

Design Problem for Summer 2021

[Click here for 3D PDF of arena](#)

[Click here for SW arena assembly model](#)

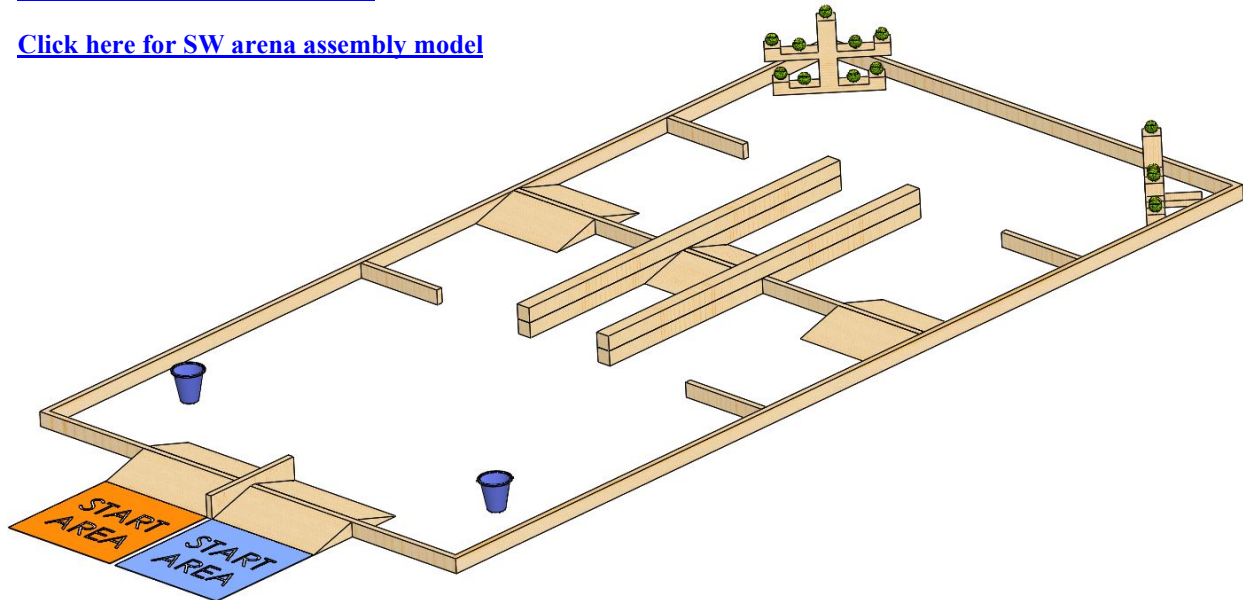


Figure 1: Arena Layout

Problem Statement:

Eighteen tennis balls are placed on two wooden trees within a 10' x 20' enclosed arena. The arena also contains two empty buckets. Your assignment is to design a mobile device to enter the arena and move five tennis balls from the source tree into the goal bucket on your team's side of the arena. The balls cannot touch the ground and the goal bucket must be upright (within 5° of vertical) at the end of the run for the deposited balls to be scored. The mobile device will be allowed to enter and exit the far side of the arena two times during each competition run.

This is a timed competition and a bonus is awarded for each additional ball released into the goal bucket. To simulate the competitiveness in real-world engineering and make the challenge more exciting, this is a head-to-head competition in which two teams compete in the arena simultaneously. See the attached drawings for course and ball layout details.

Rules:

