



Project Competition Guidelines and Rules

UCSD Mechanical and Aerospace Engineering 3
MAE 3 FA21

Last Revision Date: 11/09/2021

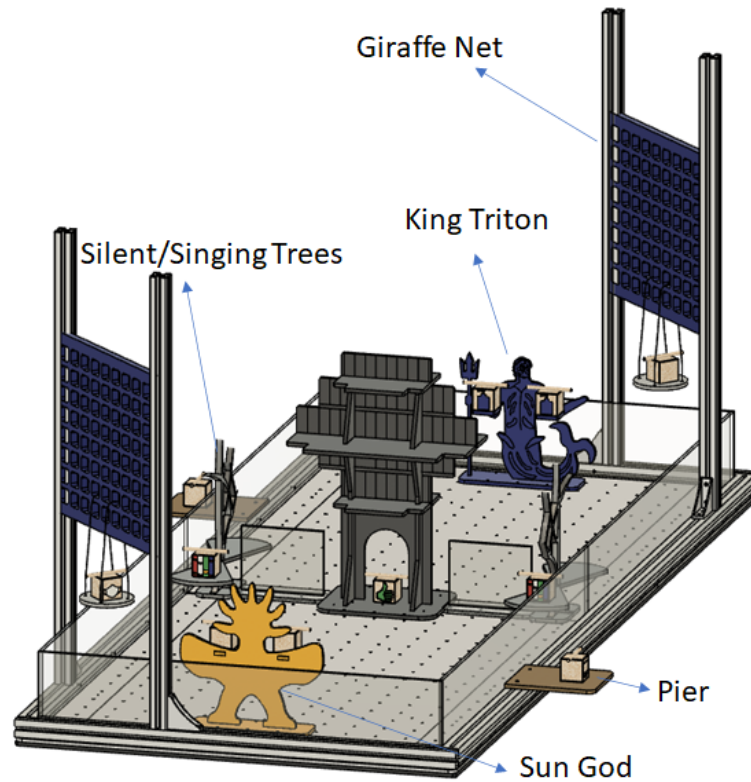
Project: **Return to Learn**

Written by: MAE Instructional Team

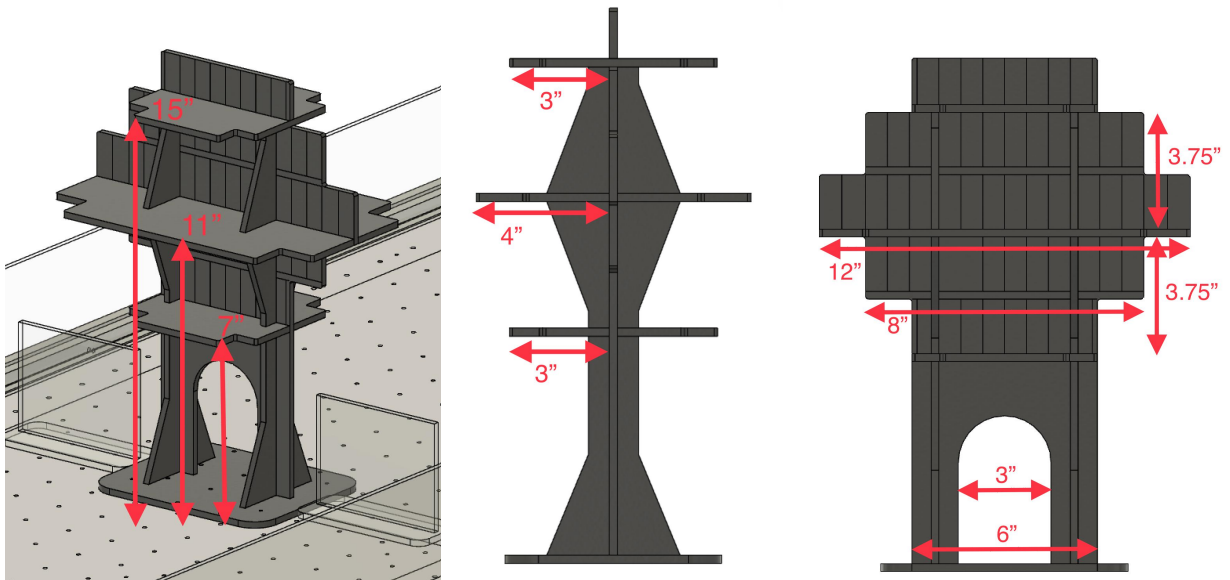
Overview

UCSD needs your help! The overwhelming number of students coming back for in-person classes is flooding the campus with a level of activity never seen before, and we will need more resources to help students get back to school! Because of all the new construction, the delivery trucks are having trouble getting the supplies to their final destination -- Geisel Library! The delivery trucks are parked near different UCSD landmarks, and we need you to build a robot that can help with these deliveries. Your job, as a team, is to design, test, analyze, fabricate, and deploy your robot to pick up supplies from different locations around campus, and deliver them to the university center at Geisel.

Two robots will compete head-to-head for 60 seconds. Robots will try to score as many points as possible, by gathering the supply boxes and delivering them to various floors of Geisel Library. Based on the relative difficulty to retrieve the different supplies, certain ones are worth more than others. In order to reduce the workload of our already tired librarians, more points will be awarded for supplies delivered to higher floors. All scoring will be done at the completion of the contest after all parts have finished moving. Read the details of points below, and set your priorities straight when grabbing those supplies!



- Geisel Library Dimensions



Height of Top Level: 15"
 Height of Middle Level: 11"
 Height of Bottom Level: 7"

Scoring

