ME218b Smart Product Design

ME 218b Winter 2010 Project: Hats Off!

Project Preview on February 26, 2009 6-10PM in SPDL
Grading Session on March 3, 2010 6-10PM
Project Presentations on March 4 2010 in Annenberg Auditorium starting at 7:00 PM

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.

Your lab kit contains sensors, actuators and power transistors. Although you might be able to construct the electro-mechanical parts of this project using only the parts provided, you are not limited to this.

The Game:

The object of the game is to knock the "hats" off of the goal columns in the order specified by a Target Commander device.

Specifications

The Field:

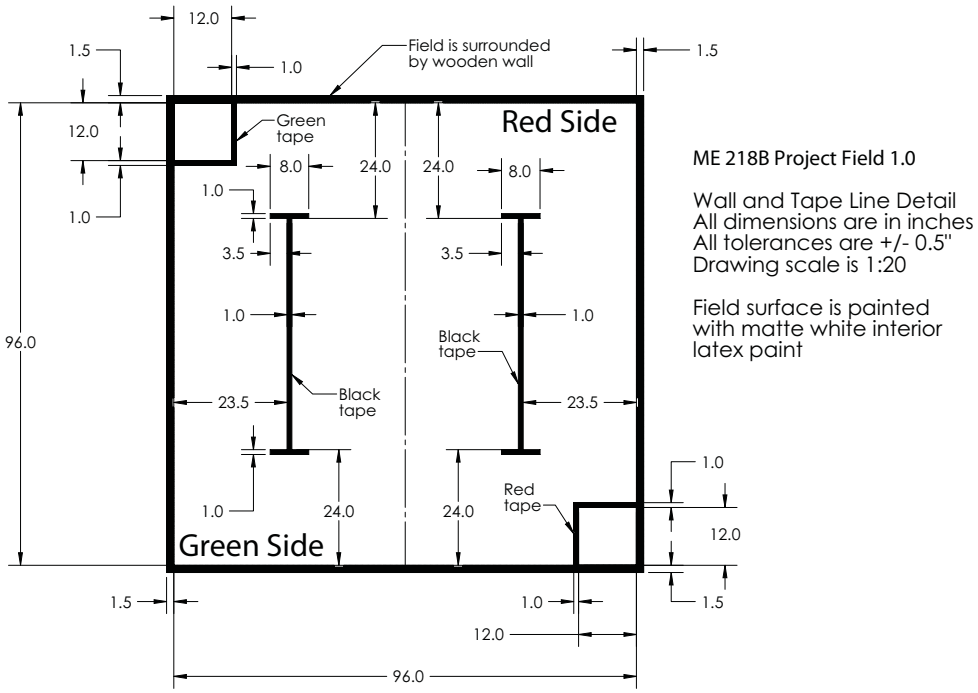

Fig. 1 Top View of Playing Field

- ☐ The total playing field measures 8'x8'. 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.
- ☐ Each side of the field will contain a line made of 1" black tape with the ends of the line capped by short lines, also of 1" black tape, perpendicular to the long tape line.
- ☐ In diagonally opposite corners of the field there will be a 12" square region bounded on 2 sides by green or red tape and on 2 sides by the perimeter walls
- ☐ Each of the numbered circles in Fig. 2, below, is a goal column

