ME 210 Winter 2023: RobOSCARS
Our Strategic Competitive Autonomous Robot Show

Project Presentation on March 12 starting at 7:00 pm.
Revision 0: 2/14/23

Purpose:

The purpose of this project is to provide you with an opportunity to apply what you have learned so far in ME210 to solve an open-ended mechatronics design problem.

Background:

Congratulations! Your FILM (Fun, Intelligent, Live-action Movie-bot) has been nominated for an award at the RobOSCARS (Robo Overly Strategic Competitive Autonomous Robot Show). But wait before you take your seats! It wouldn't be an award show without a walk down the red carpet, as well as some beef between competing FILMs. Before the ceremony starts you will need to make sure you are the crowd favorite by promoting your FILM with good PRESS and sabotaging your opponent's with bad PRESS.

The Task:

Design an autonomous robot that is able to deliver good and bad press from the STUDIO (STUdent Delivered Input Outpost) to the audience and media. The objective is to deliver more good press to your audience than your opponent does to theirs, and/or deliver sufficient bad press to your opponent's audience to offset their ratings.

Specifications

Your FILM will start in its respective STUDIO. Here, you can manually pre-load 4x PRESS which are represented by balls, 1.6in in diameter. The objective is to transport the PRESS from the STUDIO to your AUDIENCE. But beware! Your opponent will be working against you in two ways, delivering good PRESS to their own AUDIENCE and bad PRESS to your AUDIENCE.

The Field:

- ☐ The field, seen in Figure 1, is constructed from wood and split into 2 sides: an 8 foot by 4 foot area for FILM A and an 8 by 4 foot area for FILM B. The two halves will be divided along the 8 foot side by two scales representing Audience A and Audience B.
- ☐ FILM A will start in their STUDIO located on the top right corner of the field and will be scored on the scale to the left. FILM B will start in their STUDIO located on the bottom left corner of the field and will be scored on the scale to the right. Each STUDIO will be 16 in x 16 in, and each scale will have buckets of size 9 in x 9 in. Note that the scales will start below the playing surface, but will move up and down as good/bad press is delivered during gameplay.
- ☐ IR beacons will be placed near each STUDIO, emitting at a height of 7 inches. FILM A's beacon will pulse at a frequency of 3333 Hz, and FILM B's beacon will pulse at a frequency of 909 Hz.
- ☐ Red tape will be placed on each half of the field going from the STUDIO to the press buckets as illustrated in 1. The tape will lead to your good press as well as your opponent's good press and bad press buckets.
- ☐ Black tape will be placed between each half of the playing field and the scales. Beware of going beyond the black tape, as your robot will fall into the scale! A wall will line the perimeter of the remaining 3 walls as illustrated in 1.

The Game:

- ☐ The game is designed for two robots to go head-to-head. Each robot will start in its own STUDIO in a **randomized orientation** decided by the teaching staff! Their objective is to have a better net press score than their opponent!
- ☐ You can **manually load a maximum of 4 press** in the loading area at one time. Your robot may not possess more than 4 press at a time. You may only re-load in your STUDIO.

