

**Goals:**

The goal of this project is to provide you with an opportunity to apply your knowledge to solve an open-ended problem. The task is to design and build a machine that can play an interesting game against an opponent machine.

**Purpose:**

The underlying purpose of this project is to give you some experience in integrating all that you have learned. The avenue through which you will gain this experience is the design and implementation of an autonomous mobile robot that can compete in a game of skill and strategy against a machine constructed by another team from the class.

**The Game:**

The object of the game is to make baskets through the Hoops using Nerf balls, in a game patterned after Basketball.

**Specifications**

**The Field:**

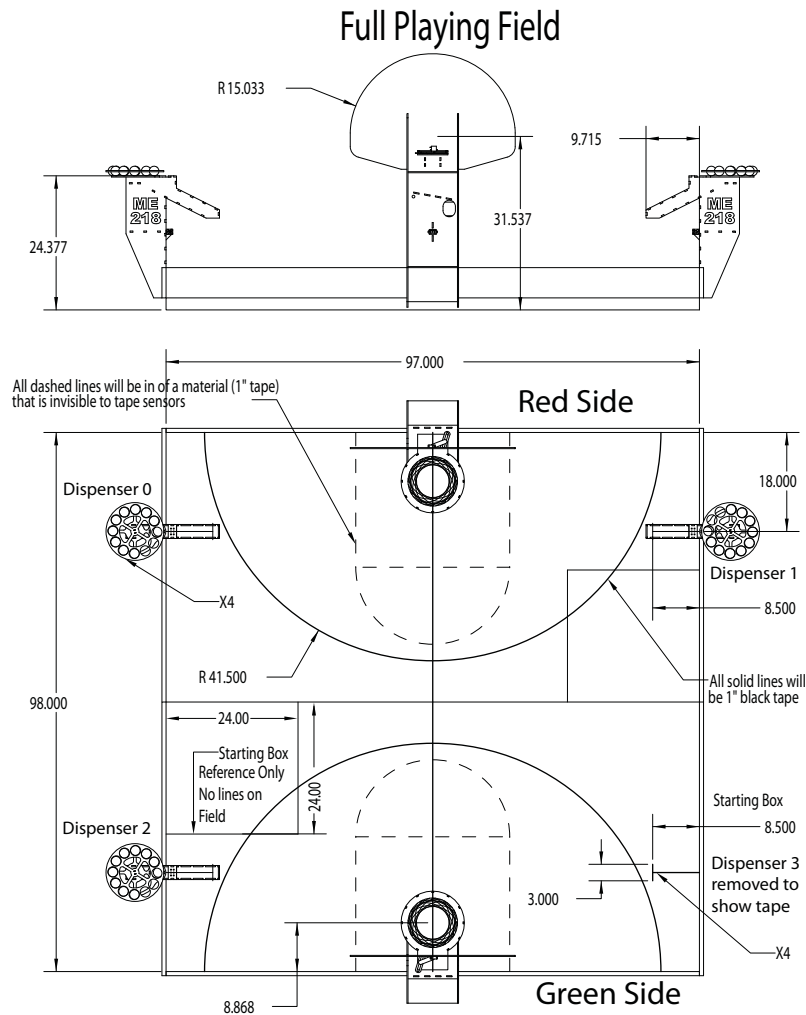


Fig. 1 The Playing Field

- The field is divided into two halves. During the initial rounds of play a 3-1/2" high wall will divide the two halves. For later rounds, the wall will be removed. The outer perimeter of the playing field is bounded by a 3-1/2" high wall.

- The Red 'bot will start on the Red side and shoot to the Red basket. The Green 'bot will start on the Green side and shoot to the Green basket.

