Welcome to the 24th Annual

ENGINEERING

OLYMPICS

Michigan Tech

Sponsored by:

Michigan Technological University

Department of Engineering Fundamentals

Center for Pre-College Outreach

March 24, 2015

Schedule of Events

Sign in	8:15-8:30
Welcome	8:30-8:45
Events Begin	8:45
Engineer Here	9:45-10:45
Lunch	10:45-11:45
On-Site	11:45-12:30
Awards	12:30
Dismissed	1:00

Schools and Team Counts

School	Teacher	Students	Bridge	Mouse Car	Tennis Ball	Trebuchet	Eng Here	On Site Teams

Team Scoring Rules

The scoring for this year's Engineering Olympics will place the teams based on team performance.

Definitions

Team
Group of 2-4 students from a school working together on a challenge. Each school may enter multiple teams per event.

Engineer Here Team
Each school must register one team of up to 4 students for this 'mystery' challenge.

On-Site Challenge
A short event in which all students will participate.

Event
Any one of the challenges that are a part of the Engineering Olympics!

Event Scoring

Each team will earn a score for their event (there will be a different scoring system for each event). Schools are encouraged to have more than two teams participate in any event. First, second, third and fourth places for each event will be awarded to team members from each event. Ties are broken based on judge's discretion.

Engineering Olympics School Champion

At the end of the Engineering Olympics, each team's points will be totaled to determine the overall champion.

For each event, teams will receive points as follows:

First Place	4 pts
Second Place	3 pts
Third Place	2 pts
Fourth Place	1 pts

Participant Conduct

Teams, coaches, parents, etc. are expected to participate with *gracious professionalism*. What is gracious professionalism? Below, gracious professionalism is defined by Dr Woodie Flowers, FIRST (For Inspiration and Recognition of Science and Technology) National Advisor.

Gracious Professionalism

Edited from FIRST National Advisor Dr. Woodie Flowers

It is completely consistent with the FIRST spirit to encourage doing high quality, well-informed work in a manner that leaves everyone feeling valued. Gracious professionalism seems to be a good descriptor for part of the ethos of FIRST. It is part of what makes FIRST different and wonderful.

Gracious professionalism has purposefully been left somewhat undefined because it can and should mean different things to each of us. We can, however, outline some of its possible meanings. Gracious attitudes and behaviors are win-win. Gracious folks respect others and let that respect show in their actions. Professionals possess special knowledge and are trusted by society to use that knowledge responsibly. Thus, gracious professionals make a valued contribution in a manner pleasing to others and themselves.

In FIRST, one of the most straightforward interpretations of gracious professionalism is that we learn and compete like crazy, but treat one another with respect and kindness in the process. We try to avoid leaving anyone feeling like they are losers. No chest thumping barbarian tough talk, but no sticky sweet platitudes either. Knowledge, pride and empathy comfortably blended.

Understanding that gracious professionalism works is not rocket science. It is, however, missing in too many activities. At FIRST, it is alive and well. Please help us take care of it.

In the long run, gracious professionalism is part of pursuing a meaningful life. If one becomes a professional, and uses knowledge in a gracious manner, everyone wins. One can add to society and enjoy the satisfaction of knowing that you have acted with integrity and sensitivity. That's good stuff!

Competition: The Mackintooth Bridge 2015

Objective: To construct a bridge that accommodates Hot Wheel track and car, spans a given distance, and withstands an applied gravity load. See Design/Material Constraints below for further details.

Engineering Disciplines: Civil Engineering, Mechanics of Materials, Statics

Related Topics: Free body diagrams, force distribution, geometry, trigonometry

Evaluation

The score for each bridge will be the ratio of load held to mass of the bridge.

An additional 5 pounds will be added to the load held for any bridge that meets all design/material constraints upon initial check-in.

Note: students must bring and wear safety glasses for testing.

Material and Construction Constraints

- Bridges are to be constructed of only generic flat or rectangular toothpicks. Toothpicks must have a rectangular (not square) cross-section over the entire length.
- The toothpicks must be bonded using Elmer's White School Glue.
- Excessive amounts of glue will result in removal of the bridge from the competition.
- Bridges are not to be painted.
- Bridge elements may have no more than a 3 toothpick cross-section at any location with the only exception being the immediate area of the joint. The number of toothpicks in a cross-section is the number of toothpicks that would be cut if the element was cut in half, perpendicular to the toothpick's length.
- Bridge elements that are parallel (within +/-10°) must be more than 0.5 in. apart.
- Any and all gaps between toothpicks will be treated as separate elements.
- No joint may have an intersection longer than 0.375 inches. Joints less than 0.125 inches apart are considered one joint or intersection. A joint or intersection is defined as an area where elements come together.