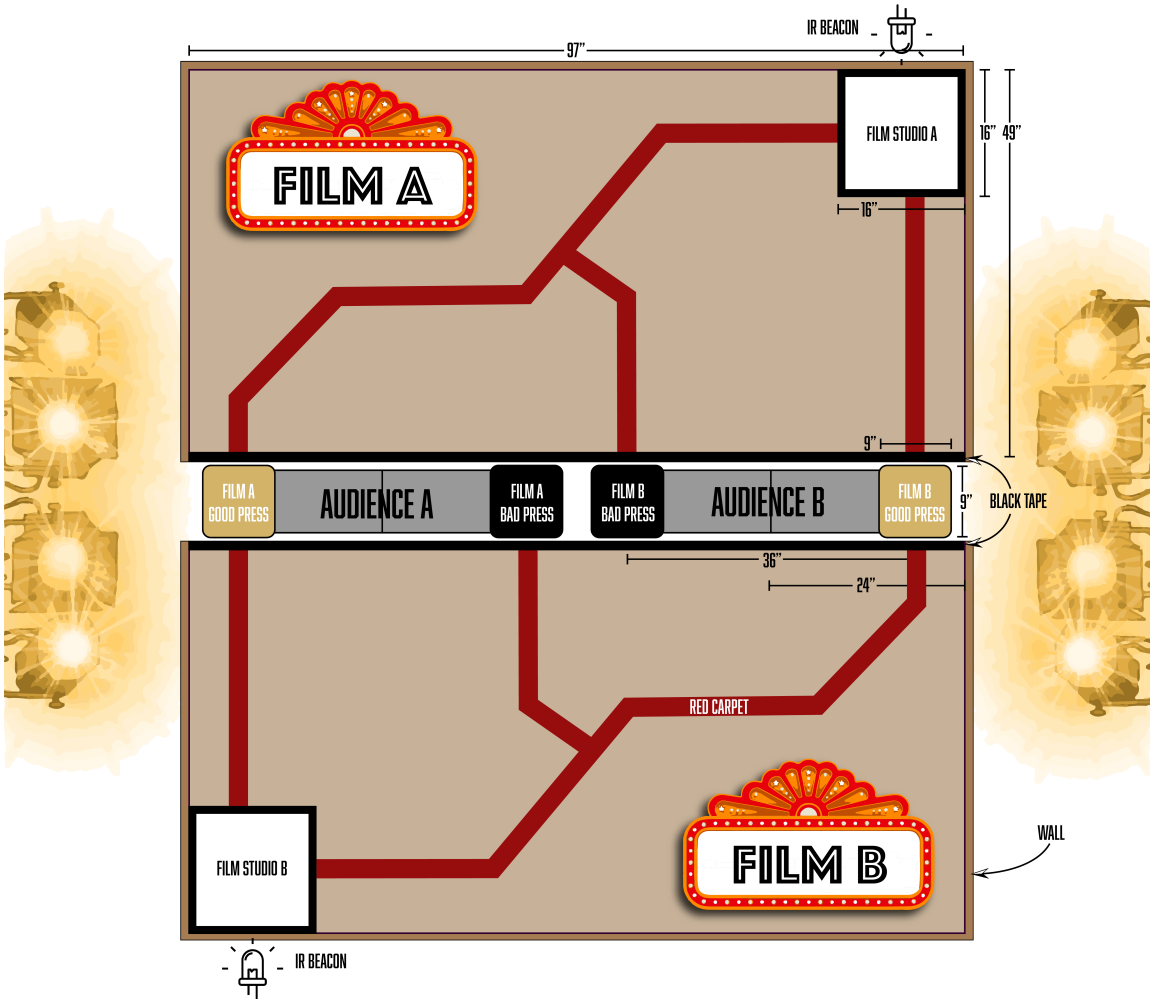

Figure 1: Top view of the field.

- ☐ **"Loading" means placing the press in your robot, on your robot, or the floor within the loading zone (STUDIO)**. Your robot must be completely within the STUDIO (and have attempted to score your balls) in order to be re-loaded.
- ☐ When your robot is in the STUDIO, you may only interact with it via a button, a switch, or a potentiometer.
- ☐ As seen in Figure 2, there are four baskets. You should only be interacting with two: your good press basket and the opponent's bad press baskets. You must navigate out of the loading area and deposit your press to one or both of the aforementioned baskets.
- ☐ You can only score once your robot is entirely out of the loading area.
- ☐ You may not enter the other team's half of the field.
- ☐ You may not play "defense" against the other team's STUDIO or touch any aspect of the scoring zone (e.g. the basket and scale lever arm).
- ☐ If you lose press in the gap between fields, that press is removed from the game.
- ☐ The robot with the highest score at the end of 2 minutes and 10 seconds of gameplay wins!