### The Goals:

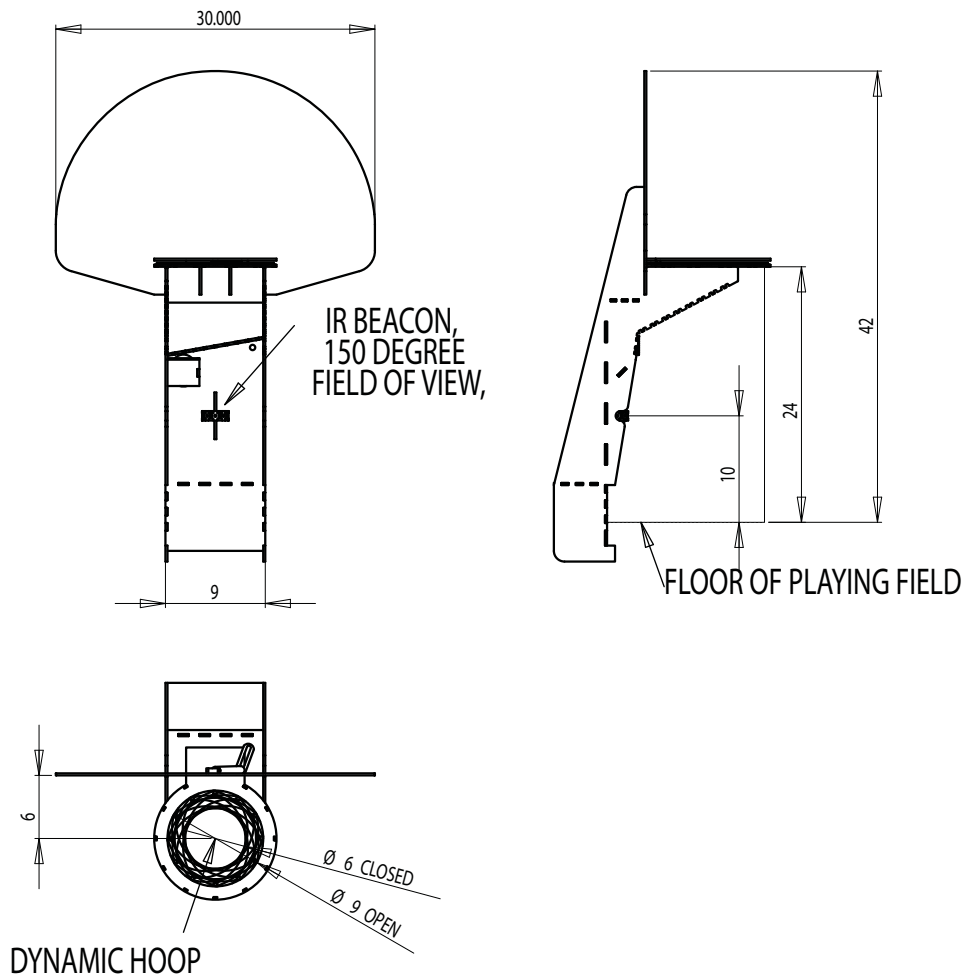


Fig. 2 The Hoop

- The goal column will have a beacon emitting modulated IR driven by a square wave. The emitters for the beacons will be LTE5208A IR LEDs. The IR emitters will be mounted at a height of 10" off the playing surface.
- The beacon on the Red Goal will be modulated with a period of 1120 $\mu$ S, and a high time of 560 $\mu$ S. The beacon on the Green Goal will be modulated with a period of 880 $\mu$ S, and a high time of 560 $\mu$ S.
- The inner diameter of the Hoop can be dynamically changed via communication with the Offensive Coordinator.

