

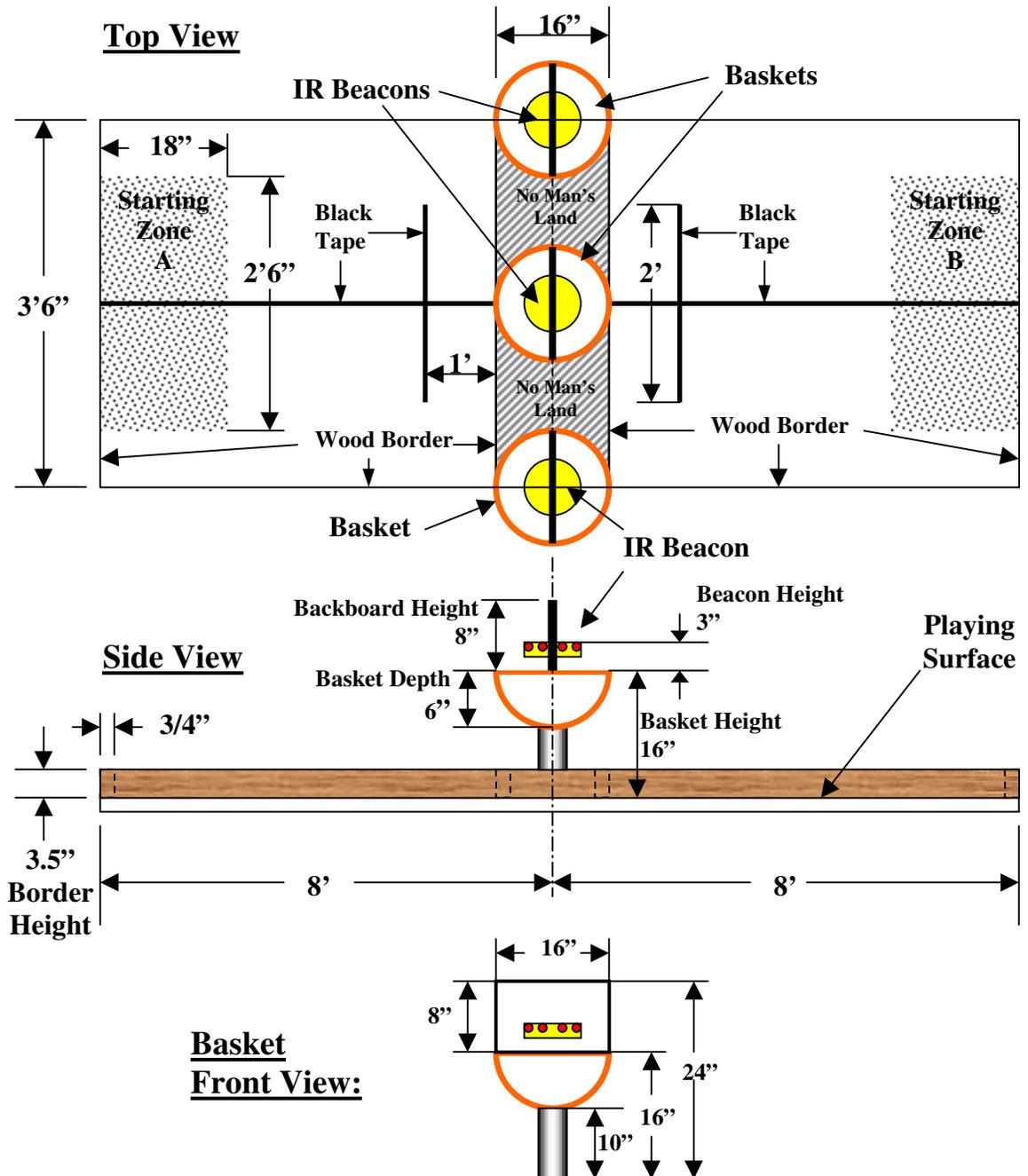
# Basket-Bots

ME210 Project Specifications

Winter, 2003

## Purpose:

The purpose of this project is to provide an opportunity to apply all that you have learned 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 head-to-head, one-on-one mechatronic basketball.