Mass and Dimension Constraints

- The mass of each bridge shall not exceed 55 grams.
- No part of the bridge shall extend more than 1 inch below the top surface of the embankments.
- The bridge must extend 3 inches or more above the top surface of the embankments. There is no maximum height for the bridge.
- The bridge must span the 20 inches between the embankments.
- Bridges may bear on no more than 1 inch of the top surface of each embankment. Therefore, total length must be more than 20 inches, but not more than 22 inches.
- The maximum width of any part of the bridge shall be equal to the length of one flat toothpick (approximately 2 ¼ inches).
- The bridge must have a vertical hole approximately 1 inch in diameter that will accommodate the pipe on the testing apparatus.

- The bridge must have a horizontal hole that will accommodate straight, orange Hot Wheel track and an average Hot Wheel car. The track and car will be supplied at the competition; they will be used only to verify design requirements. To accommodate the track and car, the horizontal hole should be approximately 1¾ inches wide and 1¼ inches high. When inserted, the track must extend continuously from one embankment to the other and the car must be able to run the full length of the track. In addition, the bottom of the track must be no higher than 1 inch above the embankments and no lower than the top surface of the embankments.

Testing Apparatus

The testing apparatus design can be found in Figure 1 below. The bridge will be placed on embankments to test for load held (weighting platform and weight lifting weights). The testing apparatus will be a base with 6 inch tall embankments for the bridge to rest on. There will be 20 inches between the embankments.

Half way between the embankments will be a pipe that will be used to align weights. The bridge must be designed with an approximate 1 inch diameter hole so the pipe can go directly through the center of the bridge.

A 12 by 12 inch weighting platform will be placed on top of the bridge in an orientation that minimizes the contact area with the bridge (i.e. the edges of the weighting platform will be parallel to the edges of the base). The weighting platform will have a hole in the center for the pipe to go though. This weighting platform weighs 3 +/- 0.1 lbs.

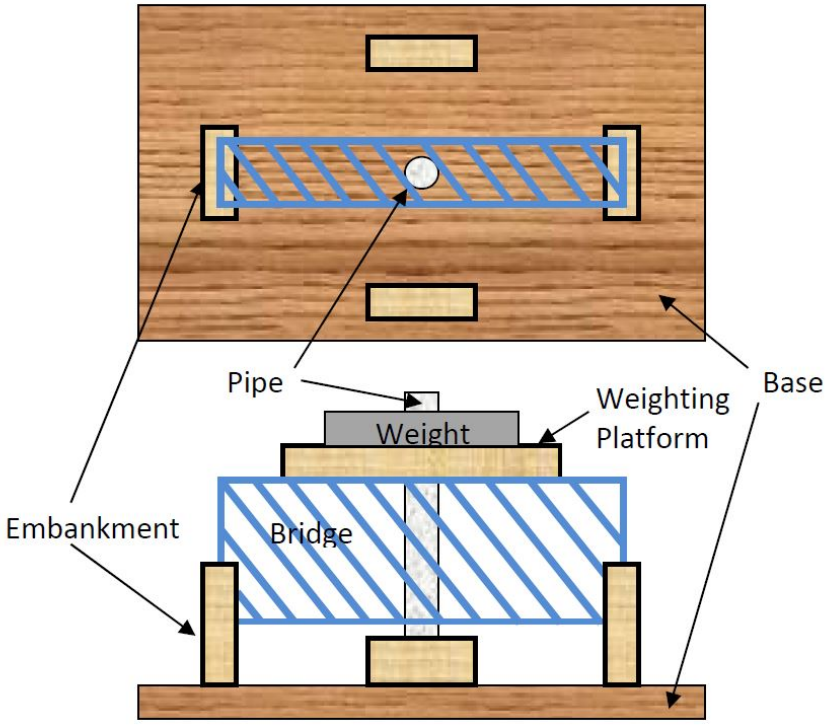


Figure 1: Top and front view of bridge and testing apparatus (drawing is not to scale).

Competition: The Mackintooth Bridge 2015

Testing Procedure

Bridges will be checked prior to testing using the checklist below. Note that the items in the checklist below are abbreviated. See the Constraints above for complete descriptions.

