

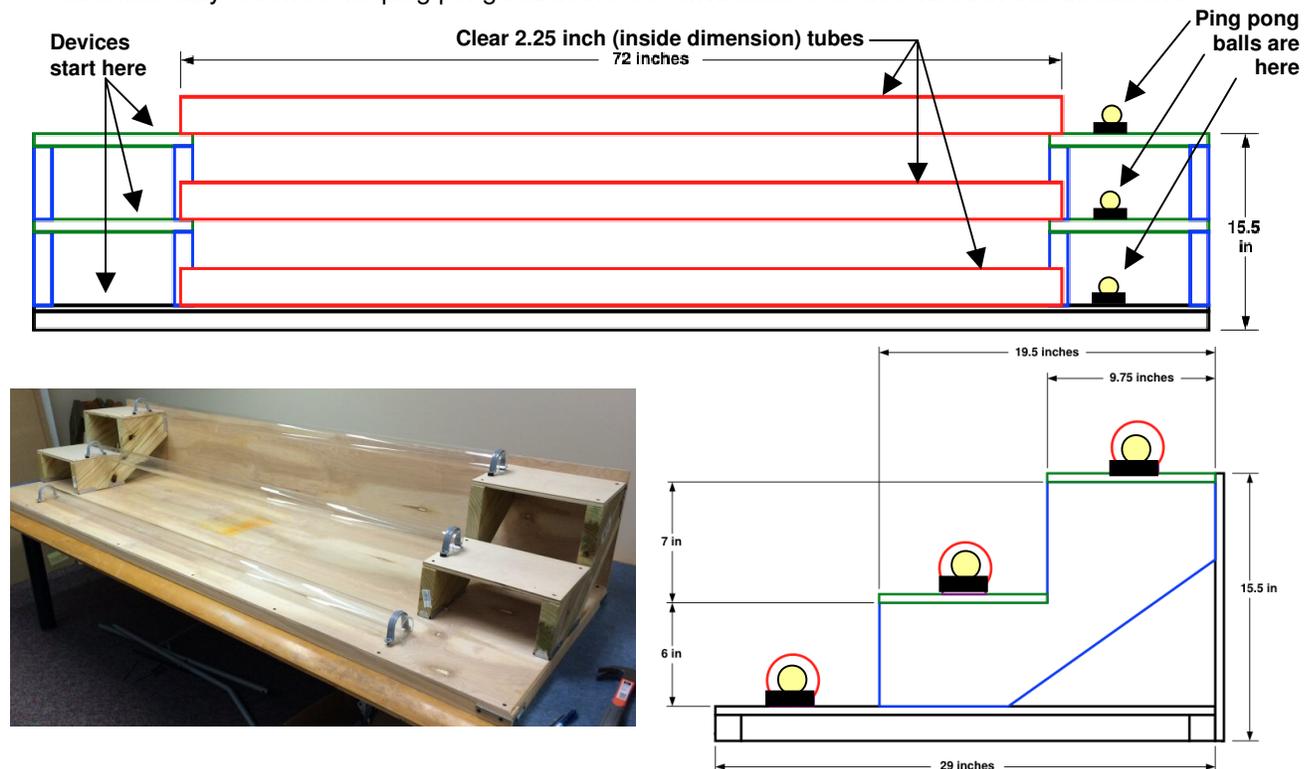
## MECH 202 Fall 2014 Competition Project: Ping Pong Ball Rescue Rev3-Updated 09 November 2014)

Your team is to design, fabricate, and compete with a working device that safely “rescues” a ping pong ball accessible through a 2.25 inch diameter 6 foot tube. Your team must also submit a report detailing your device and your design process. The competition will be **Sat, Nov 15<sup>th</sup> in Scott BioEngineering 101.**

- Your project report must be submitted as a single PDF to the drop-box folder by 7am that day.
- Check-in starts at 8:15am per the schedule in Appendix E. Competition starts at 9am.
- The competition takes the entire morning. The final rounds are expected to occur before noon.

### Competition Overview

1. Your team is competing to design and build a safe, most reliable, and lightest weight device that autonomously retrieves the ping pong ball in the test environment as described in this document.



2. The sketches and photo above show give a general overview of the fixture. Lanes are spaced about 10 inches apart and offset in height. Appendix B provides additional detail. Groups should measure the fixture and design their device to handle all potential variability they may encounter.
3. Devices must stay within the depth of their “step” of the fixture (about 9 inches for narrowest lane). Devices can have a total length (left to right) of 25 inches when starting, but cannot extend beyond the right (tube) edge of their “step” prior to the starting gate being lifted. This means devices can overhang the left side by about 11.5 inches. There will be openings in the starting gate. These openings will be the size of the 2 ¼ inch inside diameter of the tube and aligned with the tube so devices can enter the first 1 inch of the tube prior to starting. Devices cannot be over 7 inches high (not including extensions underneath that go into the mounting holes). After starting, devices should either extend into or “drive through” the tube to “rescue” the ping pong ball. See Appendix B.
4. Amit will keep the fixture locked prior to competition day, except during viewing times. Your team should schedule with Amit to see and measure the fixture and use your measurements and analysis to ensure that your device will work correctly and reliably. You are not allowed to visit the fixture outside of scheduled times or place your device on the competition fixture until the first time you

compete on November 15. You can make your own test fixture to develop and test your device. We will also provide a simplified one lane clear tube fixture (to be located in the EMEC) that you can use for testing. We will let you know when this test fixture will be available.