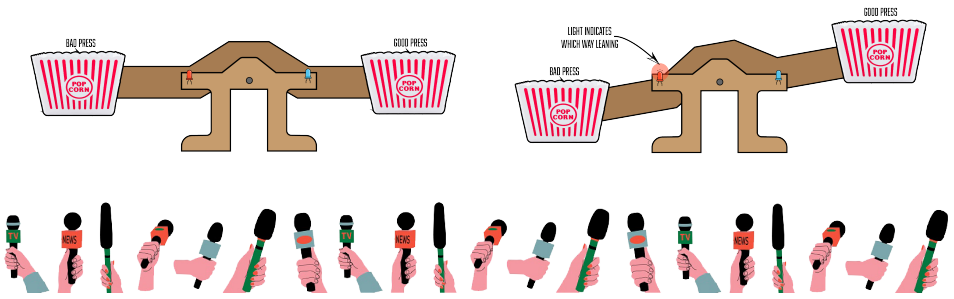

Figure 2: Side view of the press scales.

Scoring:

- ☐ Each good press for your FILM's scale is scored as 3 points.
- ☐ Each bad press on your FILM's scale removes 2 points from your score.
- ☐ If your robot gets stuck, you may request to manually reset it at the STUDIO with a 4 PRESS penalty.

$$SCORE = (3 * GOOD\_PRESS - 2 * BAD\_PRESS)$$

Robot requirements:

- ☐ Each student team will be responsible for designing, building, and demonstrating an operational robot. The robot should be an autonomous machine which will compete according to the specifications and rules defined in this document.
- ☐ Each robot must be a stand-alone entity, capable of meeting all project specifications, and must operate completely untethered during grading and competition.
- ☐ Power for the robot must be supplied by batteries, which are carried on board of each robot. Each team will receive two 7.2V NiMH rechargeable battery packs. The use of circuit breakers is mandatory. We will provide one circuit breaker per team, which will allow you to start your motors (it accepts short current surges).
- ☐ The provided batteries are the only batteries that may be utilized.
- ☐ Each robot should incorporate an easily accessible toggle switch on its exterior, which will serve as an emergency stop switch. The switch must cut all power to the robot when toggled.
- ☐ At the beginning of each round, your robot must fit within a 12" x 12" x 12" cube. Your robot may be dismembered to conform to this specification :)
- ☐ The robot's control software should be executed from the flash memory of one or more Arduino UNO micro-controllers. Tethering of robots to computers during competition is strictly prohibited.
- ☐ Each robot must be constructed as part of ME 210 activities during the remainder of the quarter. It may not be based on a commercial or otherwise preexisting platform. Rulings from a member of the staff may be requested if there are questions about the content of your robot.
- ☐ Each team must adhere to an expenditure limit of **US $200** for the materials and parts used in the construction of the robot. The cost of the two provided NiMH battery packs, fuses/circuit breakers, and the lab kit components (including a single Arduino per team member) do not count towards this limit.
- ☐ Robots must be robust enough to deal with all normal game interactions including, but not limited to, collisions with any part of the field or debris.

Rules of Engagement:

- ☐ Rounds last for 2 minutes and 10 seconds. The robot that scores the most points wins.

- ☐ In the event of a scoring tie, the staff will preside over the final ruling of the round.
- ☐ Robots must automatically cease gameplay at the end of a round.
- ☐ The initial orientation will be randomly set by the staff. The side of your team will also be randomly assigned at the beginning of the round.
- ☐ An auditory start command will be issued by a member of the staff, at which time a member of each team will activate their robot, thereby initializing gameplay. This is the last human interaction with the robot allowed until the 2 minutes and 10 seconds have elapsed (with an exception being while the robot is in the STUDIO and resets approved by the teaching staff).
- ☐ Sideline coaching is strictly prohibited; no information may be passed to your robot during the match aside from the button, switch or potentiometer interactions aforementioned.
- ☐ Intentional destruction, damage, or alteration of any part of the field or other robots is expressly forbidden.
- ☐ Intentional jamming of your opponent's sensing abilities is prohibited.
- ☐ When robots intersect during normal gameplay, they are not required to yield to one another. The robots may be constructed such that an oncoming robot is diverted in this instance. However, strategies that intentionally create interaction with another robot, or upon interaction intentionally dismantle or disable the other robot (i.e. flipping or affecting sensing) are not permitted
- ☐ Robots must show good sportsmanship: any celebratory actions or displays prior to the end of the game will be penalized and censured harshly by staff.
- ☐ All machines and devices must be safe to users, to the lab, and to any spectators.
- ☐ Staff reserves the right to require a team to reduce their robot's speed if said speed is considered unsafe.
- ☐ No part of the robot may become ballistic (shoot balls not metal!).
- ☐ The competition seed position will be determined by the order in which teams perform the graded check off (see performance requirements).
- ☐ Members of your team are not allowed to position themselves (that's you, the humans) in a way that will interfere with the activities of any opponent's robot. Polite, "G-rated" heckling is permitted, of course.