Mass and Dimensions

_____		Mass	Less than or equal to 55 grams
Y	N	Height	No more than 1” below top surface of embankments
Y	N	Height	No less than 3” above top surface of embankments (weight bearing)
Y	N	Span	Bridge spans the 20” gap between embankments
Y	N	Length	Less than 22” (max. 1” on the top surface of each embankment)
Y	N	Width	Less than or equal to length of one toothpick ~2.25”
Y	N	Vertical Hole	Vertical hole in center approx.. 1” diameter to accommodate pipe
Y	N	Horiz. Hole	Accommodates track and car; is within 1” above embankment

Materials and Construction

Y	N	Only use FLAT rectangular (not square) toothpicks
Y	N	Only use Elmer's White School Glue
Y	N	Appropriate amount of glue used (not excessive)
Y	N	Bridge is not painted
Y	N	Cross section of bridge elements limited to no more than 3 toothpicks
Y	N	Joints do not exceed 0.375"
Y	N	Parallel bridge elements (+/- 10deg) separated by at least 0.5"

Bonus

Y N Meets all constraints upon initial check-in (add 5 pounds to weight held)

BONUS: The additional 5 pounds will be added to the load held for any bridge that meets ALL material and design constraints upon initial check-in. If a bridge does not meet all material and design constraint requirements at initial check-in, the team will be given the option to 1) test the bridge as-is, but remove it from competition, or 2) fix the bridge before testing. Once a bridge has been thoroughly checked, the bridge will be tested. **Please remember that students must bring and wear safety glasses.**

Competition: The Mackintooth Bridge 2015

A 15 minute time limit will begin when the team enters the test area to break their bridge. The bridge team will set the bridge on the embankments and then set the weighting platform and a 5 pound weight on the top of the bridge. The bridge must hold this load for 10 seconds. Any bridge that fails to hold this load for 10 seconds will not receive any points.

The bridge team will load their bridge to failure by placing weights on top of the weighting platform. The bridge must hold each weight for a minimum of 10 seconds before the next weight is added.

The load held by the bridge will be the total load causing the bridge to fail minus the last weight placed on the platform. The load held will be determined once the bridge fails or at 15 minutes - whichever comes first. The weights available will be at least the following:

- At least four of each of the following: 1.24 lb & 5 lb,
- At least eight of each of the following: 2.5 lb & 10 lb

Tie Breaker:
If two teams have the same final score (ratio of load held to mass of the bridge); the team with the lighter bridge will win. If both bridges are the same mass and hold the same load, the two teams will be awarded the same place. The following place will not be awarded.

Score Card: Mackintooth Bridge 2015

Initial Check-in Data

Mass and Dimensions

_____		Mass	Less than or equal to 55 grams
Y	N	Height	No more than 1” below top surface of embankments
Y	N	Height	No less than 3” above top surface of embankments (weight bearing)
Y	N	Span	Bridge spans the 20” gap between embankments
Y	N	Length	Less than 22” (max. 1” on the top surface of each embankment)
Y	N	Width	Less than or equal to length of one toothpick ~2.25”
Y	N	Vertical Hole	Vertical hole in center approx.. 1” diameter to accommodate pipe
Y	N	Horiz. Hole	Accommodates track and car; is within 1” above embankment

Materials and Construction

Y	N	Only use FLAT rectangular (not square) toothpicks
Y	N	Only use Elmer's White School Glue
Y	N	Appropriate amount of glue used (not excessive)
Y	N	Bridge is not painted
Y	N	Cross section of bridge elements limited to no more than 3 toothpicks
Y	N	Parallel bridge elements (+/- 10deg) separated by at least 0.5"
Y	N	Joints do not exceed 0.375"

Bonus

Y	N	Meets all constraints upon initial check-in (add 5 pounds to weight held)

Score Card: Mackintooth Bridge 2015

Testing Results

School _____ Team_____

Names _____ _____ Bridge Mass

_____ Y N Held Weighting Platform + 5 lb

_____ Y N Check-in bonus + 5 lb

_____ _____ Load Held

_____ _____ Capacity
Ratio of weight held to bridge mass

Weights held (check boxes) – *does not include the final weight added to break bridge*:

____ #1 ____ #2 ____ #3 ____ #4 ____ #5 ____ #6 ____ #7 ____ #8 ____ #9

____ #10 ____ #11 ____ #12 ____ #13 ____ #14

____ #15 ____ #16 ____ #17 ____ #18 ____ #19 ____ #20 ____ #21 ____#22

____ #23 ____ #24 ____ #25

____ #51 ____ #52 ____ #53 ____ #54 ____ #55 ____ #56 ____ #57B ____ #58

____ #59 ____ #60 ____ #61 ____ #62 ____ #63

____ #100 ____ #101 ____ #102 ____ #103 ____ #104 ____ #105 ____ #106

____ #107 ____ #108 ____ #109 ____ #110

____ #111 ____ #112 ____ #113

Competition: Mousetrap Vehicle 2015

Objective: Design a vehicle, which is powered only by standard Victor mousetraps, that drives a specified distance, deposits a payload of **five** quarters into different target areas, and passes the finish line.