### More detailed competition rules

5. Each round consists of 2-3 autonomously competing devices. The winner of a round is determined based on (i) the correct sequence of tasks safely completed during the 45 seconds from the time the starting gate is lifted, (ii) device weight, and (iii) how close the ping pong ball is to being “rescued”.
6. The correct sequence of tasks to be safely completed is as follows:

1.	You must <b>place the device in its starting location in the 45 seconds</b> allocated from the time we announce “place your devices.” After placing your device, your team must completely leave the starting area. You cannot have contact with your device until after the round is over.
2.	The <b>entire device must fit</b> into the starting area and <b>weigh less than 3 pounds</b> . The starting area has a depth (when looking at the front of the fixture) of 9 inches, <b>a width of 25 inches (when looking at the front of the fixture)</b> and a maximum height of 7 inches (not including use of the mounting holes). Your device must also contain functionality designed to perform all tasks including starting autonomously (task 3), traveling at least 12 inches into the tube (task 4), making contact with the ping pong ball (task 5), and retrieving the ping pong ball (task 6).
3.	The entire device must <b>start autonomously</b> from the left side of the fixture <b>when the hinged starting gate is opened</b> and no part of the device can be anywhere other than in the starting area, in the tube or in the “retrieval area” during any part of the competition. The “retrieval area” is a mirror image of the starting area on the right side of the fixture.
4.	Once the starting gate is hinged open, a part of the device (or the entire device) must enter the tube and at least part of the device must <b>travel at least 12 inches into the tube</b> . There will be a line marked on the tube that allows us to see that the device has met this requirement.
5.	After meeting task 4 (above), the device must <b>make contact with the ping pong ball</b> . “Contact with the ping pong ball” is defined as “causing the ping pong ball to move within its holder as a result of activity from your device.”
6.	After performing task 5 (above), the device must <b>retrieve the ping pong ball</b> and bring it through the tube at least past the line 12 inches from the left side (starting area) of the tube.

7. The winner of a round will be determined as follows:

a.	If only one device in the round safely completes all six tasks listed above in the allocated time and stayed in bounds until the end of the round, this device and team will win the round.
b.	If multiple devices safely complete all six tasks in the allocated time, and stay in bounds, <b>the lightest device</b> that safely completed the tasks and stayed in bounds wins this round.
If no devices safely complete all tasks in the allocated time and stay in bounds until the end of a round, the winner of the round will be determined as described in the next sections.	
c.	If only one device in the round safely completes the first five tasks in the allocated time and stays in bounds until the end of the round, this device and team will win the round.
d.	If more than one device in the round safely completes the first five tasks in the allocated time and stayed in bounds until the end of the round, the device that safely completed the first five tasks in the allocated time and stayed in bounds and brought the ping pong ball <b>closest to the line 12 inches from the left side</b> (starting area) will be the winner.
If no devices safely complete five or six tasks in the allocated time and stay in bounds until the end of a round, the winner of the round will be determined as described in the next sections	
e.	If only one device in the round safely completed the first four tasks (moved to 12 inches) in the allocated time and stayed in bounds until the end of the round, this device will be the winner.
f.	If more than one device in the round safely completed the first four tasks (moved to 12 inches) in the allocated time and stayed in bounds until the end of the round, <b>the lightest device</b> that safely completed the four tasks in the allocated time and stayed in bounds will be the winner.
If no devices safely completed at least 4 tasks (moved to 12 inches) as described in the sections a through f above, we will do the steps described below.	
g.	The round will be re-run with the same participants. However, if there had been a gross safety

	violation (see below), that device will be removed from the competition and from this round. If there had been a device damaged, up to 30 minutes will be provided during all rounds except the final rounds for this group to repair their device. The rerun round will then be judged based on the criteria in a through f above.
h.	If during the rerun no devices safely completed at least four tasks as described in the sections a - f above, but at least one device safely started autonomously (task 3) and stayed on the fixture, <b>the lightest device that safely started autonomously</b> will be declared the winner.
i.	If during the rerun, no devices safely started autonomously (task 3) and stayed on the fixture until the end of the round, the round will be rerun one last time and judged based on the criteria in a-h. If no devices moved during this final rerun, all devices will be deemed to have lost the round. If this occurred in the first set of rounds when devices are run, the devices will get one last chance to run as part of the "elimination brackets". If this occurred after the first set of rounds, all devices will be out of the competition.

8. The safety requirements and their impact on competition results are as follows:

a.	Each device must pass a safety audit prior to noon on Friday, November 15. This audit will be conducted by Amit and your team should schedule a time with Amit during the Monday-Friday before the competition to conduct this audit. Bring your device to the audit so they can identify anything that is hazardous or might be considered hazardous. If you have concerns or questions prior to the week before the competition, please contact the Amit to discuss this.
b.	Gross violations of the safety rules will result in your group's device being eliminated from the competition. Examples of gross violations include damaging the fixture or any part of your device wandering so far out of bounds or causing a disturbance so significant that another device is damaged or touched. Note that minor vibrations or air disturbances caused by your device on the fixture do not count. All devices must be tolerant of minor vibrations and still stay on the fixture. If you have any questions about your device and any potential areas of risk, check with the Amit. When judging whether a safety violation is a gross violation, we will also look at your design intent and what you did to ensure that a safety violation could not occur.
c.	Your device cannot win a round if it has a minor safety violation. Minor safety violations are things such as: <ul style="list-style-type: none"> <li>- Moving out of bounds during any time in a round.</li> <li>- Any part of your device falling off. Your device must stay as a single unit during the entire round.</li> </ul>
d.	Your device also cannot "injure" the ping pong ball by damaging it in some way or causing it to fall off of the fixture and on to the ground. Causing the ping pong ball to fall on the ground is equivalent to creating a fatality. If you create a fatality, your device is also eliminated from the competition.