Essential Guidelines for Safety

- ☐ **All projects shall respect the spirit of the rules, as established in this specification and in the culture of ME210. If you are considering something that may violate official sanctions, you must first consult with a member of the staff. Interpretations and rulings are the sole domain of the teaching staff.**
- ☐ All machines and devices must be safe to users, to the lab, and to any spectators.
- ☐ High speed projectiles are not permitted. If your robot has appendages, they should remain tethered to your robot at all times.
- ☐ If your robot stores energy anywhere other than the batteries, you must justify by analysis and demonstration that the stored energy cannot become hazardous. There is no explicit restriction on the amount of energy that may be stored. Any such device must start the round with zero stored energy.
- ☐ The powers of the staff to protect ME210 and its participants are very substantial and shall not be questioned.
- ☐ Tolerances on the dimensions of the field are ± 1 inch unless otherwise specified. (double check this with our field, once its is built).
- ☐ Once the field is constructed, its dimensions may supersede the above tolerances.
- ☐ Although ungraded, teams are encouraged to use creative themes and aesthetics with their robots.

- ☐ Pyrotechnics and combustion of any kind are prohibited.
- ☐ A main circuit breaker/switch will be provided and must be used as a main power shut down. When the switch is in the off position, all power must be disabled, and no subsystems may remain energized.

Performance Requirements

- ☐ For the purposes of grading, the minimum requirement for each robot is to start in the STUDIO, orient, and place at least one PRESS in its own good press bucket and one PRESS in its opponent's bad press bucket/ We call this "beating the brick"; there will be no opponent during this checkoff.
- ☐ **Your robot must indicate that the game is afoot using some electro-mechanical mechanism.** For example: waving to the paparazzi when time starts, and then again at 2:10 when the game is over. Turning LEDs on and off will not be permitted for this requirement.
- ☐ Your team may check off at any time by declaring[1] your wish to check off to a staff member prior to the check off attempt. If disaster strikes ("Its never done THAT before!?!!"), and your robot fails to check off, your robot's check off requirement will henceforth be raised to two successive, successful check-offs. If either of these consecutive check-off attempts fails, you will be required to perform no more than three successful checkoffs. **Check-offs must be completed for all teams no later than 5:00 pm on 3/10/23.**
- ☐ It is important for everyone to remember that the minimum performance requirement is the goal for the class. Student teams are strongly encouraged to strive for demonstration of the minimum performance functionality as early as reasonably possible, so that the members of these teams may return to their regularly-scheduled lives.
- ☐ The results of the tournament held at the public presentation session will not affect grading. The public presentation is purely an opportunity for you to enjoy the devices you've created, and to show your friends and families why you have disappeared for 3 weeks.

