

**MECH 202 Spring 2010 Competition Project**  
**“Climbing the Engineering Ladder” (updated April 19, 2010)**

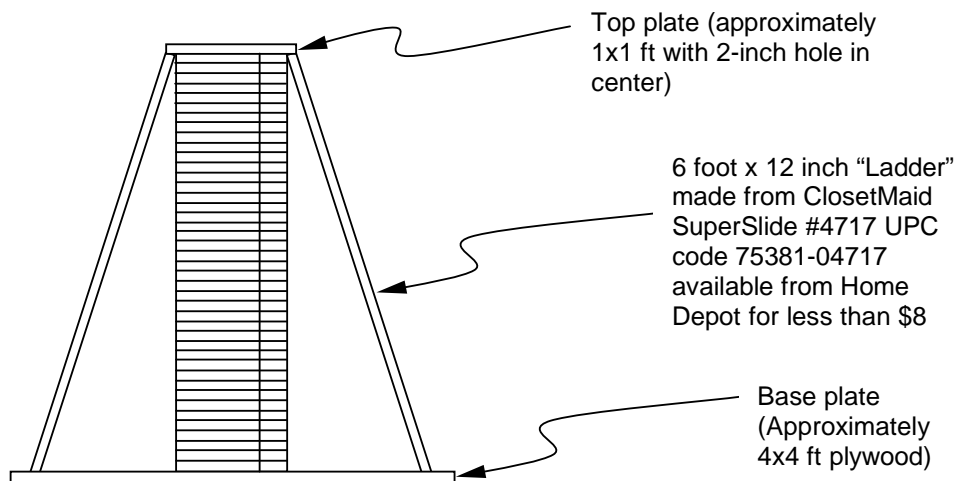
Your team is to design, fabricate, assemble and compete with a device that will climb a “ladder” and satisfy the rules of the competition as described below. The MECH202 TA’s are the “Judges of the Competition.” Bob Thilmont and Bert Vermeulen will act as Chief Judges.

**The Time**

The Competition will be held Saturday, May 1 starting at 10am in Eng 100 (a). You should plan for this to take most of the day.

**The Competition**

1. The objective is to be the first team (of four in each round) to place a ping-pong ball into a hole at the top of a test fixture.
2. The test fixture looks like four ladders (made from closet racks having steps 1 inch apart) angled at about 76 degrees from horizontal (b). This creates a pyramid shape. Each ladder is 6 feet long (c). Below is a conceptual (not to scale) view of the configuration. The actual test fixture will be kept in the TA’s office. You are encouraged to visit the office and take any measurements of the test fixture so that you can ensure that you build your device to work correctly on it. However, you are not allowed to place your device onto the test fixture until the first time you compete on May 1.



3. At the top center of the pyramid there is square plate approximately 12” x 12”. In the center of this plate is a hole approximately 2 inches in diameter (d).
4. At the start of each round of the competition, four devices will be placed at the base of each of the four ladders. At the starting time, the device can extend no more than 9 inches from the base of the ladder in the direction of its peak. This point will be marked on each ladder as being the 9<sup>th</sup> rung on the ladder. The devices cannot be touching the 9<sup>th</sup> rung on each ladder at the start of the round. The devices must fit entirely on the ladders at the start of the race and cannot touch or use the base for support. The devices can have elements that extend up to 1 inch into the ladder steps in order to hold onto the ladder. This means that at the start, the device can be no longer than 9 inches and no wider than 12 inches. The device may also be no taller than 9 inches at the start of the round (including the 1 inch that can extend into the ladder steps). Once the go signal has been given, your device can enlarge itself so long as it stays a single device, except for releasing the ping-pong ball. For safety reasons related to the strength of the ladders, the device can weigh no more than 5 lbs.

5. At the start of the round of the competition, each of the four competing teams will be given a colored ping-pong ball that is of regulation size and weight. The ping-pong ball must be carried on the device.
6. At the sound of “go” you will start your device. Once you have started the device, no one can physically touch the device until the round is finished and the judges have declared a winner. No part of the device may be left behind after the device starts. All parts of your device must ascend the ladder. ~~Note, I would prefer to use an electric start if we can get one fabricated prior to spring break. The electric start would use solenoids and some predefined hook that would pull an actuation pin on each of the four devices at the same time. By using such an electric start we could ensure that all teams have stepped away from their devices. We need to talk about this and whether it would be feasible in time (e).~~
7. Each round of the contest is 45 seconds long. At the end of the round, the devices will preferably be stopped or stop themselves.
8. In order to qualify as a working device, your entire device must have moved past the 3-foot point (36<sup>th</sup> rung) on the ladder prior to your ping-pong ball going into the hole. During this 45-second period, the judges will confirm that the devices have moved past the 3-foot point and will observe whether any of the four devices have placed (and released) their ping-pong ball in the hole. If so, the device that placed (and released) its ping-pong ball first (after entirely clearing the 3-foot point) will be deemed the winner.
9. If, during the 45-second period, none of the four devices places its ping-pong ball in the hole after clearing the 3-foot point, the device that (a) has completely cleared the 3-foot point and (b) has its ping-pong ball at the highest elevation (but still physically attached to its device) will be declared the winner.
10. If no competing device has cleared the 3-foot point then the device that has its furthest back point at the highest elevation will be declared the winner.
11. The competition will be “double elimination” so each team will have at least two chances to participate. Details of how the heats and how the winners and losers move from round to round will be available prior to the day of the competition (f).