9. Except in any special cases that might have been mentioned above, the competition is double elimination. 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. Only the first place winners will advance to the next round. We will try to record which devices came in second, third, and fourth place and all tasks that each device accomplished, but will not use this for determining competition results.

10. Any device that has run less than three rounds prior to being eliminated from the competition that has never safely completed the first four tasks in the allocated time and stayed in bounds until the end of the round will be retested one more time prior to the finals. During that test we provide one more chance to demonstrate that the device can safely complete the first four tasks in the allocated time. If the device again fails to complete the first four tasks, two points will be deducted from the score on the final report.

#### Further Clarification about the Competiton

11. As mentioned previously, you can build your own test fixture. The fixture includes one relatively expensive (\$25) plastic tube, which can be obtained from Colorado Plastic Products in Louisville, Colorado. See Appendix B for more info about this part and others used to make the fixture.

12. The components used to make the competition fixture will 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 an important aspect of having a robust design. Note that you cannot place your device on the test fixture prior to the competition. You can take measurements. Every year there are many devices that fail to operate due to dimensional differences between the competition fixture and the test fixtures built by students. This is your warning to ensure this doesn't happen to your device.
13. 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:
  - Explosives, combustion processes, or highly exothermic reactions (such as model rockets).
  - A compressed fluid that might release too quickly
  - Anything deemed to be unnecessarily harmful to either the fixture or another competitor's device. This includes having motors that overheat, generate sparks, etc or wheels that leave a residue.
14. 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.
15. No human contact with the device is allowed at any time during the time from the start of a round until that round has finished.
16. The device cannot contain any biological components. For example, you are not allowed to employ a trained hamster (or very small dog) as part of your device.
17. In each round your team will have a maximum of 45 seconds for you to place your device onto the fixture and move away prior to the start. You should design a device that does not need to be calibrated to the lane it will be running in.
18. Your team must check into the registration table at the designated time given in Appendix E. If your team is more than 5 minutes late, and this is deemed to hold up the competition, your team will lose its first round.
19. 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, overheating any part of the fixture, generating noticeable nicks or notches that will impact the integrity of the competition, or adding foreign substances such as oil, adhesives (or adhesive specks), or lubricants onto the fixture.
20. Judging. Amit and other TAs from previous years will determine which device accomplished which tasks during each round. They are also the primary referees to observe any safety violations. Device weights will be recorded at checkin and may be rechecked later if devices have been modified.
21. 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.
22. 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 the last five year's competitions at [www.mech202.com](http://www.mech202.com).
23. 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 crossbow, for

example would be considered dangerous because we don't think any of your team members would feel safe standing in front of it.

24. Can we grab our device after it completes the task? Not until the round has been declared completed. Please ensure that your device cannot fall off the table, damage itself, or spin its wheels in a way that will damage the table or generate excessive heating.
25. Will there be any changes made to the competition fixture prior to November 15? We may make minor improvements to ensure that the fixture is stable and race worthy. These changes may slightly affect the geometry of the fixture and the starting gate, but not alter any of the fundamental functionality.
26. Note that, although we will do the best we can, we cannot guarantee that the fixture will be absolutely rigid. Please design your device to be as tolerant as possible of any movement that may occur to the fixture as it is used during the competition.

### **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, the judges will decide anything not covered by these rules and the interpretations of these rules. 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

Note that all three winning teams must be present during the lecture on April 30, as we may ask you to help explain to others in the class how you designed your device and some of its more successful features.

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

### **Sharing the Experience**

You are encouraged to bring friends, family, and supporters to the competition.

We will have a display area during the morning of the competition. You are encouraged to keep your device in this display area after you've checked in and between rounds so that it can be seen by the judges and by other visitors.

After the competition we would like to keep your device until after next semester's competition. We are planning to build a display area where devices can be seen by anyone.

### **The Lead Up**

Your design group may ask any questions whatsoever of Bert Vermeulen or Amit. 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

If you did not get one of the top three places in the competition, your grade for this project will be based almost entirely on the report that you submit, except for the following:

- A. Only 1<sup>st</sup>, 2<sup>nd</sup>, or 3<sup>rd</sup> place groups will be graded based on how the device placed in competition.
- B. Your report score will be reduced by 2 points if your device did not at least once safely accomplish the first four tasks and stay in bounds during an entire round on the day of the competition as described in section 6 on page 2.
- C. We reserve the right to further lower your project report grade for the project if we feel that you did not make a serious effort to build a device capable of meeting at least the first four tasks described in section 6 on page 2.

The report must be turned in as a correctly labeled single PDF (GroupXX\_Project2.pdf) with any supplemental materials in a zip file or folder that is also correctly labeled (GroupXX\_Project2.zip). These items must be turned into the drop folder on the T-Drive by 7am on Saturday, November 15. We encourage you to submit your project the night before and then get a good night's sleep. You cannot compete if we have not received the electronic copy of your report as a single PDF.

## Required Design Review

There will be a design review that Amit and Bert will schedule with your group during the week of October 27-31. Your entire group will need to attend this review. During the review, you must have completed and show the following:

A first draft of your project plan, specification development, engineering analysis, concept generation, and concept selection as described in sections c, d, e, and f below.

A physical implementation of at least one subsystem that you will need to use to accomplish one of the key functions of your system based on your analysis of the key functions your device must include.