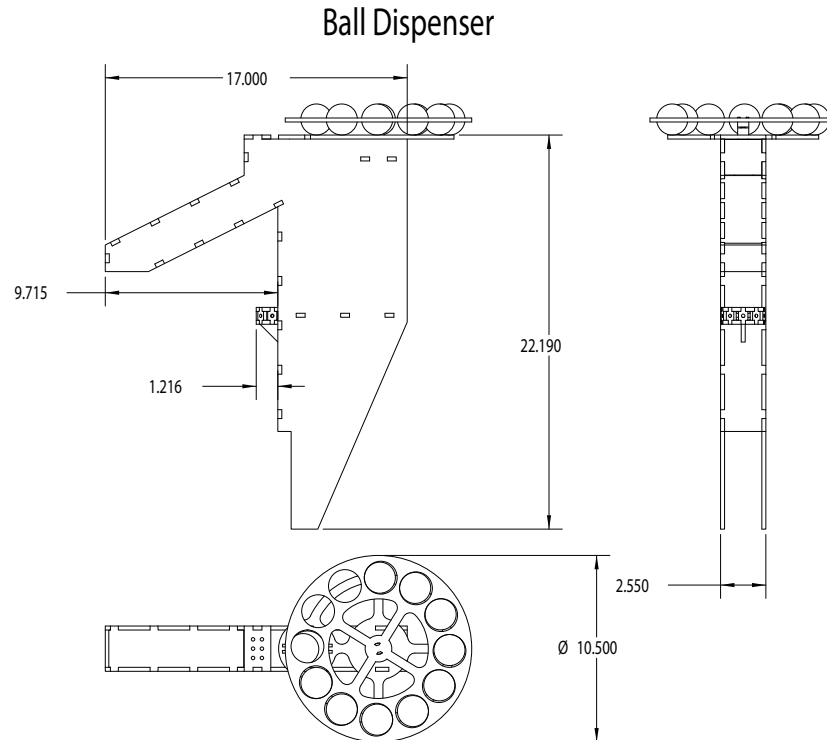
**The Ball Dispensers:**

Fig. 3 The Ball Dispenser

- The Ball Dispensers will be as shown in Fig. 3.
- The dispensers will release one ball at a time in response to a request made through the Offensive Coordinator providing that the maximum delivery rate is not exceeded.
- The dispensers will dispense balls at a maximum rate of one ball every 2 seconds with a maximum of three balls per team per dispenser within a 30 second period.
- Any requests made in excess of the maximum rate will be declined.
- The dispensers will each have a beacon emitting modulated IR driven by a square wave. The emitters for the beacons will be LTE5208A IR LEDs. The IR emitters will be mounted at a height of 10" off the playing surface.
- The beacon on Dispenser 0 will be modulated with a period of 1120 $\mu$ S, a high time of 880 $\mu$ S  
 The beacon on Dispenser 1 will be modulated with a period of 1120 $\mu$ S, a high time of 720 $\mu$ S  
 The beacon on Dispenser 2 will be modulated with a period of 880 $\mu$ S, a high time of 240 $\mu$ S  
 The beacon on Dispenser 3 will be modulated with a period of 880 $\mu$ S, a high time of 400 $\mu$ S

**The Offensive Coordinator:**

- The Offensive Coordinator will communicate with your robot over a 4-wire SPI bus.
- The Offensive Coordinator will communicate wirelessly with the field infrastructure, so it must be mounted on the top-most level of your robot with no structure above or surrounding it.
- A complete description of the Offensive Coordinator, from both an electrical and protocol standpoint, is included in a separate document that accompanies this project description.

**The Robots:**

- Your robot must be a stand-alone entity, capable of meeting all specifications described in this document. Battery power is required. Your robot must execute from code contained in Flash on either (or both of) the 'C32 and 'E128.
- Robots must be autonomous and un-tethered.
- The only parts of the Robot that may ever touch the playing field surface are wheels, ball transfers, or slippery supports used to balance the Robot.
- The smallest bounding box (rectangular prism) that entirely encloses your robot must not exceed a 1 cubic foot volume at the beginning of the game.
- All robots must present a continuous perimeter covering the entire region between a height of 0.5" and 3.5" off the playing field. This perimeter will act as a bumper to protect the robots in the case of robot to robot contact. This perimeter must represent the outermost extent of the robot's platform. When in motion, no part of the robot may extend beyond this perimeter.
- Each robot will carry an easily accessible switch on the top of the robot. The purpose of the switch will be to cut power to the 'bot in case of a software or hardware malfunction.
- Control of Red/Green side assignment should be determined by a switch input to your microcontroller. Each Robot must, under software control, identify itself as playing the Red side or the Green side and display this information in a highly visible manner to the audience.
- Each Robot must be constructed as part of ME218b. It may not be based on a commercial or otherwise pre-existing platform.
- Any exterior corners on the robot must have a radius of at least 1/4".
- You are limited to an expenditure of **\$150.00/ team** for all materials and parts used in the construction of your project. Materials from the lab kit or the Cabinet Of Freedom do not count against the limit, all other items count at their Fair Market Value.
- 'Bot speed must be kept low enough to be safe to the other 'bot on the field. We reserve the right to disqualify any 'bot for excessive speed. If in doubt, get an assessment from Ed before proceeding.
- The supplied motors must be used to drive anything that transfers force to the ground.