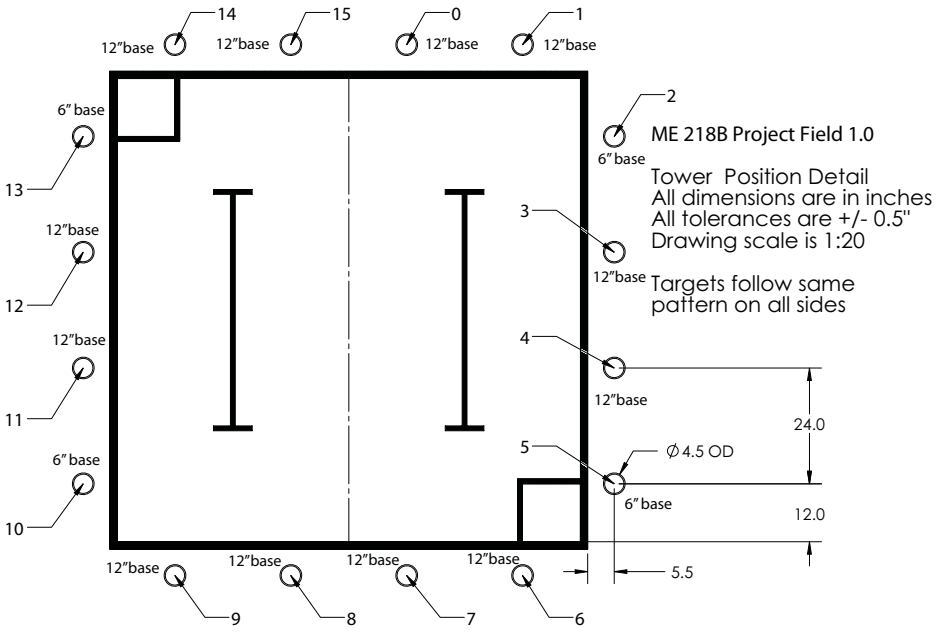

Fig. 2 Top View Positions of the Goal Columns

The Goal Columns:

- The goal columns will consist of a 4.5" diameter, cylinder rigidly mounted just outside the perimeter wall of the playing field. The height of the column will be either 6" or 12", as indicated in Fig. 2.
- Each goal column will have a beacon emitting IR modulated at 1250Hz with a 50% Duty Cycle. The emitters for the beacons will be LTE5208A IR LEDs. The IR emitters will be mounted at a height of 6" off the playing surface.
- The beacons will normally be off. When requested by your 'Bot via communication with the Target Commander, a specific beacon may be illuminated. An illumination request will result in the requested beacon turning on for 5 seconds. Once the 5 second illumination time has expired, the beacon will remain dark for at least 3 seconds.
- You may only request that one beacon at a time that is currently or previously assigned to you be illuminated.