## The report will consist of:

- a. **Page 1** (1 point) is the cover sheet in the exact format shown in Appendix C. It must show:
  - Group number
  - Names and email address for each member of your group
  - Checklist of all report content and page(s) where this content can be found.
- b. **Page 2** (2 points) is the title page that needs to show:
  - A title identifying the device
  - A photo of the device to fit in the remainder of the space on this page

**Pages 3 and beyond of the report** will have all of the other information required as listed below. Note that it is important that each section has page numbers that correspond to the pages listed on the cover sheet and that the first page of each section is labeled so that we can identify which section we are reading as we go through the report. We strongly prefer and recommend that you compile your report in exactly the order below.

- c. **Project plan** (5 points). Your project plan should include all of the information that we requested for Project 1. This includes: tasks, milestones, owners, planned completion dates, actual completion dates, the critical path, and weekly status snapshots. For the second project, we also want to see how many hours total for the group that you estimated the project would take and how many total hours the product did take. There would be some kind of analysis of planned versus actual schedule and planned hours versus total actual hours for the group.

- d. **Specification development** (10 points). You should show how you developed the specifications for your device and its various systems. This should include identification of customers and requirements, competitive analysis, metrics for your specifications, targets, and tradeoffs. Your specification development should be as clear and easy to follow as possible. There should be a table that clearly shows the “how much” (step 7 of QFD). The “importance to customers” part of this “how much” should then be used for your concept generation, concept selection, etc. Your specification should be in your own words, drawings, charts, equations, etc. Your specification should attempt to quantify as much as possible using measurements that can later be verified. Please also your prioritized the musts and wants (delighted and disgusted) for functional specifications and list all constraints. Note that since this is a unique problem, you may not be able to define competitors the way we have done in QFD so far. In class I will present some alternate ways to generate targets.
- e. **Engineering analysis** (15 points). You should demonstrate how you have used engineering concepts learned in other classes you’ve taken (such as Statics) to help understand and solve this design problem. You can use any other type of analysis and any other resources as long as you tell us what you used for your analysis. This is an important section and has historically been significant in the report grades, and success in the competition.
- f. **Concept generation and concept selection** (10 points). There should be a description of the concepts your group considered, the methods used to generate concepts, and the process used to make the choices that lead to the design (or designs) your group decided to build and test as prototypes. The conclusion of this section needs to tie back to the specifications, constraints, and analysis performed in steps d and e above.
- g. **Device description** (15 points). There should be annotated drawings or annotated photos that explain the following in a way that we can understand:
- How to make a device similar to yours. This could be photos of all of your parts and how they are to be assembled, an exploded view, or any other method you think conveys all of the information.
  - The process (movement steps and sequence) of how your device has been designed to accomplish the tasks given in section 7 on page 2.
  - Any critical elements or features that making your device work and work reliably.
  - Any clever ideas that you think make your device unique.
- We do not require Creo drawings or solid models, but you can use Creo or another CAD package to help you generate your design prior to fabrication. CAD software can also be useful for you to generate the images that explain how to build your device and how it works. If you do create any models, include the important images in the main body of the report and put all source files into a ZIP file.
- h. **Bill of materials** (5 points). The bill or materials (BOM) for this project is different than the one for the first project Appendix D provides a sample. The BOM for this project must include:
- The cost of each item required to fabricate your device
  - Where each item can be obtained (where you got it)
  - There should be a total cost so we see how much it would cost to buy the components to build a device similar to yours.
- Also please tell us how much in total you spent (including spares, parts you didn’t end up using, things that broke, etc)
- i. **Reliability and design margin analysis** (4 points). This analysis should show the places where you believe your device is most likely to fail and what you have done to build design margin into those areas. This should also identify how much variability in the dimensions of the competition fixture your device can tolerate and an assessment of the impact of vibration during storage and usage that your device can tolerate.
- j. **Testing** (10 points). A description of the 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. It also needs to compare your actual device to the specification targets and constraints you developed in part d above.

- k. **Safety** (4 points). A safety analysis of your design or design choices showing risks and what your team did to minimize the most critical hazards.
- l. **Service and support plan** (4 points). This should show what you plan to do in case any part of your device should fail and you need to make emergency repairs during competition day. What spares will you have?
- m. **Teamwork analysis** (4 points). This requirement is the same as it was for the first project. We encourage you to use team contracts, health assessments, meeting minutes, and other tools that allow you to work effectively as a team and include this information. We recommend that you have a summary of lessons learned in preparing the device and the report for the competition.

To summarize, the grading of this report is done using the same approach as for Project 1, but we do not need CREO models and we expect significantly better technical analysis and grade to a higher standard based on the things that you've learned in this class. Just like for Project 1, we expect that reports worthy of a grade of 90 or above will demonstrate initiative by including additional relevant material, demonstrate critical thinking in the analysis, and have a "WOW" factor to them.

#### **After the Competition**

We would like to keep all of your devices for one semester after the competition. We are building a display case near the EMEC where your devices will be displayed until after the MECH 202 competition the next semester. Once that display period next semester is complete, you will be able to collect your device if you'd like to keep it.

#### **Post Mortem**

By Monday evening November 17 (at 6pm), all groups including those that won first, second, or third place must turn in brief post-mortem listing at least eight things they learned from the project, including competition day. Doing a post-mortem is a good idea for any project. This post mortem is your homework assignment for November 17 and will be described in a homework assignment that will be posted on the T-Drive.

**APPENDIX A.**

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**Request for Confidentiality** (use if you need to share info with TAs or Instructors)

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.

