will serve to clearly demarcate the in-bounds area, and to ensure that Bots are not able to navigate off the edges of the court to their doom. The borders will be constructed of $\frac{3}{4}$ "-wide boards and be 4" tall relative to the playing surface. The two sides of the Dodgeball Arena are identical, and placed side-by-side for competitions. At the start of a game, one Bot will be placed on each side of the Arena. At no time during play may a Bot cross the half-court line.

Down the center of each side of the Arena, there will be a length of 1" wide non-reflective black tape. This will be parallel to the long (6') sides of the border walls. Perpendicular to this length of tape, there will be 12" lengths of tape 1' from the wall on either end. These pieces of tape will be centered with respect to the short (3') sides of the field. An additional 6" length of tape, parallel to these pieces of tape, will mark the center of the Arena.

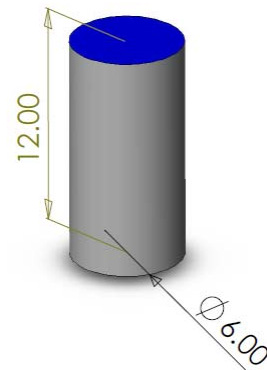
The walls at either end of the long side of the arena will incorporate 12" x 8" x 0.25" (W x H x T) "Bumpers". The top of the Bumper will be 9" above the playing surface. Bumpers will be centered along the short wall. The Bumpers are sections of the border wall with which Bots may make contact in order to score a point. Bumpers will be hinged at the top, and when a Bot makes positive contact with a Bumper it will depress a switch and register a "tag". There will be a visual indication to the audience when a Bumper is successfully tagged by a Bot. A single Bumper may not be tagged twice in a row without crossing the entire length of the field and returning. There is no limit to the number of points that may be scored tagging Bumpers, but the Bot must always alternate sides.

Before each game of Dodgeball, each Bot will be loaded with up to 10 Nerf Ballistic foam balls. One point will be awarded each time a Bot hits its opponent with a Nerf ball.

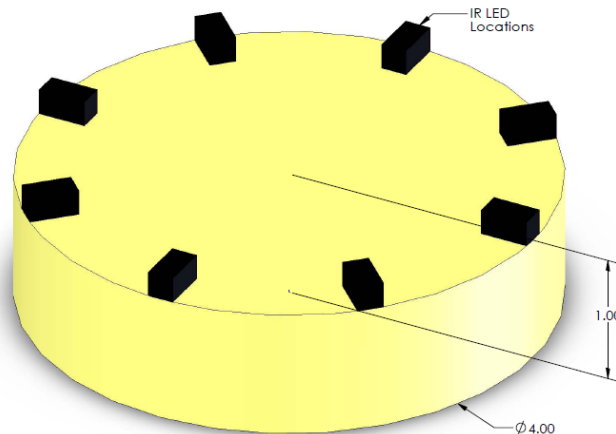
At the start of each game, Bots will be placed in a random orientation as close as possible to the corner of the Start Zones defined by the half-court Border and the outside wall. A start command will be issued, at which time teams will initiate the activities of their Bots. This is the last human interaction allowed with the Bots. The game will last 2 minutes. Bots must cease all motion 2 minutes after the start command is issued.



Robot Maximum Dimensions



Robot Minimum Dimensions



Infrared Beacon Dimensions

Each Bot is required to occupy a volume not to exceed 13" x 13" in horizontal dimensions and 12" in height when initiated. From any orientation, each Bot must present a target with a projected width of at least 6". At the top of each Bot there must be a flat and level platform, no smaller than a 6" diameter circle, to which a beacon will be affixed using adhesive-backed Velcro strips. The purpose of the beacons is to enable opponents to locate and target a Bot with Nerf balls. The beacons will be circular in shape, with a diameter of approximately 4". They will be spaced above the platform at the top of each Bot by approximately 1". Beacons, spacers and Velcro will be provided by the ME210 teaching staff. A uniform mounting location is required on each Bot. Beacons will incorporate an array of bright infrared LEDs that will be modulated at a frequency of 1500 Hz with a 50% duty cycle, and be detectable from any orientation. No element of a Bot may interfere with the light emitted by a beacon. Each Bot will make provisions to supply power to the beacons with a standardized power connector. The beacons will require approximately 1 A at a minimum of 5 V.