## **Background Information:**

The world has always been fanatical about sports, but only recently has begun to appreciate *robots* playing sports. But, in a sad indication of one aspect of human nature, this interest has largely taken the form of droids pounding, sawing, pulverizing, flambéing, grinding, pureeing or otherwise reducing one another to dust, as in the shows Robot Wars or Battle-Bots.

There are, however, glimmers of hope for us all, such as the RoboCup program ([www.robocup.org](http://www.robocup.org)), in which teams of autonomous robots play soccer. The stated mission of this program is to create a team of robots that can defeat a human World Cup team by the year 2050! Now, admittedly there are elements of violence in soccer (most notably the spectators), but it's not quite the same as the violence in RobotWars, for example...

ME210 hopes to further this anti-violence trend and advance the state-of-the-art in robot sports by introducing a new version of basketball, called "Basket-Bots." Basket-Bots promises to be a fast-paced, head-to-head game of robot one-on-one, in which Bots compete to score baskets and points in quick 2-minute games on a specialized field. And by the time NCAA March Madness is starting to build, the ME210 Basket-Bot Tournament will have already reached a fevered pitch and created the first Basket-Bot Champion.

## **Project Specifications:**

Each Bot must be a stand-alone entity, capable of meeting all specifications while connected only to power and ground of a standard ME210 Lab power supply. For setup purposes, computers will be available in Terman 556 to download your operational code. The computers will be connected to the network in a fashion identical to those in the lab. Once the download of code to your Bot is complete, the computer will be disconnected.

The ME210 Basket-Bot Court will consist of 2 pieces of particle board (3'6" x 8'), uniformly covered with green felt. The 2 boards will be arranged end-to-end, so that they form a larger playing field 3'6" x 16'. At the centerline of the court, there will be three round baskets (one in the center, and one at both ends of the centerline), each with rims that have openings that are 16" in diameter, at a height of 16" from the court's playing surface. Above each basket, a rectangular backboard will be mounted that measures 16" wide by 8" high, that divides the basket into two halves down the centerline of the court. A 4/4" diameter, circular infrared beacon will be placed at the center of each basket at a height of 3" above the rim (19" above the playing surface). The beacons will protrude out from the flat surface of the backboards approximately 2". Around the perimeter of each side of the Basket-Bot Court, a protective border will be installed. This will serve to clearly demarcate the in-bounds areas, and to ensure that Bots are not able to navigate off the edges of the court. Each side of the court is completely separated from the other side by these borders, which will be constructed of boards measuring 3/4" wide by 3/2" high. They will extend from the back of both halves of the court (behind the Starting Zones), down the sides, and along the front edges of the baskets. Separating the two sides of the court will be a 16"-wide "No Man's Land," in which the bases of the baskets are attached. At no time during play may a Bot enter this area. A single piece of non-reflective black tape will be placed down the central axis of both sides of the court. At right angles to these strips of tape, 2' lengths of tape will be placed at a distance of 1' from the rim of the center basket, again on both sides of the court.

Each basket will be equipped with two semi-circular lids that may be brought down to cover the opening of the basket. When beacons are active, they will modulate infrared light at a frequency of 1560 Hz, with a duty cycle of 50%. When active, the beacons will be visible from all points on both sides of the court.

At the beginning of a game, each Bot will be loaded with Nerf balls. There is no limit to the number of balls a Bot may carry, provided the Bot meets all size requirements. One competitor's Bot will be placed somewhere inside the boundaries of Start Zone A (with dimensions 18" x 30") at a random orientation, and the other's Bot will be placed somewhere inside the boundaries of Start Zone B (also 18" x 30"). Bots will be placed so that they are entirely inside the boundaries of the start zones. Teams will not be told in advance which start zone they will be assigned. A start command will be issued, at which time teams may initiate the activities of their Bots. This is the last human interaction allowed with the Bots. Each game will last 2 minutes.