1. The supplied wireless controllers allow for two proportional and three relay-controlled motors. You must be able to attach and wire the controller module to your assembled device within five minutes **and** LED status indicators must be visible at all times through the clear plastic viewing window on top of the module.
The controller module measures approximately 12" × 10" × 6", and its mounting flanges are the only parts which can touch your device (*i.e. the control box cannot be used for supporting other components*). At least one of the two holes in each of the two mounting flanges must be used for fastening the control box to your mobile device. No other controllers or power sources can be used for the project.
2. Each team must be capable of competing on either side of the arena; sides will be randomly assigned the day of the competition.
3. Each device must begin its timed run completely within the starting area adjacent to the entry ramp (see attached arena drawing). Team members cannot touch the devices, buckets, or balls during timed runs, but they can assist with navigation from outside the arena boundaries. Neither balls nor bottles may be modified.
4. Balls that drop onto the painted laboratory floor will not count towards the team's score.
5. The arena will be set up on a flat ($\pm 2^\circ$), clean, painted concrete floor; note the floor (and wooden ramps) friction coefficients and design accordingly.
6. A budget of \$50 is provided for each team, which is accessed via a provided [course purchase order template](#). Teams can provide any desired items; however personal reimbursements will not be made for these expenditures. Commonly used and/or reusable items like adhesives, fasteners, string, tape, and wire are provided by the lab and shall not count against the team's budget.
7. Each team is allocated 6' of 80/20 1" × 1" aluminum extrusion and connectors. If needed, additional 80/20 can be purchased from the group's budget (see the [material price list](#) for cost information). Groups are in no way limited to using this material; it is simply provided as one solution for rapidly prototyping rigid structures and mechanisms.
8. Any materials may be used except liquids; you are not limited by what is available in the lab. Suitability of selected materials will be evaluated, as will project appearance.
9. Each group is allocated up to five motors and four wheels from the lab, which are not counted against the team's budget; **modifications may not be made to these parts.**
10. Disqualification from a round will result if any of the following occur:
 - a. scratching the arena floor (**i.e. touching it with any metallic object(s)**)
 - b. intentionally ramming the other team's device (rubbing = fine; ramming = bad ☺)
 - c. intentionally limiting the other team's mobility (*i.e.* blocking)
 - d. interfering with another team's source tree or goal bucket
 - e. exiting the arena over the bounding wall

Purchase Orders for Design Groups:

As you work on the project it will be helpful to purchase parts from companies like Lowes, McMaster-Carr, and Surplus Center. Purchase order (PO) requests are placed each week. You can avoid shipping costs by sourcing items locally when available. If ordering from out of town vendors check item availability, shipping time, and shipping cost. The procedure for placing POs is described on the [course webpage](#) and will be discussed when we reach that point in the semester. It is each group's responsibility to track their budget and communicate clearly with each member as to what items are to be purchased. *Failure to submit POs for all materials used on your design, or exceeding the allocated budget limit, incurs a 10% project grade penalty.*

Key Project Dates:

- conceptual design generation report [DR1]: **week of May 24th**
- concept selection design report [first DR2]: **week of May 31st**
- concept selection design report resub. [DR2R]: **week of June 7th**
- detailed design report [DR3]: **week of July 12th**
- formal design review: **week of July 12th**
- revised detailed design report resub. [DR3R]: **week of July 19th**

Note: design reports are due promptly before the beginning of your formally scheduled lab period.

Grading:

Each timed run is limited to 5 minute (pre-bonus) and only stops when a team calls "time!" after bucketing as many balls as possible. The better of two runs is used to assess each team's dynamic performance. Completion times are used to rank teams achieving equal scores. If the team achieves a perfect run (i.e. 5 balls bucketed), a 60 second time bonus is awarded for each additional ball successfully deposited at the end of each run.

The project evaluation sheet is presented on the following page.

In general, we are looking for the following:

- a. students who read the project description and reference materials thoroughly
- b. students who select suitable project materials via physical testing or structural analysis
- c. students who test conceptual ideas by building representative prototypes
- d. students who work together to meet the weekly project deliverables and deadlines
- e. students who design a device that looks visually presentable and intentional
- f. students who communicate and work well in a group environment
- g. students who respect the facility, equipment, and staff

EML2322L Competition Evaluation

Group Number: _____

	1st Run	2nd Run
Completion time (5 min. max):	_____	_____
Number of required balls (5 max):	_____	_____
Number of bonus balls (4 max):	_____ × -60sec	_____ × -60sec
Total (Official) Time:	_____	_____

Note: teams receive a project grade bonus according to their competition performance / placement. The team achieving the fastest time receives a 10% project bonus, the team achieving the slowest time receives 0% bonus and all other teams receive a bonus proportional to their competition time ranking.

(0: Unacceptable 20: Poor 40: Below Average 60: Satisfactory 80: Good 100: Excellent)

1. Project completed according to instructions listed for the assignment (20%).

(Size: 10% // POs: 20% // BOM/ASSY DRAWINGS: 40% // ECNs: 30%)

0 20 40 60 80 100

2. Attention to detail, development of technical ability, quality of project visually (20%).

(Use well designed, machined components & avoid band-aids like cardboard & duct tape)

0 20 40 60 80 100

3. Overall effectiveness / success of project (20%)

(20% for each required ball)

0 20 40 60 80 100

4. Design reports (40%). _____

5. Project completed within the allocated \$50 budget.

(NO = 10% project grade penalty)

YES / NO

6. Respect for laboratory resources & staff; project disassembly & cleanup (-10%)

(Disassemble project, clean out lab bin, clean work area, and submit toolbox check-off sheet)

0 25 50 75 100

Overall Project Grade: _____