For the purposes of grading, the minimum requirement for each Bot is to "Beat the Brick" (the standard inanimate ME210 check-off opponent). Specifically, each Bot must be able to score at least 5 points within 2 minutes, when facing off against – literally – a brick. Once your machine has been activated, the operator may not touch it again until the entire game is complete. During operation, the machine is required to stay within the boundaries of the Dodgeball Arena. The results of the Dodgeball Tournament at the public presentation will not affect grading – this is purely an opportunity for you to enjoy the devices you've created.

A report describing the technical details of the machine is required. The report should be of sufficient detail that a person skilled at the level of ME210 could understand, reproduce and modify the design.

Other Guidelines & Disclaimers:

The machines must be safe to the user, the lab and the spectators.

For this project, excessively high-velocity ball discharge will be discouraged. No projectile other than the supplied Nerf balls is allowed to be released during games. The teaching staff reserves the right to require you to reduce the speed that your launcher delivers Nerf balls for the safety of the other Bots.

Pyrotechnics are similarly discouraged, as are violations of either the 1st or 2nd Laws of Thermodynamics.

All projects must respect the spirit of the rules, as established in this specification. If your team is considering something that may violate them, you must consult with a member of the teaching staff. Interpretations and rulings are the sole domain of the teaching staff.

Evaluation:

Performance testing procedures:

All machines will be operated by one of the team members. There will be one round for grading purposes, and one round for entertainment purposes.

Level 1: Grading evaluation. Each machine will be graded based on its performance during the check-off period, the last day of which is Friday, 3/6. The public presentation will be on the evening of the following Monday, 3/9. During the grading session, each machine will have up to 2 minutes to meet the minimum project requirements. Grading is not based on the score achieved during the evaluation, only on the ability to meet the requirements.

Level 2: Public evaluation/performance. After a warm-up period, teams and machines will be entered into a head-to-head, single-elimination tournament. Each machine will receive points based on the scoring scheme outlined above, and the winner of each game will advance to the next round. The brackets for the single-elimination tournament will be seeded based on the order that teams successfully meet the grading criteria during the grading session.

Grading Criteria:

1. **Concept (25%)** This will be based on the technical merit of the design and programming for the machine. Included in this grade will be evaluation of the appropriateness of the solution, as well as innovative hardware and software and use of physical principles in the solution.
2. **Implementation (25%)** This will be based on the Bot displayed at the evaluation session. Included in this grade will be evaluation of the physical appearance of the machine and the quality of construction. We will not presume to judge aesthetics, but will concentrate on craftsmanship and finished appearance.
3. **Performance (25%)** Based on the results of the performance during the evaluation session.
4. **Coach Evaluations (10%)** Based on the four project milestone reviews.
5. **Report (15%)** This will be based on an evaluation of the final report. It will be judged on clarity of explanations, completeness and appropriateness of the documentation. This report should be prepared in HTML format, and submitted to a folder on the server ready for publication on the web. For reference and a few examples, you can see reports from previous ME210 projects at the course website: <http://design.stanford.edu/Courses/me118/me118.html>.

Note: This is a *mechatronics* project design activity. While we have emphasized electronics and software aspects of this subject in class this quarter, it is important to realize that any Mechatronic project also requires substantial mechanical design. Grading in this class is based on complete system design and function. Therefore, a “beautiful” electronics system is not a successful project if the mechanical part of the machine fails. Be sure to allocate resources (energy, time and people) to the mechanical aspects of this project.

Project Milestones:**Event**

First Review

2/17/09

Presented in class using PowerPoint (5 minutes)

Second Review

2/20/09

Turn in documentation (Terman 538)

Third Review

2/24/09

Presented to coach

Check-off by teaching staff

Fourth Review

3/3/09

Check-off by teaching staff

Grading Session

On or before 5:00 pm, 3/6/09

Final Presentations

3/9/09

Terman 556, 7:00 pm

Deliverables

At least 5 design concepts, with sketches

Time schedules

Personnel assignments

Calculations

System Block Diagram

Preliminary Test Results

Demonstration of all functional subsystems per block diagram
beacon sensing, tape sensing, mobile platform, etc.

Integration of subsystems

Working software to test all systems

Working versions of all systems

Demonstrate minimum functionality on
the Arena set up in the lab

Finished, operational, presentable machines