The supply boxes are spread throughout the campus (playing field), as shown in the following pictures. Points are awarded based on the relative difficulty of grabbing the supply box, as well as based on which floor it is delivered to. To calculate your score in this competition follow these steps and the chart provided below.

- For each side, there are 6 possible supply boxes to retrieve, plus one shared supply box in the middle under Geisel. Each box is worth the following amount of points if placed on one of the floors of Geisel:
 - **Computer at the Piers** - 40 points
 - **Masks at the Giraffe Net** - 30 points
 - **Books at the Silent and Singing Tree** - 20 points (2 per side)
 - **Hand Sanitizer at the King Triton or Sun God statues** - 10 was points each (2 per side)
 - **Green Thumb at Geisel** (Tiebreaker) - no points, but in the case of a tie, whoever has this piece on their side will win
- 3 Levels of Geisel to deliver supplies to, each offering a different point multiplier:
 - **Bottom Level** (3rd floor of Geisel): 1X Point Multiplier (maximum of 2 boxes allowed)
 - **Middle Level** (6th floor of Geisel): 1.5X Point Multiplier (maximum of 3 boxes allowed)
 - **Top Level** (8th floor of Geisel): 2X Point Multiplier (maximum of 1 box allowed)

Please note that you are only allowed to reach over to your opponent's side of the playing field AFTER you have placed ALL of your supply boxes onto the floors of Geisel.

Calculating Points:

(Example Scoring Sheet below)

Landmarks \ Scoring Zones	Bottom (3rd floor) (x1)	Middle (6th floor) (x1.5)	Top (8th floor) (x2)
Statues (10 pts)	2	0	0
Trees (20 pts)	0	1	0
Giraffe Nets (30 pts)	0	0	1
Pier (40 pts)	0	0	0
Total pts per floor	20 pts	30 pts	60 pts
Penalties:			0
Total points:			110

