Robot Project Competition Guidelines and Rules

UCSD Mechanical and Aerospace Engineering 3
MAE 3 SP24

Last Revision Date: 04/22/24

Project: Year of the Dragon

Written by: MAE 3 Spring 2024 Instructional Team

Changelog

Sections	Changes/Addition	Date
Initial release	Point allocation and rule definitions	04/16/24
General MAE 3 Rules	Added contest specific rules	04/22/24

Disclaimer

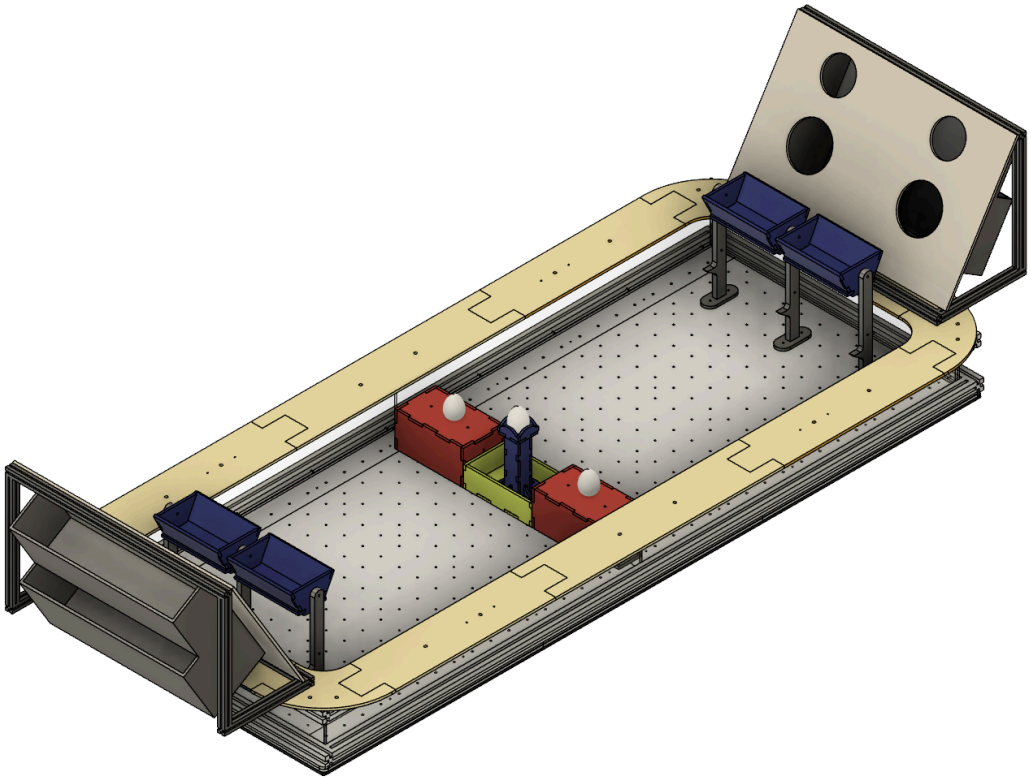
Features of the robot contest are subject to change throughout the quarter if necessary to balance the contest or to meet manufacturing constraints. In particular, the points may be subject to change. These will be finalized by Lab 5.