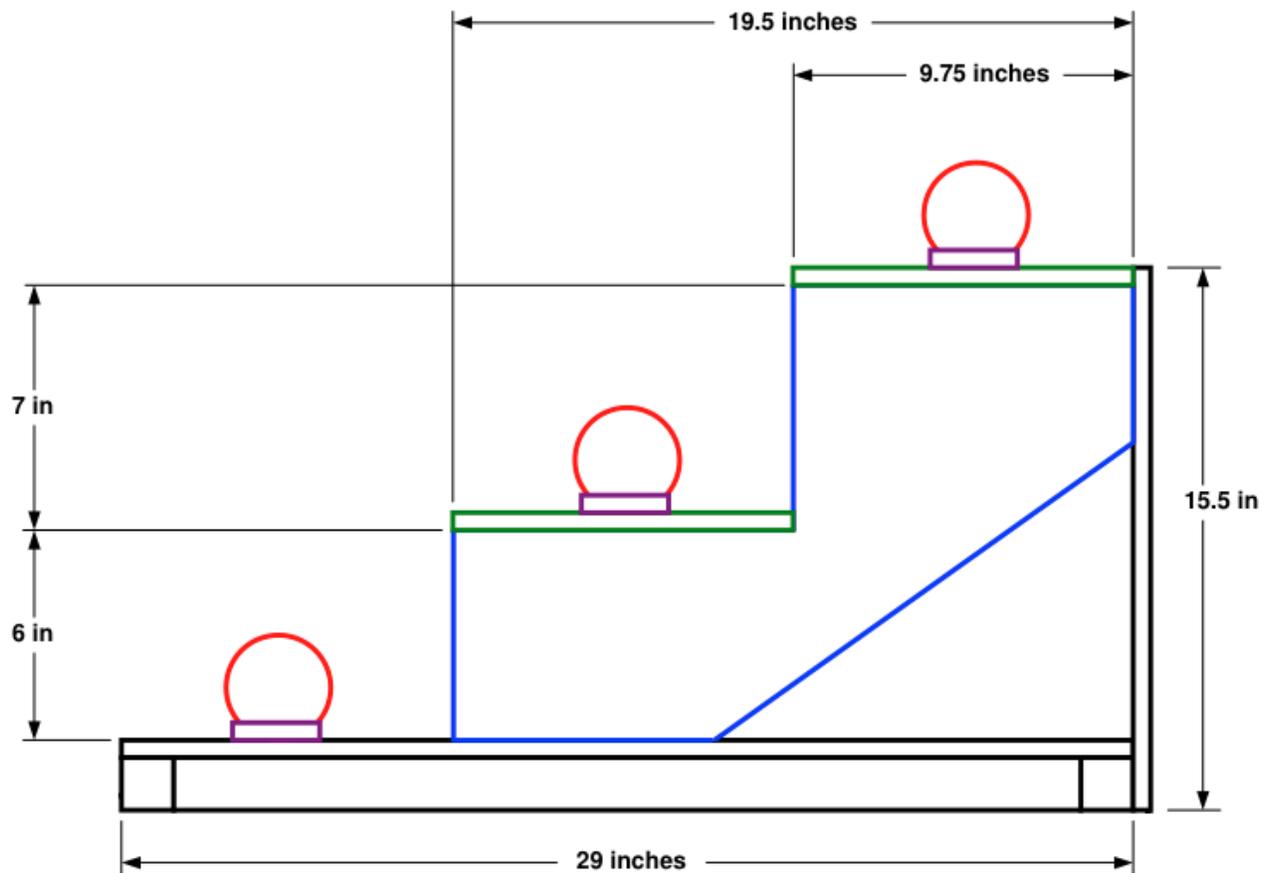
Signed:

Dated:

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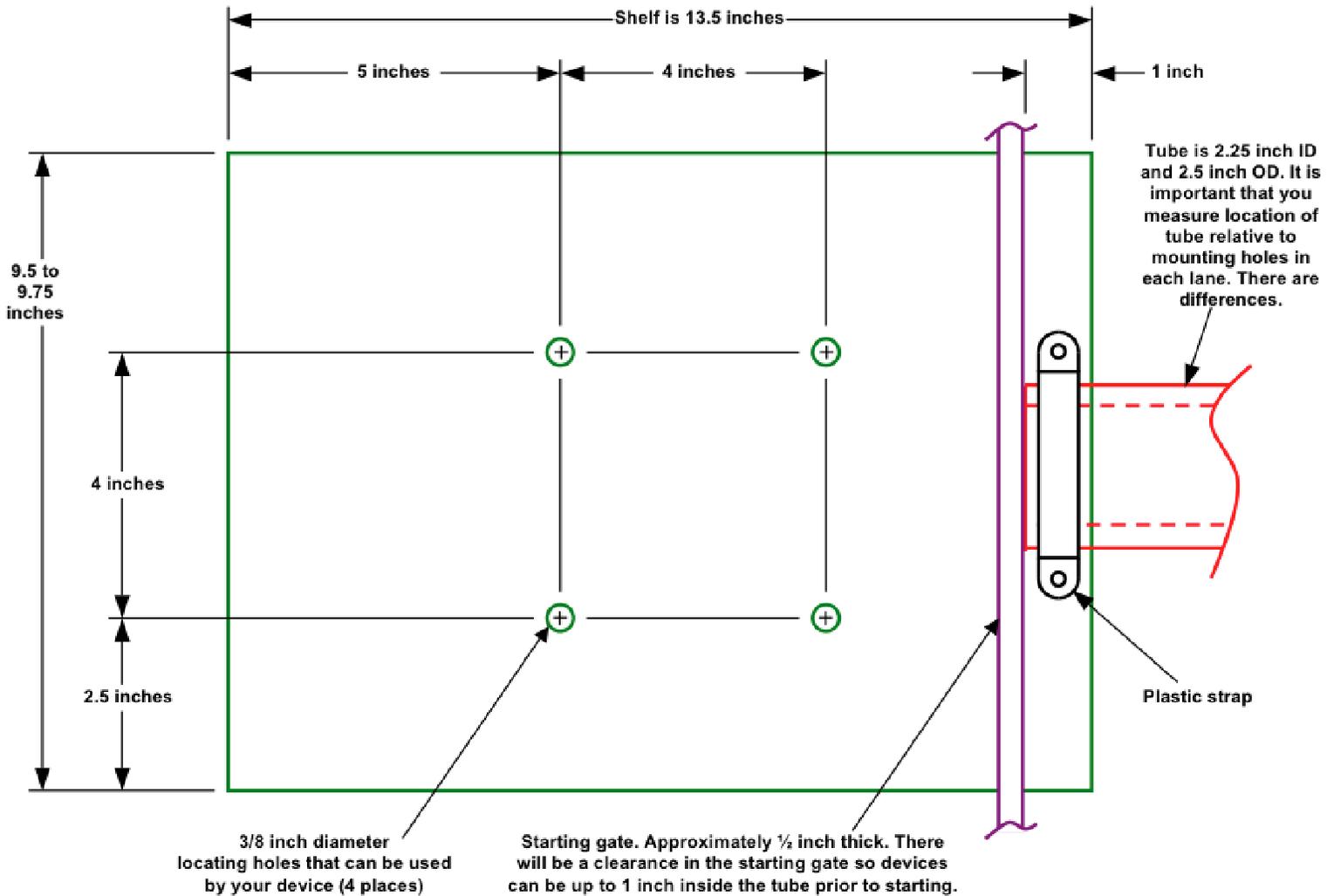
## APPENDIX B Fixture Parts List and Supplementary Fixture Info