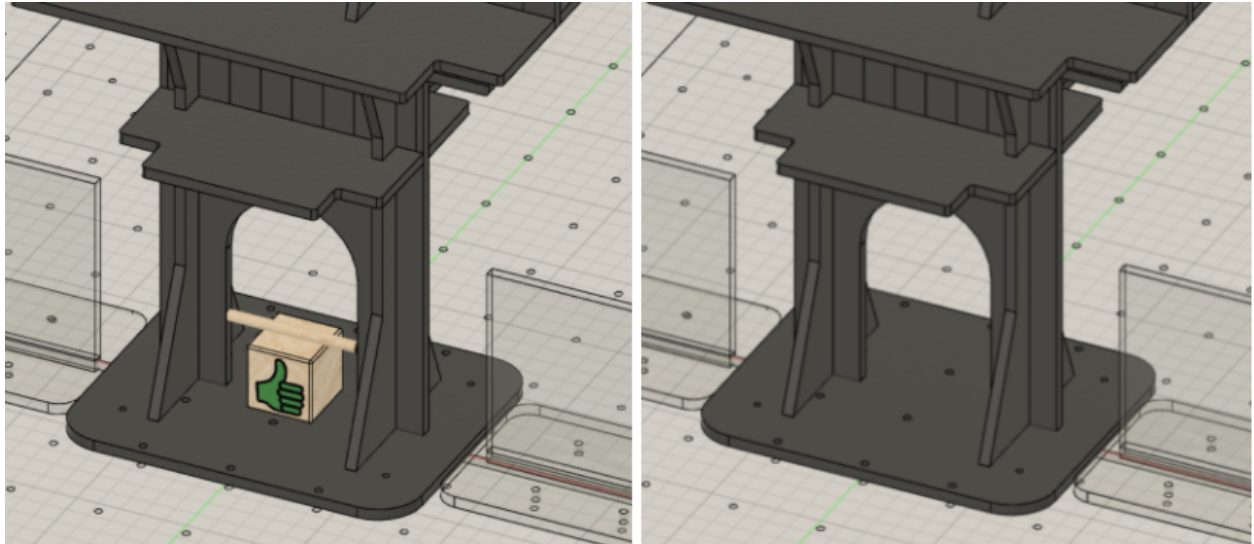
Robot Boundary Restrictions:

In the spirit of sustainability, and to support the campus's goal of becoming carbon neutral by 2025, there will be material and size limitations to your robot. Robots must fit entirely within a **10x10x10in starting box** at the start of the competition, but can be located in any position within the team's half of the field so long as no part of the starting box is touching any object on the contest table (including the side walls and any of the structures) when placed over the robot. The robot may extend past this bounding box **only after the round of the competition has begun**.

Tie Breakers:

In the event of a tie, the first tiebreaker will be possession of the Tiebreaker piece (the supply box located under Geisel). Whichever team has the Tiebreaker piece on its side of the table will be the winner. If the Tiebreaker has not been moved from its starting position, then the second tiebreaker will be settled in a duel of rock paper scissors. **The floor of Geisel below**

the first level, or 3rd floor, is considered a neutral zone, and can be entered by robots at any time.



General MAE 3 Competition Rules

A complete list of rules is provided at the end of this document, and any clarifications to the rules will be posted at the end of this webpage throughout the quarter. However, some key rules are:

- Robot setup time on the contest table cannot exceed 2 minutes.
- Manufacturing variations will exist between playing fields. It is the team's responsibility to design a robot that will work on all contest tables.
- Each robot must only be built out of kit parts provided.
- Robots must be built in the Design Studio only using Design Studio tools.
- The disassembled robot must be able to fit in the team's locker, where it must be stored.
- Robots may be designed to interact. However, it is not in the spirit of the competition to intentionally damage another machine and no part of the kit may be used in a manner that is intended to cause harm. Any device which is designed to sabotage another machine or its ability to compete will be subject to disqualification. If you think your machine may be at risk for violating this rule, ask early before you build it!
- Robots will compete in a head-to-head competition. However, operation of the robot without an opponent will be an important part of the robot grade.
- Only boxes that are on the designated floors of Geisel at the end of the competition will count for points (Note that it is okay if the boxes are touching/stacked)
- If your robot is touching a box at the end of the contest, that box will not count for points

Electrical Power

The robots must be powered solely from electrical power transferred through the power cord, and from potential energy stored in the robot at the start of the contest. The kit includes 4 geared DC motors, and 2 non-geared DC motors. Electrical power will be provided from a power supply with a maximum of 5VDC output. The power will be controlled by the following switches:

- Two Fixed 5 Volt DC switches
- Two Variable Voltage switches (0 to 5VDC) with a user-controlled knob to adjust the voltage.

Each switch is Double Pole Double Throw (DPDT) switches, which can operate a DC motor in either direction. Note the kit contains six DC motors, but only four user-controlled switches. More than one electrical device can be connected to a single switch, but the voltage may drop if a large current draw is placed on the power supply. Use of motors, solenoids, and switches will be covered in lecture and is described in the course pack.