Overview

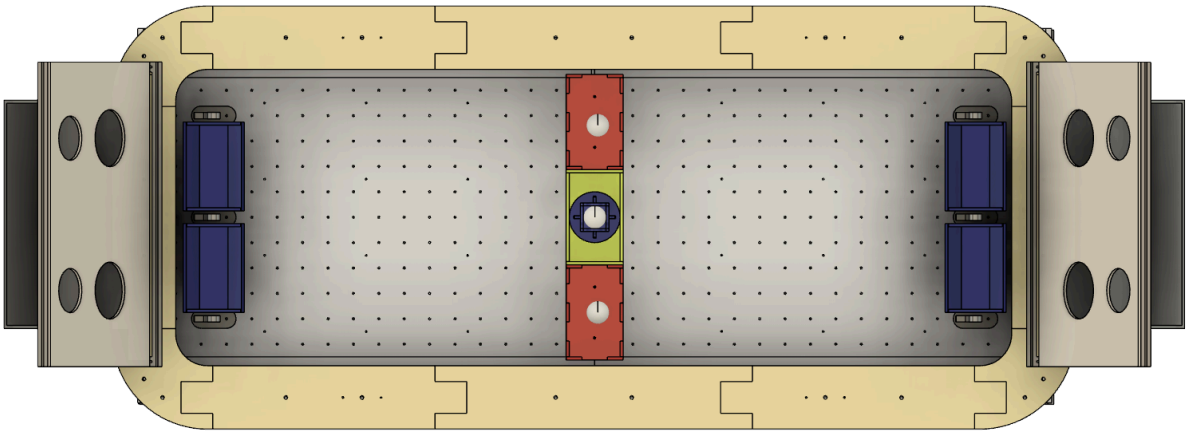
2024 is the Year of the Dragon, as well as the 50th anniversary of Dungeons and Dragons! Help the MAE department to celebrate the occasion by creating a mechanical Dragon of your own! Your job, as a team, is to design, test, analyze, fabricate, and deploy your robot, henceforth known as a Dragon, to protect their Dragon Eggs from danger and use their fire breathing skill to defend their territory!

Two teams and their Dragons will compete head-to-head for 60 seconds. Dragons will try to score as many points as possible by gathering their Dragon Eggs and Fireballs and attacking the opposing teams territory. Based on the relative difficulty to attack, certain locations will score more points than others. Dragons that are more accurate with their attacks will be awarded more points. All Scoring will be done at the completion of the contest after all parts have finished moving. Read the details of the Contest Table and points below!

Playing Field



Isometric view of the contest table



Top view of the contest table

Contest Table Dimensions

- Backboard Hole Diameters
    - Castle Hole: 3.5 in
    - Dungeon Hole: 4.5 in
- Trolley Track to Floor Height
    - 5 in
- Territory
    - 34.5 in x 27 in
- Trough Dimensions
    - Top Inner Area: 6.5 in x 4.2 in
    - Bottom Inner Area: 6.5 x 2.1 in
- Dragon Egg Center Boxes
    - Length: 7.5 in
    - Width: 4.6 in
    - Height:
        - Red: 3.75 in
        - Green: 2.25 in
- Pillar
    - Height: 7.25 in
    - Top Area: 1.79 in x 1.79 in
- Center Point of Dungeon Hole to Floor:
    - ~ 13 in
- Center Point of Castle Hole to Floor:
    - ~ 17.5 in

Scoring

Two Dragons (robots) will compete head-to-head **for 60 seconds**, aiming to score as many points as possible. Points are scored by attacking the opposing team's territory with Fireballs (rubber bouncy balls) and collecting Dragon Eggs for a score multiplier. At the start of each match, Dragons must fit entirely within a **10x10x10in starting box**. At the start of the match, no part of the starting box may touch any object on the contest table (including the side walls and any of the structures) when placed over the Dragon on the field. **The Dragon may extend past this starting size only after the round of the competition has begun.**

Fireballs are stored in 2 rotating troughs at the back of each side of the competition table. Each trough has 25 Fireballs, for a total of 50 on each side. **Fireballs can only be scored by attacking the opponent's side of the contest table.** Fireballs are worth 1 point each, with an additional multiplier depending on scoring location and egg multipliers (see below). Fireballs are uniquely colored to each side of the contest table to differentiate scoring. There are no penalties for Fireballs of your color left in your territory, but they also score no additional points.

Fireball Scoring Location	Multiplier
Territory (Contest Table Floor)	1x
Dungeon (Middle Backboard)	25x
Castle (Top Backboard)	100x

Fireballs (Bouncy Balls): 1 inch diameter, ~8 grams each

Wooden Eggs: ~32 grams, 2.37 inch tip to tip length, 1.54 inch max diameter

3 Dragon Eggs are placed in the middle of the field that may be captured for additional point multipliers based on the total number of Eggs collected. Dragons may capture these Eggs by bringing them to their side of the contest table. **Egg point multipliers only apply to Fireballs scored in Territory (Contest Table Floor)** and do not affect the Fireballs scored in the Dungeon and Castles. The more eggs captured, the higher the multiplier that the Territory Fireballs will receive.