Project Advice

- ☐ Start early (now, start now).
- ☐ Spend a lot of time perfecting your state machine, hammering out your design, agreeing on your interfaces, and picking your components. These will be the foundation for your code, and programming your robot will go a lot faster if you do these things well.
- ☐ Get out of your comfort zone. If you don't have experience with a concept or device, working on it during the project will be a great learning opportunity. For example, if you are a CS major, do not spend all of your time coding; instead work on signal conditioning or mechanical design.
- ☐ Work together and communicate. It's tempting to divide and conquer, but your teammates can't help you if they don't understand what you're working on.
- ☐ Sleep. You think you'll get more done if you stay up for 48 hours straight beating your head against a stack of datasheets, but you're wrong.
- ☐ Know where to find emergency replacement parts. If you don't have time to wait for a shipment, then Jameco and Room 36 can save your project, for a price (be wary of, but receptive to, blood contracts).
- ☐ There are other lesser known resources on campus for Laser Cutting or 3D Printing, like Lab64 in Packard building. But accesses to these resources require prior training; so try to get that ahead of time. There are just one or two laser cutters and 3D printers in Lab64, but these can save the day when PRL is overflowing with people.

[1] Note that you cannot just state your wish; you must declare it.

Milestones

Project Assigned:
February 14 (in class)

Finalize a four person team, and enter your info into the team spreadsheet.

First Checkpoint:
February 21 (in class)

2-4 minute in-class presentation. Show 3 design concepts with sketches, time schedules, a project plan, and personnel assignments.

Second Checkpoint:
February 24, 11:59 pm

Turn in physical documentation on Canvas, including schematics, state diagrams, design calculations, and any preliminary testing results.

Third Checkpoint:
March 3, 11:59 pm

Demonstration of all functional subsystems per block diagram: drive train, beacon sensing, tape sensing, navigation, etc. All components of your robot should be working individually.

Fourth Checkpoint:
March 10, 5:00 pm

All subsystems functional and integrated. Beat The Brick (your robot can move) check-off by teaching staff.

Public Presentation:
The RobOSCARs will take place on **3/12/23** at **7:00 pm** in the Atrium of Building 550. At this event, you can compete in the tournament with your finished, presentable, competition-ready machines. Guests are welcome!

Project Review:
March 14 (in class)

Brief in-class presentations from each team on project outcome and lessons learned. Bring your FILMs!

Project Report:
March 19, 5:00 pm

Report in HTML format, suitable for publishing on the ME210 website.

Evaluation

Performance Testing Procedures:

All robots will be tested by a demonstration, performed by a team member, that should show all of the possible user interactions.

Grading Criteria:

- ☐ **Concept (20 %)** The concept portion of your grade 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.
- ☐ **Implementation (25 %)** The implementation portion of your grade will be based on the machine displayed at the evaluation session. Included in this portion of the grade will be evaluation of the physical appearance of the machine and the quality of its construction. Aesthetics will not be judged, rather, craftsmanship and finished appearance are the focus of this portion.
- ☐ **Performance (25 %)** The performance portion of your grade will be based on the results of the performance during the check-off evaluation session. **To earn the performance points, you must demonstrate at least the core functionality.**
- ☐ **Coach Evaluations (10 %)** The coach evaluations portion of your grade will be based on the four project milestone reviews (see previous section).
- ☐ **Report (10 %)** The report portion of your grade will be based on an evaluation of the final report. It will be judged on clarity of explanations and on the completeness and appropriateness of the documentation. This report should be prepared in HTML format (as a website), and submitted as a compressed ZIP archive on Canvas ready for publication on the Internet. If your report is already hosted on the internet, please include a text file containing a link to the live webpage.

Resources

Websites:

SparkFun (www.sparkfun.com)
Mouser (www.mouser.com)
Adafruit (www.adafruit.com)
McMaster-Carr (www.mcmaster.com)
Seeed Studio (www.seeedstudio.com)
ServoCity (www.servocity.com)
Hackaday (www.hackaday.com)
HobbyKing (www.hobbyking.com)
Jameco (www.jameco.com)
Ponoko (www.ponoko.com)
DigiKey (www.digikey.com)
Newark (www.newark.com)

Local Stores:

Anchor Electronics in Santa Clara
Jameco in Belmont
J&M Hobby House in San Carlos
TAP Plastics in San Mateo

Revision History

Revision 0: Initial release (2/14/23)