Review the Power Supply and Multimeter Use carefully. Issues with the electrical power often occur with the Variable Voltage switches, since the maximum current output is less in these switches. The non-geared motors draw high current and startup problems may occur if multiple non-geared motors with high loads are tied to the variable voltage source!

Kit Parts and Use Guidelines

Each machine must be constructed solely from materials provided in the Kit Parts list (List attached below). Some key points on these guidelines are:

- No foam core allowed in the final robot (as stated in the kit parts list).
- The wire and string are “serve-yourself”, but are limited in length as noted.
- The paper cover on the acrylic parts is not to be used as a separate part. If it is detached from the acrylic, it must be discarded.

In addition to the kit parts listed in the table, the following items may be included in the machine:

- Nuts, bolts, and washers included in the Design Studio bin. These include bolts from size 2 to size 10, and metric screws for mounting the motors.
- Only take nuts and bolts from the bin as you need them, and **search through the spare bolt bin** before taking more (we went through \$1,500 in fasteners last year!).
- Adhesives are allowed; including hot melt glue, and acrylic adhesive.
- Tape used ONLY for electrical insulation.

- Lubricants used only to reduce friction within one's machine (not on the contest table).
- Nonfunctional decorations. These are encouraged!

Replacement Material Policy: We have some extra material that can be used for experimentation. This material will be made available in the lab scrap bins. In addition, each section tutor has access to a limited amount of replacement material for their section. If you need replacement parts, contact your tutor. Some replacement of "mistakes" made to kit parts will be available, but supplies are limited, and replacement is not guaranteed.

3D Printed Parts

See 3D printing page for complete rules:

<https://sites.google.com/a/eng.ucsd.edu/mae3/3d-printing>

Each team may have parts made in the Design Studio's 3D printers under the following guidelines.

- The combined volume of all 3D printed parts may not exceed 50 cubic inches per team.
- Individual prints must fit within a 4x4x4in cube.
- Team members must create the CAD files for all 3D printed parts, except for gears, timing belt pulleys, and selected parts that will be posted on the MAE3 webpage.
- Teams can experiment with 3D printing and parts that are not used on the robot will not count towards the team's total. However, priority to the 3D printer will go to students working during their section time and to teams which have not yet used to 3D printer as much. Use of the 3D printer may be heavy during the final weeks of the class, so do not count on readily available access at that point.

Furthermore, students are allowed to use/access other 3D printers, on or off campus, provided that the material used to print the final robot part is PLA.

Energy Sources

The energy used by the devices in the competition must come solely from:

1. Potential energy derived through a change in altitude of the center of gravity of the machine
2. Potential energy achieved by the deformation of the springs provided by the kit
3. Electrical energy derived through the umbilical during the 60 seconds when the power supply is energized.

Umbilical Cables

The electrical connections attach to a single umbilical cord hung from above the table; one on each side of the table. The umbilical cord cannot be touched during the contest, and there will be some drag from the cable. Each machine must be designed to overcome this drag as needed for motion of the machine. If requested, a TA can ensure that the umbilical cable does not snag.

Contest Day Details

The contest will be held during the MAE finals period and will be open to the public. The contest will be held in a single elimination fashion (like a tennis tournament). During the lab period of the last week of classes, each section will hold a section-wide contest. The results of this contest will be used to seed the placement of the final contest. Thus, teams that perform better during their section contest will have statistically easier contests in the early rounds. Since the number of teams in the class will not be exactly a power of 2, the higher seeded teams may get a "bye" during the first round. If necessary "wild card" teams will be selected to have a second chance in the contest, to ensure that all pyramid spots are filled.

Performance in the contest depends on numerous factors that do not relate to engineering quality of the robot, including driving skill and luck!

The grade for the project will not be adversely affected by poor performance in the contest, but will be based upon:

1. Performance of the machine without an opponent. A video record of the robot performance at its best should be included in the team's oral presentation and on the team's website.
2. Effective communication of the design (orally and in final reports).
3. Documentation of the design process and justification of decisions made.
4. Analysis of machine performance in the robot reports.
5. Following good design practices.

