Problem Statement:

Five sealed target bottles each containing two fluid ounces of water are located within a 5’ x 20’ enclosed arena. The arena also contains your choice of ten tennis balls or racquetballs. The assignment is to design and prototype a mobile device to enter the arena and topple the five target bottles using the ten provided balls within a five minute time limit. To simulate real-world engineering competitiveness and make the challenge more exciting, you will compete against another team on an adjacent identical course at the same time. Refer to 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. 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 mounting flange must be used for fastening the control box to your mobile device. No other controllers or power sources can be used for the project.

Click here for 3D PDF of arena

Click here for SW arena assembly model
2. The entire device must fit within a 17" × 12" × 15" container at the end of each weekly
lab session. Parts not completely within the fully closed container incur a grade penalty.
Teams can leave their designs fully assembled one week prior to 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, target
bottles, or balls during timed runs, but they can assist with navigation from outside the
arena boundaries. Neither balls nor bottles may be modified prior to or during a run.

4. Each team must be capable of competing on either side of the arena; sides will be
randomly assigned the day of the competition. Each team can select their desired ball
type (the arena illustration on the first page shows both ball types for clarity, but either
type will be available on either side of the arena, at each team’s request).

5. Targets must be felled from within the arena using only the balls inside the arena at the
start of each run. Balls used in attempt to fell a target must be released from behind the
designated shooting line. Targets felled via balls released with any part of the device past
the shooting line will not count and may not be righted (returned to original position).

6. Balls which roll off the carpet strips and onto the painted floor may not be collected.

7. Tipped bottles counting towards the score must be intentional; bottles felled due to ball
rebounds off arena walls or other bottles do not count towards the score and will be
righted by a TA, allowing the team another chance to intentionally fell the target(s).

8. The arena will be set up near the large overhead laboratory door; note the floor condition
and design accordingly.

9. 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.

10. 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.

11. Any materials may be used except liquids; do not feel limited by what is available in the
lab. Suitability of selected materials will be evaluated, as will project appearance.

12. 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.

13. 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. exiting the arena over the bounding wall
   c. intentionally felling the other team’s targets or inhibiting their ability to complete
      the objective (i.e. we want to see fair competition runs)
**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 September 3rd
- concept selection design report [*DR2*]: week of September 10th
- concept selection design report resubmission [*DR2R*]: week of September 17th
- detailed design report [*DR3*] & formal design review: week of October 1st
- revised detailed design report resubmission [*DR3R*]: week of October 8th
- oral project presentation: week of November 12th
- course competition / updated documentation due: week of November 19th
- final design report [*DR4*]: week of December 3rd

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

**Grading:**

Each timed run is limited to 5 minutes and only stops when a team calls “*time!*” after felling as many of the target bottles as possible. The better of two runs is used to assess each team’s dynamic performance. Completion time is used to rank teams achieving equal scores (i.e. toppled bottles).

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 prototypes in the lab during office hours
d. students who manufacture parts using equipment and processes taught in the lab
e. students who prototype, test, and modify in time to achieve the design objectives
f. students who build devices that looks visually presentable and intentional
g. students who communicate and work well in group environments
h. students who respect the facility, equipment, and staff
Group Number:  _____  

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<thead>
<tr>
<th></th>
<th>1st Run</th>
<th>2nd Run</th>
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<tbody>
<tr>
<td>Time to complete required targets:</td>
<td>______</td>
<td>______</td>
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<tr>
<td>Number of felled targets:</td>
<td>______</td>
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Note: teams receive a project grade bonus according to their competition performance. The team which fells the most bottles in the quickest time receives a 10% project bonus; the team which topples the fewest bottles in the slowest time receives 0% bonus, and all other teams receive a bonus proportional to their competition 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: 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 target)  
   | 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: __________________________
RAMP

NOTES: DIMS IN INCHES
ALL MEASUREMENTS +/-0.25" UNLESS NOTED
MATL: WOOD (PINE)