**Game Play:**

- The game is a head-to-head match up between Robots as they attempt to score points by making baskets.
- At the beginning of each game, the robots will be placed on the field by a member of the team. The centroid of the normal 2-D projection of your robot onto the plane of the field must lie within the starting box at the start of the game.
- The game will begin when a game status query to the OC returns the Running state.
- Goals scored when the hoop iris is in the narrow position score 3 points.
- Goals scored when the hoop iris is in the wide position score 2 points.
- The game ends at the end of 2 minutes. At that time, 'bots must stop all movement.
- In case of a non-zero tie at the end of a round, a sudden-death playoff match will be run. In the sudden-death playoff, the first 'bot to make a basket will win the round.
- In the case of a 0-0 tie, both 'bots are removed from the competition.

**Rules:**

- No solderless breadboards (protoboards) are permitted in the final project.

- No part of your 'bot may touch the basket or dispenser. Contact with the basket or dispenser will result in immediate disqualification.
- Each Robot must start and remain in one piece during the round.
- Your Robot may not alter the playing field **IN ANY WAY**.
- Intentional jamming of your opponent's senses is prohibited.
- Your Robot may not mar the walls or the floor.

**Safety:**

- The Robots should be safe, both to the user and the spectators. The teaching staff reserves the right to disqualify any Robot considered unsafe. This also applies during testing, so keep the 'bot velocity low enough so as not to cause problems.
- Robots must be stable in the presence of a 30MPH wind.
- No part of the machine may become ballistic. The Nerf balls are not part of your machine.
- All liquids, gels and aerosols must be in three-ounce or smaller containers. All liquids, gels and aerosols must be placed in a single, quart-size, zip-top, clear plastic bag. Each 'bot can use only one, quart-size, zip-top, clear plastic bag.
- Robots may alter the Space-Time continuum only during the public presentations.

**Check-Points****Design Review:**

During class-time on 02/08/11 we will conduct a design review. Each group should prepare a few sheets of paper showing your idea(s) and a preliminary software design (module breakdown & upper level state chart). These should be scanned into a no-frills PowerPoint file (landscape, 4:3 format, .ppt, not .pptx) for projection in Rm 200. You will have 5 minutes to walk us through your ideas. The other members of the class, the teaching staff, and coaches will be on hand to hear about your ideas and provide feedback and advice.

**First Check-Point:**

On 02/11/11, you will turn in a set of Protel schematics, textual descriptions and software design documentation (including refined state chart) that describes the state of the design *at that point in time*. The designs need not be tested at this point, but must include designs to address all of the major subsystems. It must be turned in as soft copy. Only one team member needs to submit your checkpoint.

**Second Check-Point:**

On 02/15/11, you must demonstrate your motorized platform moving under software control. Your platform must be able to rotate in 90° increments and drive forward under software control.

**Third Check-Point:**

On 02/17/11, you must demonstrate your robot's ability to communicate with the Offensive Coordinator and exercise all of the Offensive Coordinator's capabilities.

**Fourth Check-Point:**

On 02/21/11, you must demonstrate your robot's ability to sense and identify each of the IR beacons while positioned in the Red starting box.

**Fifth Check-Point:**

On 02/25/11, you must demonstrate your robot's ability to receive a ball and make a basket.

**Project Preview:**

At the **Project Preview** on 02/28/11, each Robot must demonstrate 1) the ability to move under software control and 2) the ability to communicate with the Offensive Coordinator and 3) the ability to make a basket all in an integrated package. The platform used for the Project Preview, must be the platform used in the grading session.