A trophy will be presented to each member of the winning teams, and a number of machines will be selected for display in the Design Studio. Team members must work out among themselves who will keep the final machine (after their display period). Teams will post presentations and a video of their robot on the class web page, which they can cherish forever.

Addendum

Expanded Rules List

1. Only the tools and machine equipment in the Design Studio can be used to build the robot.
2. Judges and/or instructors will disqualify any device that appears to be a safety hazard.
3. Any machine that has flying parts must notify opponents, and all contestants must wear safety glasses during the machine operation.
4. If a projectile is used, for reasons of safety, it must have a frontal area greater than 2 inch squared.
5. Contestants will randomly be assigned to start on either side of the playing field.
6. A maximum set-up time of 2 minutes will be allowed at the contest table.
7. A maximum of 1 minute will be allowed for removal of all parts of each machine after each contest.
8. Operators may interact with their machine during a contest only through normal operation of the switch boxes (for example, you cannot touch the machine with one's hands during operation).
9. It is allowable to adjust the configuration of the machine between contests; for example, adjusting the configuration to the side of the playing field the machine starts on.
10. Each machine can only interact with the surface of the playing field and objects on the playing field.
11. The judges will wait until all the playing pieces have stopped moving before determining the winner.
12. Points will be awarded based upon the final location of the playing pieces, regardless of which machine moved them.
13. Damaging the playing field or the control boxes may result in disqualification.
14. Purposefully using the electrical cables for any purpose other than transmitting electricity is not allowed.
15. Gaining traction by use of adhesives, or by abrading or breaking the surface of the playing field is not allowed. However, it is permissible for a team to bolt a stationary robot to the table using the existing mounting points.
16. A machine may not contaminate with lubricant or other substance the playing field or an opponent's machine (internal lubrication of a machine is permissible).
17. Kit materials may not be changed chemically. DC Motors may not be rewound.

18. The paper that is attached to the acrylic in the kit cannot be used as a separate element in the machine. If any piece of paper is detached (even partially) from the acrylic it must be discarded.
19. The insulation must remain on the electrical wire in the kit except where the wire end is attached to another component, and there up to 0.5" of insulating can be removed.
20. The clear acrylic 0.25 thick is for testing. If you include any of this acrylic in your final machine, you must remove an equivalent amount of colored acrylic that was used in making the part.
21. Cable ties (zip ties) can only be used for strain relief.
22. Hot glue cannot be used in the final robot! (okay for prototyping, risk reduction). Acrylic glue and super glue should be used only when necessary and should be avoided in the construction of structural elements. Excessive use of glue in the final robot will lead to reduced points on the final robot grade.
23. Spare parts are available on a limited basis. Students should go to the tutors of their section to receive replacements for parts broken. Student can purchase replacement acrylic from upper campus machine shop or off campus (see door of Chris Cassidy's office for sources)
24. Machines may be designed to interact. However, it is not in the spirit of the competition to intentionally damage another machine and no part of the kit may be used in a manner that is intended to cause harm. Any device which is designed to chop, break, or penetrate another machine will not be allowed to compete. If you think your machine may be at risk for violating this rule, ask early before you build it! (see rule clarifications)
25. Machine advertisements and decorations must be of the nature that it does not offend any other students or audience participants (use common sense!).
26. All rulings of the judges will be final.

Changelog

Sections	Changes/Addition	Date
Electrical Power	Changed "five DC motors and a solenoid" to "six DC motors"	10/19
3D Printed Parts	Added "Students are allowed to use/access other 3D printers, on	10/19

	or off campus, provided that the material used to print the final robot part is PLA.”	
Overview	Updated "Geisel Library Dimensions" with the correct dimensions”	10/23
Tie Breakers	Added “The floor of Geisel below the first level, or 3rd floor, is considered a neutral zone”	10/24
Addendum	Added changelog and project milestone	10/24
Addendum	Added expanded ruleset for clarification	11/9

Robot Project Milestones				
Week 6	Week 7	Week 8	Week 9	Week 10
Risk Reduction Presentations	One Working Powered Robot Component Fabricated	Score Points During Section With Your Robot	Beat the TA/Tutor Built Golem	Final Presentation and Finished Robot Checkoff