In a randomly-selected order and one at a time, a basket will become “Active,” and will remain Active for a period of exactly 20 seconds, after which time it will become “Inactive.” When a basket is Active, the lids that cover the opening of the baskets will be lifted to allow shots to enter and score points, and the infrared beacons will modulate. When a basket becomes Inactive, the lids are closed, the infrared beacons stop modulating, and another basket is randomly selected to become Active.

Bots score points by successfully getting Nerf balls into a basket that is Active. The first ball that enters a basket after it becomes Active will be worth 4 points, and each subsequent ball that enters the basket will be worth 1 point, up until the last ball that enters the basket before it becomes Inactive, which will be worth 4 points. To constitute a valid shot, a Nerf ball must be completely released by a Bot. Teams must not modify Nerf balls in any way, aside from the normal deformations that result in handling and shooting. A Bot’s score is the sum of the points of all of their Nerf balls during a game. Opponents’ Nerf balls will be differentiable during the presentations to allow for accurate scoring. A small opening along the edge of each basket’s lid allows for the insertion of a marker that indicates the end of each Active period for the basket for scoring purposes. Games will last 2 minutes, and will consist of 6 Active periods of 20 seconds each.

Each Bot is required to occupy a volume not to exceed 13” x 13” in horizontal dimensions and 12” in height when initiated. Your machine must contain its complete supply of Nerf balls to be used during the 2 minute game (no reloading). Bots may navigate anywhere on their half of the Basket-Bot Court (as determined by which Starting Zone they occupy at the beginning of a game). Bots may not navigate into No Man’s Land, but they may extend or reach into No Man’s Land, provided that they never break the plane of the court centerline, as delineated by the backboards. Bots may touch the baskets during play, however any Bot that touches a basket with enough force to visibly move or damage a basket will be disqualified.

For the purposes of grading, the minimum requirement for each Bot is that it be able to shoot at least 1 ball into each basket in the absence of an opponent. The results of the Tournament do not affect grading, but will serve as the basis of a competition at the public presentation. Once your machine has been activated, the operator may not touch it until the entire game is complete. During operation, the machine is required to stay within the boundaries of the Basket-Bot Court.

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

## **Safety:**

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 are allowed to be released during games.

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

## **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 on Sunday, 3/9, the day before the Public Presentation on the evening of 3/10. 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 deliver at least 1 valid shot into each of the three baskets when they are Active.

**Level 2: Public Evaluation/Performance.** After a few trial runs, teams and machines will be entered into a head-to-head, single-elimination Tournament. At the end of each game, each team will receive points as outlined above for all successful shots into the baskets.

### Grading Criteria:

1. **Concept (20%)** 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 (20%)** 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 true aesthetics, but will concentrate on craftsmanship and finished appearance.
3. **Report (10%)** This will be based on an evaluation of the written 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 on the ME210 server in the \_Reports folder for publication on the web. For a look at reports from previous ME210 (and ME118/318) projects, visit the course website at <http://me118.stanford.edu/>.
4. **Performance (20%)** Based on the results of the performance during the evaluation session.
5. **Coach Evaluations (30%)** Based on the three project milestone reviews.

**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 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 (time and people) to the mechanical aspects of this project.

### Project Milestones:

#### Event

First Review  
2/18/02  
Presented in Class (using overhead projector)

Second Review  
2/25/02  
Presented to Coach

Third Review  
3/6/02  
Presented to Coach

Grading Session  
3/9/02, 7:00-10:00pm

Final Presentations  
3/10/02  
Terman 556, 7:00 pm

#### Deliverables

At least 5 concepts, with sketches  
Time schedules  
Personnel assignments

Calculations  
System Block Diagram  
Prelim. Test Results

Working versions of all systems  
Working software to test all systems  
Integration of systems

Demonstrate minimum functionality on  
playing field in the lab

Finished, operational machines