Design Constraints

Your team's design must comply with these constraints:

- The vehicle must be self-contained (i.e., no part of the vehicle may be jettisoned or remain behind the start line). Quarters are not considered part of the vehicle.
- An unlimited number of standard "Victor" mousetrap springs may be used for energy storage. No other energy storage devices are allowed.
- The vehicle must be automatic. Team members may not touch or interact with the vehicle once released.
- The testing will occur on the wooden floor of the MTU Wood Gym.
- The pathway and target areas will be bordered with blue painter's tape.
- Vehicle must not damage the floor.
- Quarters must be loose – i.e. not connected to each other or the vehicle. **(Quarters provided by team)**

Testing and Scoring

Figure 1 shows a schematic of the test area set up (measurements in feet). The boundary lines shown delineate the exterior boundaries of the testing region and target areas (i.e., touching the tape with your vehicle will count as leaving the testing area). Quarters must be completely within the target areas for full points.

There are ten target areas, the largest target areas are 12" x 12" squares, the smallest target areas are 6" x 6" squares. There is a one foot horizontal space between large target areas. All target areas touch the edges of the pathway.

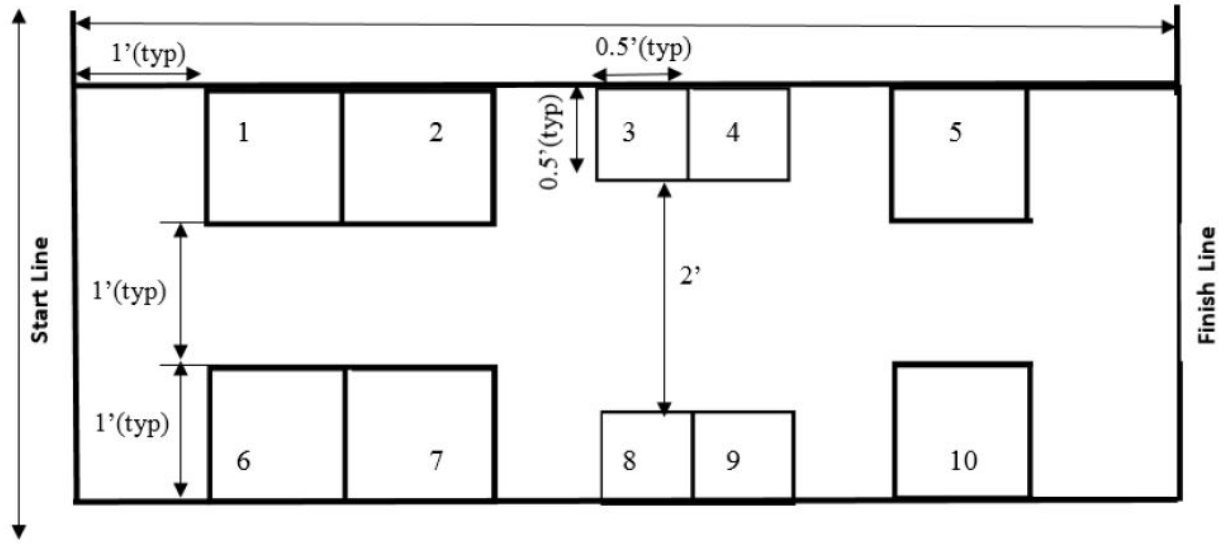


Figure 1. Mousetrap Vehicle Test Area (units = feet, not to scale)

Competition: Mousetrap Vehicle 2015

Your team's vehicle will be scored using the scale shown in Table 1. If a tie occurs, the vehicles that tie will re-run their vehicles to see which has the "best" performance. The following items explain scoring in more detail:

- The vehicle must start with the front wheels **behind** the start line.
- Each team will have **five** minutes to accumulate as many points as possible. Teams will have an unlimited number of runs to test their vehicle within this time frame. Time begins when the team's vehicle is released for the first run.
- The vehicle will travel down the test area, deposit the payload of quarters, and exit across the finish line.
- Teams will earn points based on successfully depositing the payload in one of the ten target areas. Once a target area has had any quarters deposited in it (completely or partially during a run), points can no longer be earned in that area in future runs. For example: If you get 3 quarters in Area 1 and 2 quarters in Area 2 on your first run, you would not be able to score in Areas 1 or 2 in future runs.
- Quarters deposited in the small target areas are worth more points than the large target areas (see Table 1).
- Quarters that land completely on the border between targets will count as being partially in both target areas.
- Leaving the 8' x 3' test area (except at the start/finish lines, which the vehicle must cross) will result in points deducted from your total (5 points per run).
- The final score will be the sum of the team's runs. If one of your runs is incomplete when time expires, points accrued up to the time limit will count, but the remainder of the run will not.