**Grading Session:**

During the **Grading Session on 03/01/11** each Robot will be required to demonstrate the ability to accept commands from the Offensive Coordinator to begin the game, and during the following two minutes complete at least one basket and stop moving at the end of two minutes. If your 'bot fails at its first attempt to demonstrate its ability, it must then demonstrate the ability two times in succession at its next attempt. These increases continue after repeated failed attempts to a maximum of 4 required successive demonstrations. This evaluation will take place without an opponent. Evaluation for grading purposes will occur only during these sessions. At the time of the grading session, you must submit a copy of the .S19 file that you run during the grading session to your Reports folder for archiving.

**Public Presentation:**

Will take place on 03/02/11 starting at 7pm in the Peterson Atrium.

**Report:**

Draft due on 03/07/11 at 4:00pm. Final version with revisions due by 5:00pm on 03/11/11.

**Evaluation****Performance Testing Procedures:**

One or more of the team members will operate the Robots during the performance evaluation. A competition among the class's Robots will take place after the performance evaluation.

**Performance Evaluation:**

Performance evaluation will take place twice during the project duration, at the Project Preview and at the Grading Session. Everyone will participate at this level.

**The Competition:**

On the night of the public presentations, a tournament will be held. Performance during the tournament has no impact on your grade.

**Grading Criteria:**

- Concept (10%)** This will be based on the technical merit of the design and coding for the machine. Included in this grade will be evaluation of the appropriateness of the solution, as well as innovative hardware, software and use of physical principles in the solution.
- Implementation (15%)** This will be based on the prototype displayed at the evaluation session. Included in this grade will be evaluation of the physical appearance of the prototype and quality of construction. We will not presume to judge true aesthetics, but will concentrate on craftsmanship and finished appearance.
- Check-Point Performance (10%)** Based on demonstrating the required functionality at the checkpoints.
- Preliminary Performance (10%)** Based on the results of the performance testing during the **Project Preview**.
- Performance (20%)** Based on the results of the performance testing during the **Grading Session**.

- Report (20%)** 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. The report should be in the form of a web site and must include schematics, pseudo-code, header & code listings, dimensioned sketches/drawings showing relative scale, a complete Bill-of-Materials (BOM) for the project as well as a 1 page description of function and a “Gems of Wisdom for future generations of 218ers” page. The web-site must be submitted as a single **Zip** file (The zipping software (7-zip) is installed on all the workstations in the lab). The only file types in your final report should be HTML (including style sheets if you choose), JPEG or other viewable image files and PDF files. Schematics should be PDF files, **not** bitmaps (PNG, JPEG, GIF, etc.). A bitmap place-holder with a link to a PDF is OK. Do not include .doc, .docx, .xls, .xlsx or other files that require opening a separate application outside of the browser. It is critical that your report be in the Reports folder on time so that the peer reviewing team will have an adequate opportunity to review it before class the following day. Final versions of the reports, incorporating the review comments are due (also in the form of a single zip file) by 5:00pm on 03/11/11. The front page of your project description must be in a file called `index.html` at the root folder of the web site. Test your zip-file by unzipping it into an empty folder. Once un-zipped, you should be able to view the entire site starting from the `index.html` file. Make sure to test all of your links before submitting.
- Report Review (10%)** These points will be awarded based on the thoroughness of your review of your partner team's report. Read the explanations, do they make sense? Review the circuits, do they look like they should work?
- Housekeeping (5%)** Based on the timely return of SPDL components, cleanliness of group workstations as well as the overall cleanliness of the lab. No grades will be recorded for teams who have not returned their tool kit and E128 & C32 boards.

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## **Team Organization**

While it may be tempting (as more efficient) to organize your teams around specialists who handle, for example, communications, sensing, motion, etc. I believe that in the long run this will be a mistake. I have heard from many 218 alumni who did this and reported that they were sad that they had because they didn't get, for example, communications experience. I would like to encourage you to remember that, first and foremost, the purpose of the project is to enhance your learning of the material. An organization that deeply involves all of the team members in the details of the design, implementation and debugging of all subsystems will not only provide a better learning experience, it will also prevent you from getting hung up during the integration and testing phase because the “expert” on that subsystem is not available.