Below are some more detailed photos and illustrations of the test fixture:





Note: There starting gate will be modified so your device can be up to 1 inch inside of the tube prior to the gate being lifted.



Detail for starting region (top view)

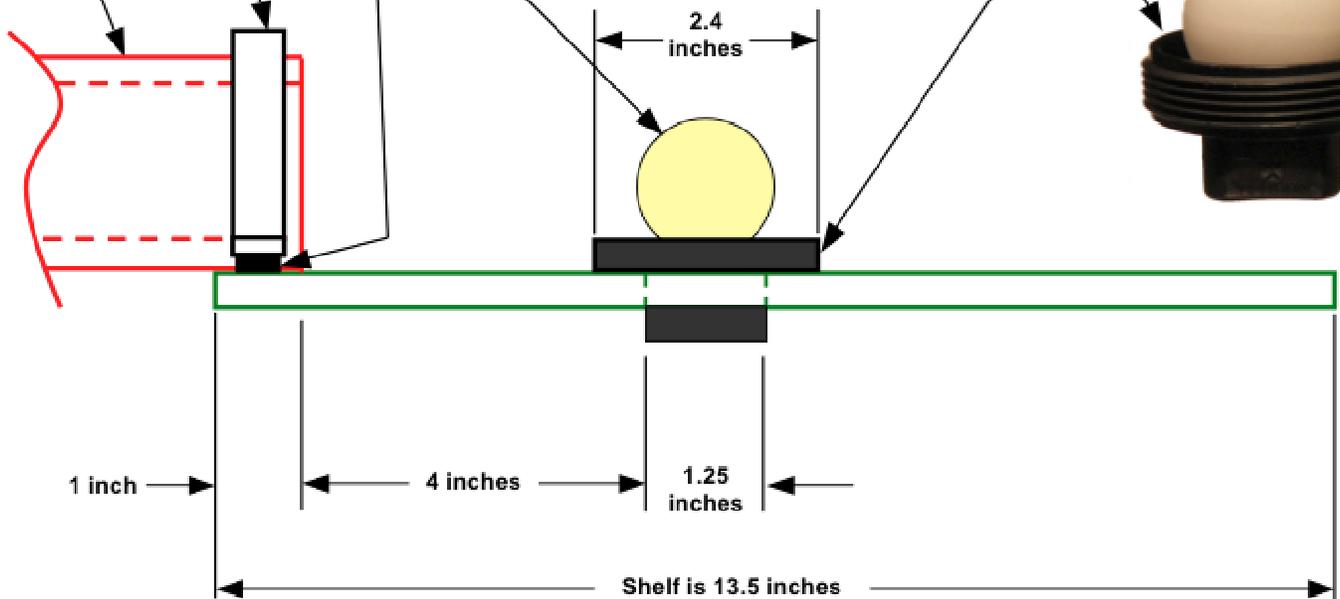
Plastic strap normally designed for securing 2" electrical conduit. Inside diameter is about 2.46". Available in the electrician parts area at Home Depot in packs of 5 (Carlton E977 JCR-CTN)

Holder is a threaded plug for 2 inch PVC piping. The exact model used is made out of black ABS and is labeled as part number D-2681 and matches the images shown here. It is available from any hardware store that sells plumbing supplies. Sides will be machined off.