Table 1: Vehicle Test Scoring

Description	Points Possible
Team comes to competition with a working vehicle	10
Vehicle completely crosses start line (3 points each run – the first 5 runs will score points for this category)	3 · (# of runs) 15 total
Vehicle completely crosses finish line (3 points each run – the first 5 runs will score points for this category)	3 · (# of runs) 15 total
Quarters deposited completely within a **large** target area (10 points each run – 2 points per quarter) Quarters deposited partially within a **large** target area (5 points each run – 1 point per quarter)	60
Quarters deposited completely within a **small** target area (25 points each run – 5 points per quarter) Quarters deposited partially within a **small** target area (10 points each run – 2 point per quarter)	100
Deduction for exiting the test area (5 points each run – the first five runs will be scored for this category)	-5 · (# of runs which exit the path)
Total	Sum of all runs

Score Card: Mousetrap Vehicle 2015

School: _____ Team: _____

Names:

Description	Points		Score
Team comes to competition with a working vehicle (**+10 points**)			**/ 10**
Vehicle completely crosses start line (**+3 points per run**)	*# of runs crossing the start line, the first 5 runs will be scored for this*		**/ 15**
Vehicle completely crosses finish line (**+3 points per run**)	*# of runs crossing the finish line, the first 5 runs will be scored for this*		**/ 15**
Deduction for exiting the pathway (**-5 points per run**)	*# of runs where car exits path, the first 5 runs will be scored for this*		**/ 0**
Target Areas	Number of Quarters Completely in Area **(+2 points each)**	Number of Quarters Partially in Area **(+1 point each)**	**Score**
Area 1			**/ 10**
Area 2			**/ 10**
Area 5			**/ 10**
Area 6			**/ 10**
Area 7			**/ 10**
Area 10			**/ 10**
Target Areas	Number of Quarters Completely in Area **(+5 points each)**	Number of Quarters Partially in Area **(+2 point each)**	**Score**
Area 3 **			**/ 25**
Area 4 **			**/ 25**
Area 8**			**/ 25**
Area 9 **			**/ 25**
Total			**/ 200**

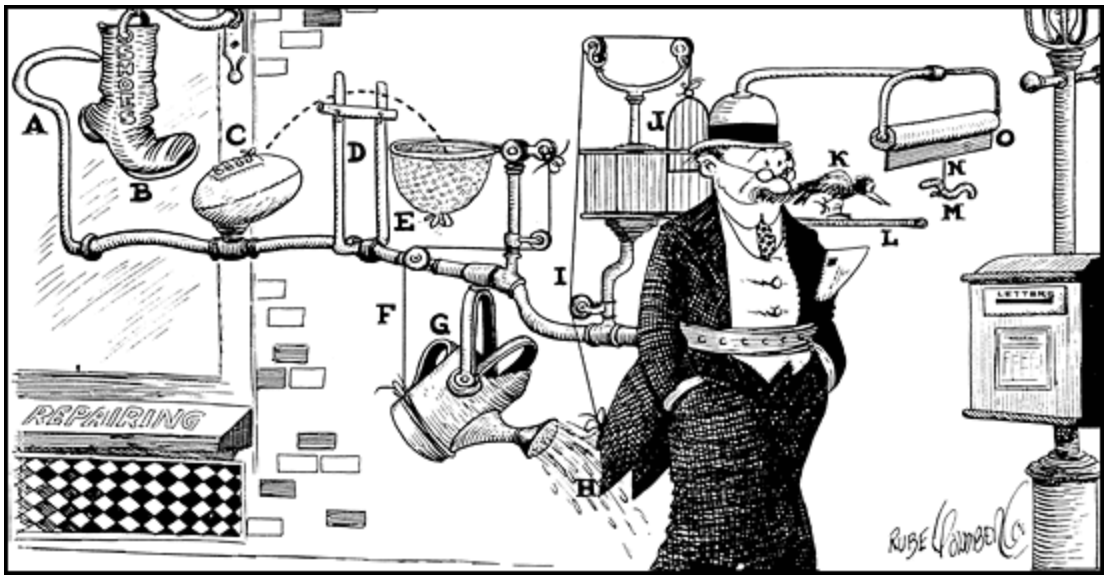
ENGINEERING OLYMPICS MichiganTech

MichiganTech

Engineering Fundamentals

Competition: A mechanical robot- Tennis ball dispenser 2015

Mechanical devices which are designed to perform a single function are popular with young and old engineers. Designing these is a hobby that could lead to an invention or at a minimum, to producing lasting memories with your child/ grandchild (most hobbyists are people who work in their basements/garages). Rube Goldberg demonstrates this concept, albeit to the extreme, in his cartoons. "Rube Goldberg gets caught in a revolving door and becomes dizzy enough to dope out an invention that keeps you from forgetting to mail your wife's letter."