#### **Other Rules**

12. You are encouraged to build your own test fixture. We deliberately made our fixture from standard parts that are low cost, so that you duplicate the key elements of the fixture in order to test your device.
13. Your device can only use and touch your ladder and the top plate. Your device can specifically not touch any of the other ladders or the base plate.
14. In case of a tie, the lightest device will be judged the winner.
15. Keep in mind that the ladders and other parts of the fixture might not be perfect or exactly like a test fixture that you might fabricate from the same parts. It is important that your device can tolerate these types of differences. This is part of having a robust design.
16. Your device can be made from any materials that you would like to use. However, you cannot use any energy storage method or device that might be deemed hazardous. Examples of hazardous energy storage devices include, but are not limited to:
  - Chemical explosives, gunpowder, combustion processes, or highly exothermic reactions (such as model rockets).
  - A compressed fluid that might release too quickly
  - A spring or other storage device that can release a tremendous amount of energy too quickly.

– Any element that is deemed to be unnecessarily harmful to either the roof truss or another competitor's device.

The TA's will serve as "OSHA" safety inspectors. You will need their certification from a safety inspector at least 18 hours prior to the start of the competition. It is in your interest to contact the safety inspectors early to ensure that you do not waste time on a device that may not be certifiable.

17. No human thrust (pushing, pulling, nudging, shooting, etc) allowed at any time. You are allowed to touch the device to start it, but that touching must not provide a force that creates work (force \* displacement up the ladder). This would be rewritten if we have an electric start (g).
18. Energy. See rule 16. If your team is not willing to stand next to your device without protective clothing or safety glasses, your device will be considered hazardous! However, since some individuals are braver than others, the judges reserve the right to deem a device hazardous.
19. Use of living beings. The device cannot contain any biological components. For example, you are not allowed to employ a trained hamster to place the ping-pong ball in the hole.
20. Electric motors. In the past a high percentage of devices have used electric motors. This is fine, but can run up the cost of your device. We have tried deliberately to try to keep the cost of this competition as low as possible. For that reason, we chose an extremely light payload (a ping-pong ball). We encourage teams to come up with elegant low-cost ways to meet the requirements that do not require motors. We have also obtained a supply of 6V DC motors with reduction gears. There is one of these motors available (along with product specifications) for any team that would like one (h).
21. ANY intentional attempt to damage the opponent in lieu of meeting the objectives of the competition will be grounds for disqualification. In the case of destruction deemed by the judges to be accidental, but severe enough to unfairly influence the competition's outcome the judges may permit repairs and a rematch.
22. You are not allowed to intentionally block the hole that the ping-pong ball should go into. The intent is that your device moves close enough to the hole that you can accurately place the ball in the hole and allows others to do the same.
23. Other than releasing the ping-pong ball (which must be released to go into the hole), your device must remain a single unit at all times – no "free" or unattached components are allowed at any time.
24. Each round will have a maximum of five minutes for you to place your device onto the ladder, start, compete and remove the device from the fixture. If your device fails to start or becomes disassembled during the competition you will forfeit that round. If all teams fail to pass the starting line rule 13 (lightest device wins) shall apply.
25. Your team must check into the registration table 15 minutes prior to your round. Failure to do so will result in a forfeit for that round. Once your round is complete you will need to track your team's placement on the bracket sheet and note the time of your next competition. You will be responsible to be ready on time for subsequent rounds based on the brackets you are assigned. If you fail to show up to your respective round you will forfeit that round.
26. Ping-pong balls. Your group will be given a ping-pong ball prior to your round. No modifications of the ping-pong balls will be allowed. You are also not allowed to use your own ping-pong ball. This guarantees that no team would be using a ping-pong ball that has been modified.
27. Can your device block the hole? Your device will be allowed to cover the hole provided your device will release its ping-pong ball within 1 second of blocking the hole. If you block the hole and the ping-pong ball is not successfully released you must prove to the judges through your design process that the device was designed with the intent to release the ping-pong ball within the 1-second rule. If your

device doesn't release its ping-pong ball and just blocks the hole with the intent of blocking the competing device, your group will be disqualified.

28. Damaging the fixture. Your team will be disqualified if your device intentionally or unintentionally damages the fixture in any manner including but not limited to: breaking any part of the fixture, generating noticeable nicks or notches that will impact the integrity of the competition, adding foreign substances such as oil or lubricants onto the fixture.

29. Protests. All protests must be registered immediately after the competing round. You must qualify your protests based on the ground rules and the project definition. Keep good engineering records (engineering book) of your development process to use to defend your positions. If you have no supporting documentation at the day of the competition, your protest will be disallowed. Bert Vermeulen will be the final judge on all protests.