- 1 egg: 2x multiplier
- 2 eggs: 3x multiplier
- 3 eggs: 4x multiplier

Please see sample scoring charts on the next page

Example Scoring Sheet:

[Scoring Calculator]

Example 1:

	Team A		Team B	
Attack Zone	**Fireballs**	**Score**	**Fireballs**	**Score**
Territory	50	50	47	47
Dungeon	0	0	2	50
Castle	0	0	1	100
Eggs Captured	3		0	
Multiplier	4		1	
Territory Updated	200		47	
Total Score:	200		197	

Example 2:

	Team A		Team B	
Attack Zone	**Fireballs**	**Score**	**Fireballs**	**Score**
Territory	20	20	40	40
Dungeon	5	125	2	50
Castle	0	0	0	0
Eggs Captured	2		1	
Multiplier	3		2	
Territory Updated	60		80	
Total Score:	185		130	

Tie Breakers:

In the event of a tie, the team with more captured Dragon eggs will be deemed the winner. If both teams have collected the same number of Dragon Eggs, teams will replay the round to determine a winner. If the result is a tie with once again the same number of Dragon Eggs, teams will designate one representative and settle the round with a game of rock paper scissors.

General MAE 3 Competition Rules

Competition Operation

- Robot setup time on the contest table cannot exceed 2 minutes per round.
- Manufacturing variations will exist between playing fields. It is the team's responsibility to design a robot that will work on all contest tables.
- 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.
- Robots may not be designed to directly interact with the opponent. 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 must remain in one piece during competition rounds with all components structurally connected via acrylic, aluminum, or PLA supports. No sub-robots or detaching components that permanently separate from the robot are permitted.

Contest Specific Rules

- Due to flying parts, **safety goggles are required** for all contestants when any robot is in operation
- While in operation, robots must remain within a region of play as defined below:
    - Robots may not reach beyond the center wall into an opponent’s side
    - Robots may not reach to block or otherwise cover any part of the backboard on their side of the field
    - Robots may not reach beyond where the 80-20 supports for the backboards begin
    - Robots may not occupy space 15” above the contest table floor for longer than 3 seconds at a time
- Clear acrylic is intended for prototyping purposes, but if a functional component is made during risk reduction efforts, it can be included in the final robot

Manufacturing

- 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 fit in the team's locker, where it must be stored.
- Cable ties (zip ties) can only be used for strain relief.
- Purposefully using the electrical cables for any purpose other than transmitting electricity is not allowed.
- Kit materials may not be changed chemically. DC Motors may not be rewound.
- The insulation must remain on the electrical wire in the kit except where the wire end is attached to another component, and there may be up to 0.5” of insulating can be removed.

Playing Field

- Damaging the playing field or the control boxes may result in disqualification.
- 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 on the table.
- A machine may not contaminate with lubricant or other substances the playing field or an opponent's machine (internal lubrication of a machine is permissible).

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 acrylic adhesive and hot glue, but should only be used when necessary. Hot glue is only allowed for non-structural components like strain relief, and excessive use of glue in the final robot will lead to reduced points on the final robot grade.
- 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.

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 5V DC 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!

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 printed parts 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 3D printers 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.

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.

For each round of the competition:

1. Contestants will randomly be assigned to start on either side of the playing field.
    a. Variations exist between contest tables, robots are expected to be able to perform regardless of what table they are assigned to.
    b. Judges and/or instructors will disqualify any robot that appears to be a safety hazard.
2. A maximum set-up time of 2 minutes will be allowed at the contest table.
    a. Configuration of the machine is permitted between rounds; for example, adjusting the configuration to the side of the playing field the machine starts on.
3. During each round, 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).
    a. Furthermore, each machine can only interact with the surface of the playing field and objects on the playing field.
    b. Robots must remain on their side of the playing field and not directly interfere with the operation of the other team’s robot or operators
4. After sixty seconds have elapsed, each team will stop providing input to their robot through their controllers

    a. Failure to stop at sixty seconds will result in disqualification
5. The judges will wait until all the playing pieces have stopped moving before determining the winner.
    a. Points will be awarded based upon the final location of the playing pieces, regardless of which machine moved them
6. A maximum of 1 minute will be allowed for removal of all parts of each machine after each contest.

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.