As you walk past the cobbler shop, hook (A) strikes suspended boot (B), causing it to kick football (C) through goal posts (D). Football drops into basket (E), string (F) tilts sprinkling can, (G) causing water to soak coattails (H). As coat shrinks, cord (I) opens door (J) of cage, allowing bird (K) to walk out on perch (L) and grab worm (M) which is attached to string (N). This pulls down window shade (O) on which is written, "YOU SAP, MAIL THAT LETTER."

A **Rube Goldberg machine** is an exceedingly complex apparatus that performs a very simple task in a very indirect and convoluted way. It first appeared in *Webster's Third New International Dictionary* with the definition, "accomplishing by extremely complex roundabout means what actually or seemingly could be done simply." The expression has been dated as originating in the US around 1930[1] to describe Rube Goldberg's illustrations of "absurdly-connected machines".[2] Since then, the expression's meaning has expanded to denote any form of overly confusing or complicated system. For example, recent news headlines include "Is Rep. Bill Thomas the Rube Goldberg of Legislative Reform?",[3] and "Retirement 'insurance' as a Rube Goldberg machine".[4]

Challenge:

You will build a mechanical robot. This robot will include a ramp where a descending ball will trigger a racket which then will hit the falling ball into a box located at a predetermined location. You must build your own ramp as part of your device. No electronic devices may be used for this project.
Your design should be flexible enough to permit changing the ramp angle (i.e. 30, 45, 60 degree) which will then affect the location of the ball landing on the racket, and hence will change the distance the ball travels.

Sequence of events:

You will release a ball onto a ramp which is fixed at 45 degrees. Upon release of the ball, you may not touch your robot again. The descending ball will trigger a release mechanism which is connected to a tennis racket. The ball must hit the releasing mechanism when it is in free fall. This will release the tennis racket which is held under tension by a spring. The tennis racket will then hit the falling ball into the target box. Only one ball will be used for each trial.

Your mechanical robot is to be built from the following materials:

1- Lumber 2X4
2- A ramp
3- Two springs (i.e. a mouse trap is considered to be one spring), you may not substitute a spring with rubber bands, bungee cords.
4- A tennis racket (standard)
5- A release mechanism
6- A mechanism for holding the tennis racket under tension

Not all materials need to be used. The mechanical robot cannot be touched once the ball is released.

Safety:

If a section of your Release Mechanism is ejected, your team will be disqualified.

Size of your robot and Potential energy (limitations):

Your robot's dimensions may not exceed: H= 3 ft, W = 3 ft, and L = 3 ft.
Potential energy cannot be added by modifying the racket and/or the attached arm.

Testing Rules:

1. The box will be H = 7.5 inch, W = 25 inch, L = 29 inch.
2. The box will be placed 12 ft from the launch line.
3. The ball must land in the box; it may not touch the ground. (You must account for the height of the box.)
4. The ball may hit the edge of the box prior to landing in the box.
5. The mechanical robot must rest on the floor when fired (i.e. not hand-held or resting on a table).
6. The mechanical robot must not damage the floor.
7. The mechanical robot cannot be touched once set into motion.

8. No tape or other adhesives may be used to attach the device to the floor.
9. All mechanical robots must pass a safety inspection prior to launching – judge's decisions on safety are final - make it safe!
10. All team members must wear eye protection while in the firing area (bring your own).
11. The front of your mechanical robot will be placed at the launch line. The front of the mechanical robot is defined as the forward-most point in contact with the ground when in the "ready to fire" position.

Three types of balls will be tested:

a. Tennis ball, approximate mass of 56 g, approximate diameter of 6.4 cm
b. Racquet ball, approximate mass of 41 g, approximate diameter of 5.6 cm
c. Super bounce ball, approximate mass of 50 g, approximate diameter of 4.1 cm

Testing Procedure (See Figure 1 for testing schematic):