30. Definitions.

Forfeit = Team loses the round

Disqualification = Team is eliminated from the competition

31. And keep in mind. This competition is a lot of fun and an opportunity to cheer and encourage everyone. Feel free to invite your friends and family as well. You can see elements of last year's competition at [www.mech202.com](http://www.mech202.com).

### **Judges Decisions Disclaimer**

In a competition of this nature it is hard to anticipate all the interpretations of the rules and situations that will arise in the competition. Therefore, anything not covered by these rules and the interpretations of the rules will be decided by the judges. These rules are subject to optimization, and may be altered by the staff to preserve the "spirit" of the contest.

### **The Rewards**

1. The winning team will receive an A for the course and will not have to take the final examination
2. The 2nd place team will receive an A for the project and a 100 for the final
3. The 3rd place team will receive an A for the project

We will ask other faculty members to help judge the devices for other areas of merit, which might include:

- Manufacturing craftsmanship.
- The use of mechatronics.
- Design simplicity and elegance
- Low cost (i)

### **The Lead Up**

Your design group may ask any questions whatsoever of Bob Thilmont, Bert Vermeulen or the TAs. This is strongly encouraged to ensure that your device meets the spirit of the competition. We encourage you to use RamCT to ask these questions. If you email questions to us, these questions and their answers will be posted on RAMCT. If you have any of us sign a "non-disclosure agreement" (sample attached), we will then discuss with you confidentially those issues you have, and will not disseminate your questions or the answers to the entire class.

### **Required Report**

Grading for this competition will consist of a required report. Your competition outcomes will not affect the grade of the report unless you place in one of the top 3 positions. The report will be turned in at the time of the competition, the first time your device runs on the truss. Please bind the report in a professional manner and also put an electronic (PDF) version of the report into the Drop Box. The report will consist of:

Page 1:

- Names and contact information for each member of your group
- A title identifying the device
- A photo of the device to fit in the remainder of the space of page 1

Report:

1. The specification that you designed the device to meet. This should be in your own words. It can use the information above, but should include other items that you thought were relevant. Your specification should attempt to quantify as much as possible using measurements that can later be verified. Please include how you prioritized the musts and wants.
2. An analysis of the physical and technical challenges that you needed to overcome including a description of alternatives for each of these challenges and a description of why you chose the design that you did. This analysis should include a description of how the design you chose intends to overcome these physical and technical challenges.
3. A set of drawings that show how your device functions. These don't need to be Pro/E drawings and they don't need all details. There needs to be text to accompany these drawings that explains the drawings in sufficient detail so that anyone "skilled in the art" (i.e. another student in this class) could fabricate a device that functioned similarly to your device.
4. A description of testing that you did to verify that your device would perform well in the competition. This should include a description of things you learned during these tests and improvements that you made as a result of testing.
5. An analysis of any safety concerns on your device and how you addressed them.
6. An analysis of any reliability concerns on your device and how you addressed them.

### **Post Mortem**

On Tuesday, May 4, all groups that did not win first second or third place should turn in brief post-mortem listing five – ten things they learned from the competition. The teams that won one of the top three places may also turn in something if they like. Doing a post-mortem is a good idea for any project.

---

**Request for Confidentiality**

The undersigned agrees to hold confidential information of a competitive nature with the group members listed here. If the discussion leads to items of general interest (eg. – rules, competition or grading clarification), the design group allows publication of those items of general interest. Otherwise, any discussion of a competitive nature leading to a competitive advantage for the group will be held confidential.

Signed:

Dated:

---

**Frequently Asked Questions (Added April 19, 2010):**

**32. *Can we use remote control?***

No, this would violate several of the rules including

- (a) The device must stay as a single unit.
- (b) No team member can touch the device after the go signal is given.

**33. *Can our device extend beyond the sides of the shelf?***

No. This would violate the size rule. This means that you cannot use the outsides of the shelf for guidance. However, you should not need to because there is a rail about two inches from the left on the top side of each "ladder".

**34. *Can we use a spring?***

There's no problem in using a spring, rubber band, or other means of propulsion as long as it does not generate so much force as to be dangerous. Using a cross-bow, for example would be considered dangerous because we don't think any of your team members would feel safe standing in front of it.

**35. *Is it electric start or manual start?***

The competition will be manual start. At the start, one team member can touch your device to release it or turn on a switch. After the go signal no one from your team will be allowed to touch the device until the end of the round is declared. We will try to provide some padding around the base to help your device from breaking if it falls off the fixture.

**36. *Will there be any changes made to the competition fixture prior to May 1?***

We will make some minor improvements to ensure that the fixture is stable. These changes will involve better attachment between the shelving (ladders) and the base and top. These changes may affect your device's ability to access the top and bottom rungs of the fixture, but should not change anything else.

We will also mark the 9<sup>th</sup> rung and the 36<sup>th</sup> rung as these are important to judging the competition. This will probably be done with a magic marker.