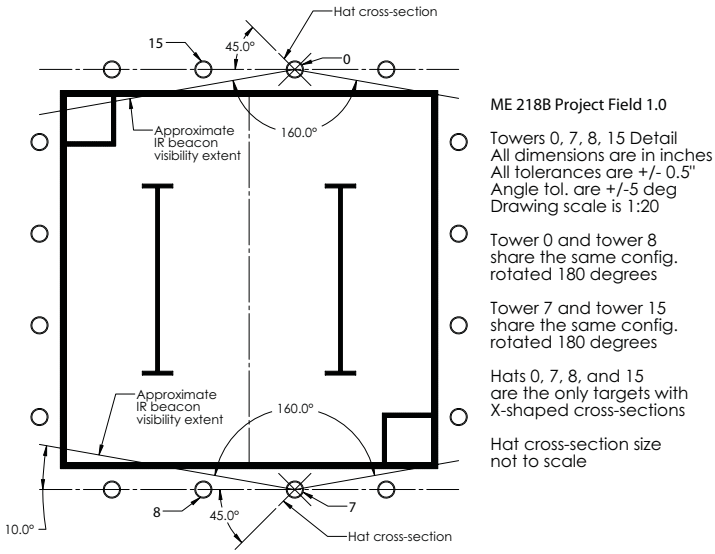

Fig. 3 Goal Tower Detail for towers 0, 7, 8 & 15

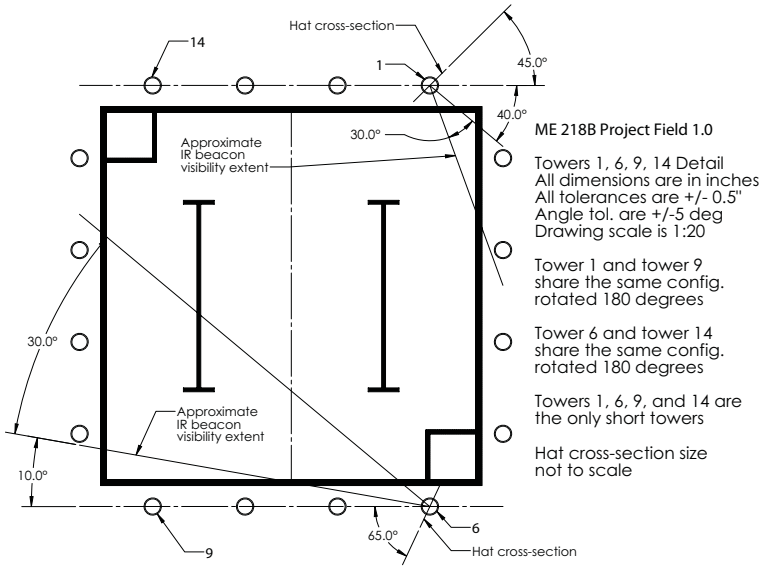

Fig. 4 Goal Tower Detail for towers 1, 6, 9 & 14

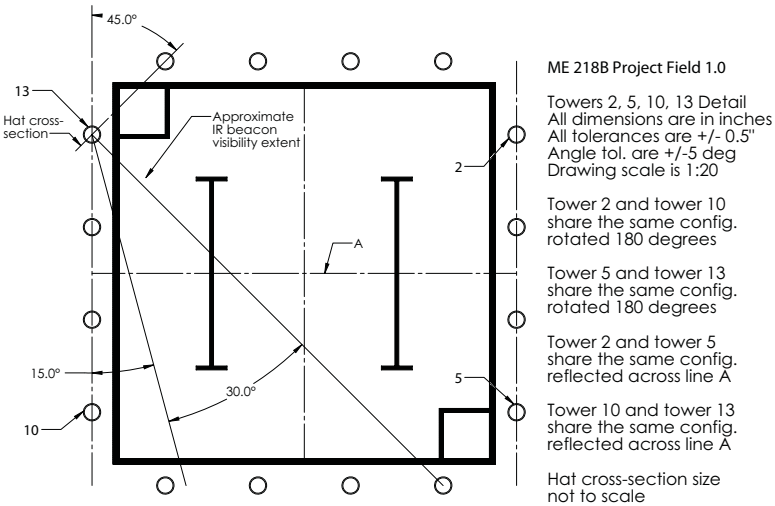

Fig. 5 Goal Tower Detail for towers 2, 5, 10 & 13

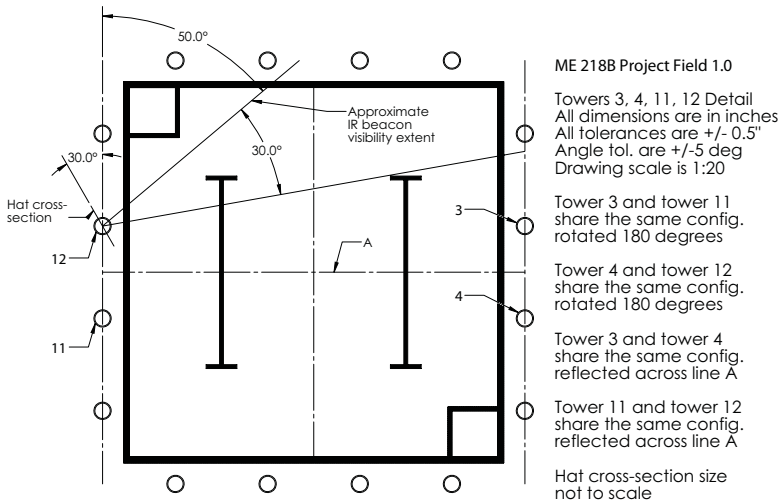

Fig. 6 Goal Tower Detail for towers 3, 4, 11 & 12

The Hats:

- The Hats will be of either a uni-planar or bi-planar design, as shown in Fig. 7 & 8. The locations of the uni and bi-planar designs will be as shown in Fig. 3, 4, 5 & 6.