1. Each team must check in and have their robot examined for safety and proper use of materials before entering the testing area.
2. The team will have three minutes to re-set the robot for each new ball. Once the judge marks the scorecard and is ready, the team will set their spring to the proper tension for the next ball. Teams will NOT be allowed ANY mis-fires or mis-aims. All six attempts will be recorded. If a team is taking too long, it might not be able to take all six shots. A ball may not bounce off the floor into the target box.
3. In case of a tie, the teams with highest total scores (total six shots) will have to test their robots from a new launch line of 15 ft.
4. No coaches are allowed within the competition area.
5. All decisions are at the discretion of the judges and NOT at the discretion of fellow competitors.
6. **Teams found not to be practicing gracious professionalism will not be allowed to compete.**
7. A friction increasing device (i.e. rubber mats, carpet, etc.) may be placed under the launcher. However, NO adhesive will be allowed. If you choose to use such a device and it leaves ANY residue on the floor surface, your team will be assessed a penalty or disqualified from the event. NO chemicals of any kind (including water) may be placed on the floor. Teams or judges may wipe the floor clean with a dry towel. Any friction-aiding device used must be weighed with the launcher at time of check-in. Any friction-increasing devices other than rubber mats or carpet must be pre-approved prior to testing (i.e. - email mir@mtu.edu for approval).
8. Each team must remove its robot from the competition site at the end of competition.

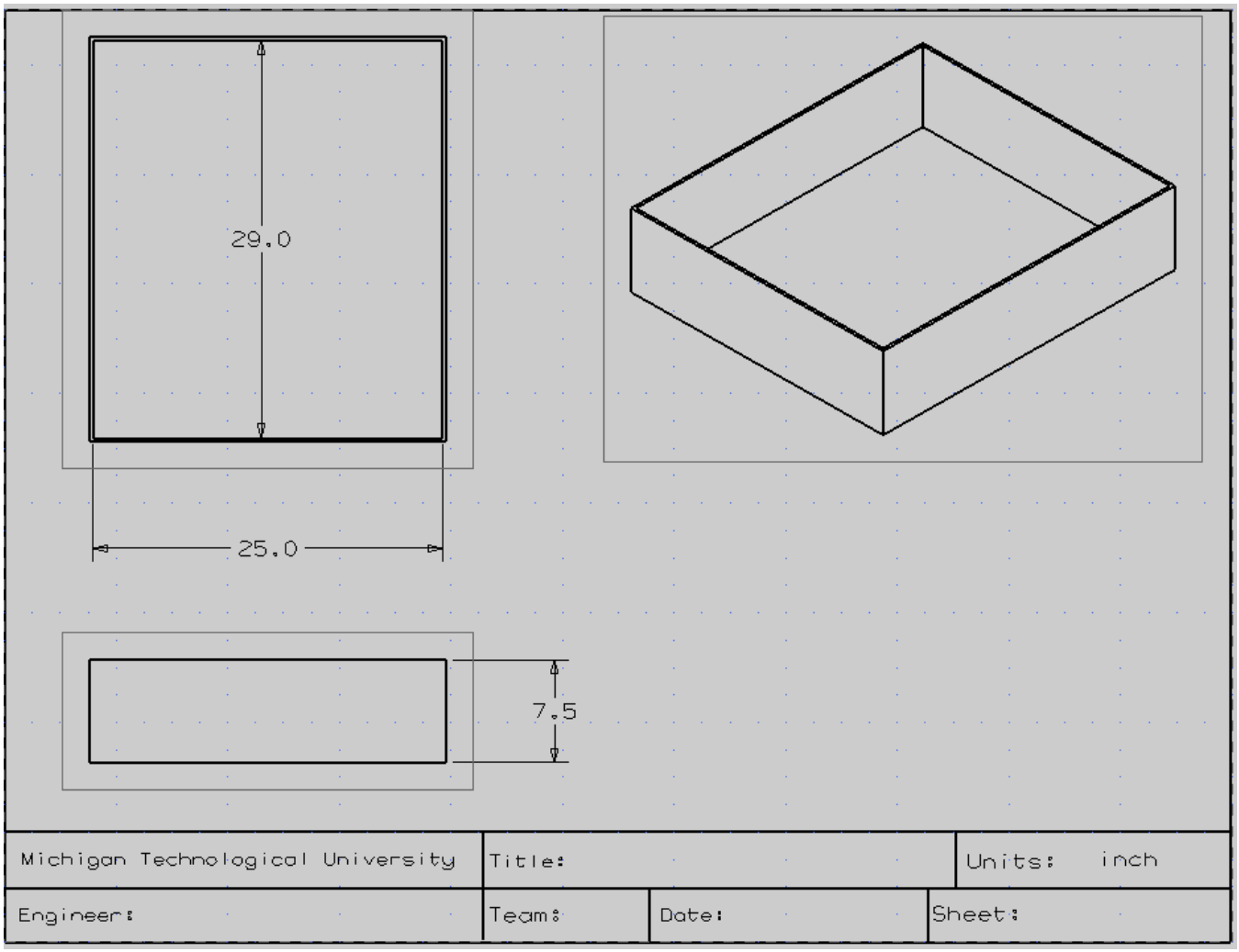
Testing Score

Possible points for each shot is: zero, three or ten

You will earn three points if the ball hits the inside or outside wall of the box without bouncing off the ground