Tube is 2.25 inch ID and 2.5 inch OD

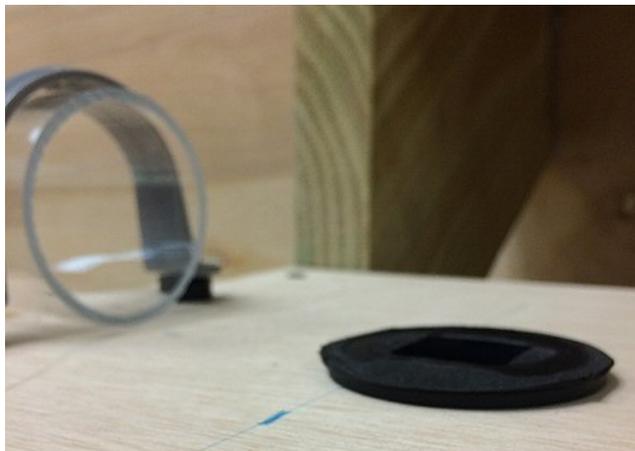
Rubber spacer approx 1/4" thick

Ping-pong balls are 40 mm OD

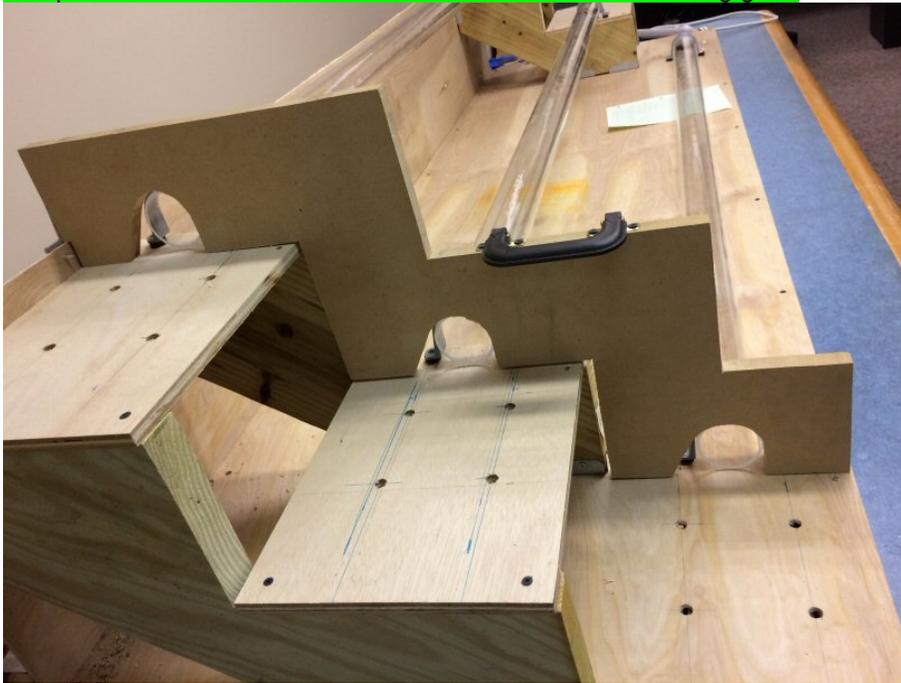


**Detail for ball pickup region**

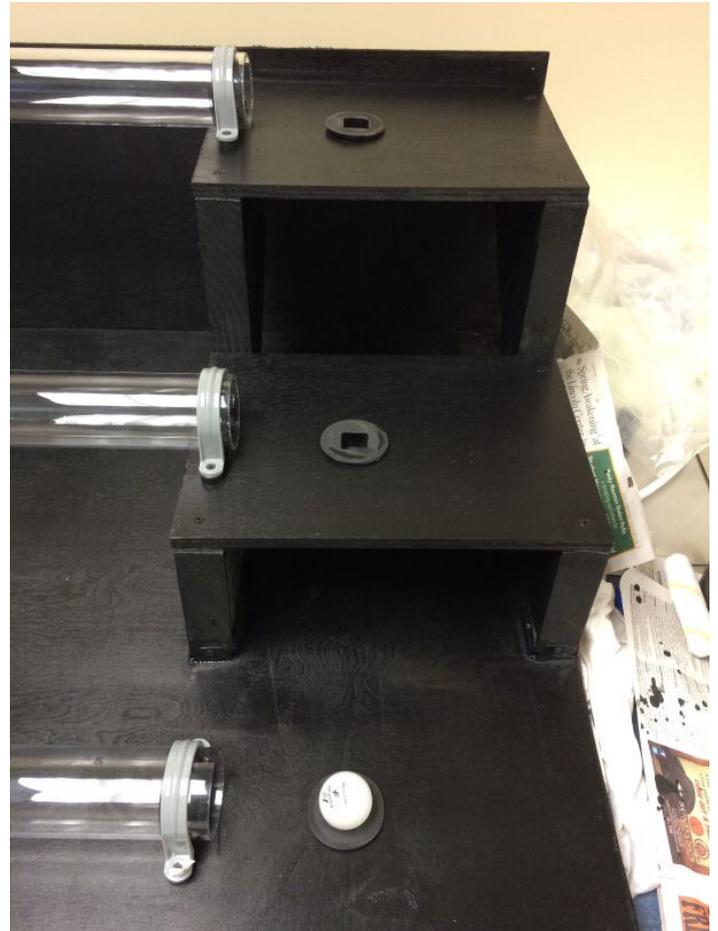
Here are additional photos added on November 9. The photos below show the ping pong ball holder that has its sides removed.



The photo below shows the holes and clearance in the starting gate.



The photos below show the painted fixture the way it will appear for the competition



**Here is the information needed to purchase the most important parts for doing your own testing:**

- **Tube.** This is a 6 foot long extruded acrylic tube with an inside diameter of 2.25 inches and an outside diameter of 2.5 inches. If you'd like to buy one exactly like it, they are available for about \$25 at:

Colorado Plastic Products Inc  
500 south Arthur Avenue #600  
Louisville, CO 80027  
303-443-9271  
[www.coloradoplastics.com](http://www.coloradoplastics.com)

- **Holder.** This is a threaded plug for 2 inch PVC piping. The specific plugs that will be used in the competition are made from black ABS and have the dimensions shown in the diagrams above. These threaded plugs can be purchased in the plumbing section of Home Depot.
- **Plastic strap.** The strap that secures the plastic tube is an electrical conduit strap. It is available in the electrical department of at Home Depot. The inside diameter is slightly smaller than 2.5 inches.