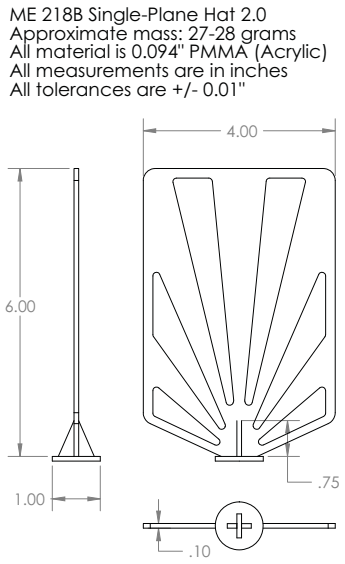

Fig. 7 Uni-Planar Hat Design

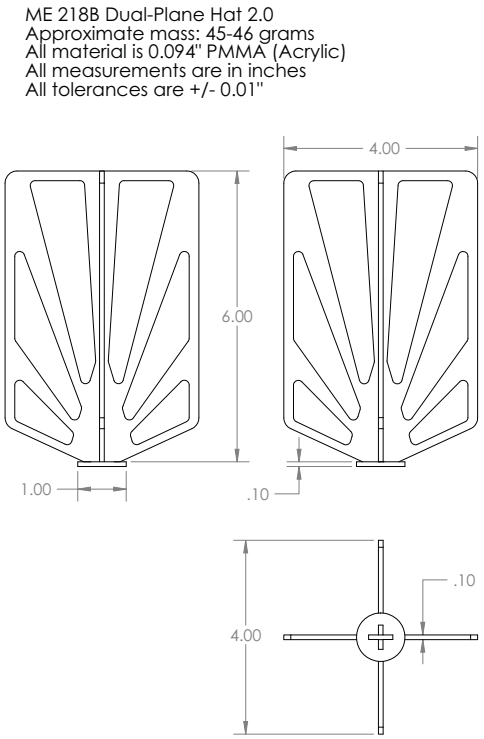

Fig. 8 Bi-Planar Hat Design

The Target Commander:

- ☐ The Target Commander will communicate with your robot over a 4-wire SPI bus.
- ☐ The Target Commander 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.
- ☐ The Target Commander will specify which target is currently active by indicating the Goal number as shown in Fig. 2
- ☐ A complete description of the target commander, 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 the processor.
- ☐ Robots must be autonomous and un-tethered.
- ☐ The only parts of the Robot that may ever touch the playing field surface are wheels, balls or slippery supports used to balance the Robot.
- ☐ All parts of the robot (except for the Target Commander) must fit within the bounds of a 12” square 11.5" high 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.
- ☐ No part of the robot may touch the floor outside the initial footprint.

- ☐ Each Robot must be able, under software control, to 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 knock the hats off of the goal columns in the order specified by their Target Commander.
- ☐ At the beginning of each game, the robots will be placed in the 12" square regions shown in Fig.1. Orientation is free, but the entire robot must fit within the 12" square.
- ☐ The game will begin when the Target Commander assigns the first target.
- ☐ The first target assigned will always be either 0 or 8, depending on which side of the field that your robot is starting from.
- ☐ Targets must not be knocked off before they have been assigned by the Target Commander.
- ☐ A hat knocked off after it has been assigned will score 1 point for the robot.
- ☐ Any hat knocked off before it has been assigned will incur a 2 point penalty.
- ☐ After a target is assigned, the robot has a maximum of 15 seconds to knock the hat off of that target. If the hat has not been knocked off by the end of that time, then a new target will be assigned. Any missed target may be revisited at any subsequent time.
- ☐ After the 8^{th} hat has been knocked off, the robot will be instructed by the Target Commander to return to its starting square.
- ☐ In the situation in which both robots succeed in knocking off 8 hats, the first robot to return to their starting square will be the winner.
- ☐ In the event that neither robots succeeds in knocking off 8 hats, the game will end when two minutes have elapsed since the first target was assigned..
- ☐ At the end of two minutes the 'bot must stop all motion.
- ☐ In the event that neither robots succeeds in knocking off 8 hats within two minutes, the team with the most hats knocked off wins.
- ☐ In case of a tie at the end of a round, a sudden-death playoff match will be run. In the sudden-death playoff, the first 'bot to knock off the second of its assigned hats will win the round.

Rules:

- ☐ Nerf balls (greater than 50% intact) are the only thing that may contact the hats to knock them off.
- ☐ 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.
- ☐ 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 02/09/10 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 556. 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 02/12/10, 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 02/16/10, you must demonstrate your motorized platform moving under software control. Your platform must be able to autonomously drive from one end of the tape line to the other, execute a 180 degree turn and return to the starting point.

Third Check-Point:

On 02/18/10, you must demonstrate your robot's ability to communicate with the Target Commander and exercise all of the Target Commander's capabilities.

Fourth Check-Point:

On 02/22/10, you must demonstrate your robot's ability to sense Beacon #0 while positioned in the Red starting box.

Fifth Check-Point:

On 02/26/10, you must demonstrate your robot's ability to knock off a hat.

Project Preview:

At the **Project Preview** on 03/01/10, each Robot must demonstrate 1) the ability to move and 2) the ability to communicate with the Target Commander and 3) the ability to sense the beacons and 4) the ability to knock off a hat 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 03/03/10** each Robot will be required to demonstrate the ability to accept commands from the Target Commander and knock off at least 4 of the hats, in the order specified by the Target Commander. 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 03/04/10 starting at 7pm in Annenberg Auditorium.

Report:

Draft due on 03/08/10 at 4:00pm. Final version with revisions due by 5:00pm on 03/12/10.

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.
- ☐ **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.

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.