## Appendix C Cover Sheet Template

Group Number \_\_\_\_\_

Group Members	Email Addresses

Section	Pages where found
a. Cover sheet	1
b. Title and photo of device	2
c. Project plan & hours spent	
d. Specification development	
e. Engineering analysis	
f. Concept development and choice	
g. Illustrated description of device function	
h. Bill of materials	
i. Description of testing	
j. Safety analysis	
k. Reliability and design margin analysis	
l. Service and support plan	
m. Teamwork analysis	

Supplemental Information	Where located



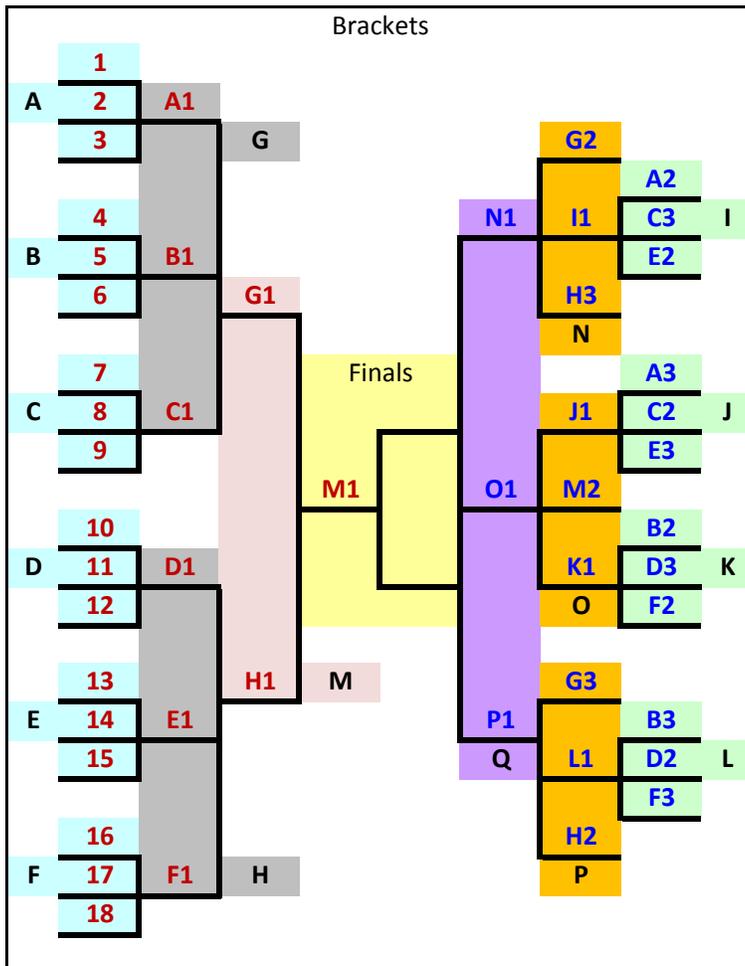
**Appendix E  
Competition Day Schedule (November 15, 2014)**

**Note:** Groups that do not checkin on the schedule time may not be able to run in the first round.

**The competition begins at 9am.**

**Check in**

Time	Groups		
8:15	1	2	3
8:20	4	5	6
8:25	7	8	9
8:30	10	11	12
8:45	13	14	15
8:50	16	17	18



9:00	Opening Remarks	1st	2nd	3rd			
9:05	A	1	2	3	A1	A2	A3
9:10	B	4	5	6	B1	B2	B3
9:15	C	7	8	9	C1	C2	C3
9:20	D	10	11	12	D1	D2	D3
9:25	E	13	14	15	E1	E2	E3
9:30	F	16	17	18	F1	F2	F3
9:35	G	A1	B1	C1	G1	G2	G3
9:40	H	D1	E1	F1	H1	H2	H3

9:50	I	A2	C3	E2	I1	I2	I3
9:55	J	A3	C2	E3	J1	J2	J3
10:00	K	B2	D3	F2	K1	K2	K3
10:05	L	B3	D2	F3	L1	L2	L3

10:15	Rerun1						
10:20	Rerun2						
10:25	Rerun3						
10:30	Rerun4						
10:35	M	G1	H1		M1	M2	
10:40	N	G2	I1	H3	N1	N2	N3
10:45	O	J1	M2	K1	O1	O2	O3
10:50	P	G3	L1	H2	P1	P2	P3

**Invited external judges**

11:10	Q	N1	O1	P1	Q1	Q2	Q3
11:15	Final 1	M1	Q1	Q2			
11:20	Final 2						

## Appendix F Revision History

Date	Revision	Changes made
08-Oct	First release	Not applicable
20-Oct	Second release	<ol style="list-style-type: none"> <li>1. The competition will be in Scott BioEngineering 101. (See page 1)</li> <li>2. Maximum device width changed to 25 inches. (See page 1)</li> <li>3. Starting gate will have openings so that devices can be placed up to 1 inch inside of the tube prior to the start. (See page 1)</li> <li>4. The details of the mounting holes in the starting area are now shown in Appendix B.</li> <li>5. Walls of the ball holder will be removed to make it easier to pick. See Appendix B. Note that this will make it more difficult for you to have a “fatality” in which the ball. See 8d on page 3 regarding “fatalities”.</li> <li>6. We would like to keep and display your devices next semester. See page 8.</li> </ol>
09-Nov	Third release	<ol style="list-style-type: none"> <li>1. Added further pictures to Appendix B</li> <li>2. Added Appendix B (Schedule for November 15)</li> </ol>