You will earn ten points if the ball lands in the box (even if the ball bounces out of the box after hitting the bottom of the target box you get ten points)

Maximum points for each shot is ten points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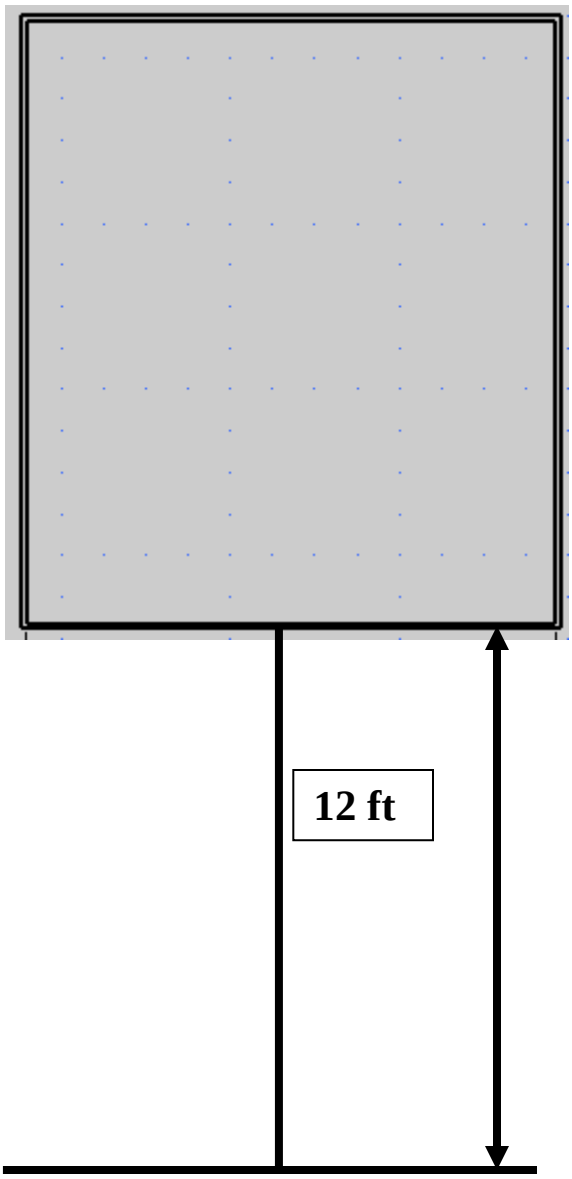

Launch line

Score Card – Mechanical Robot - Tennis Ball Dispenser 2015

School: _____ Team #:_____

Names:

Testing Score

Possible points for each shot is: zero, three, or ten

You will earn three points if the ball hits the inside or outside wall of the box without bouncing off the ground.

You will earn ten points if the ball lands in the box (even if the ball bounces out of the box after hitting the floor, you get ten points)

Maximum points for each shot is ten points

Shot	Type of ball	Hit the box (inside or outside, 3 pts)	In the box (10 pts)
First	Tennis		
Second	Tennis		
First	Racquet		
Second	Racquet		
First	Super-bouncing		
Second	Super-bouncing		
Total			

Team Score: _____

ENGINEERING OLYMPICS MichiganTech

Competition: Falling Mass Trebuchet Free Throw 2015

A trebuchet works by using the mechanical principle of leverage to propel a stone or other projectile much farther and more accurately than other catapults, which swing off the ground. The sling and the arm swing up to the vertical position, where, usually assisted by a hook, one end of the sling releases, propelling the projectile towards the target with great force.

In the competition described below, it is not force, but finesse that will matter the most.

Objective

Your goal is to build a trebuchet powered solely by gravitational potential energy to propel a basketball into a basket from the free throw line. Your team may bring its own basketball(s) to the specs listed in this document, or you may use basketballs provided at the competition.

The competition will take place indoors. Some useful websites before you begin design and construction:

http://www.globalspec.com/trebuchet/

http://www.trebuchet.com

Please be sure to read all instructions and rules carefully before beginning construction of your trebuchet!

ENGINEERING OLYMPICS MichiganTech

Competition: Falling Mass Trebuchet Free Throw 2015

Overview of the Competition

This year's event will focus on the accuracy of hitting a target and the precision to hit the target consistently. Contestants will have a **maximum of ten** free throw attempts during a ten minute time span.

In general, standard NCAA court dimensions will apply, which generally are the same as high school basketball courts. The following specifications will be useful in developing the device.

- Horiz. distance from back of free throw line to center of basket: 4.19 m (13.75 ft)
- Horiz. distance from the back of the free throw line to backboard: 4.57 m (15 ft)
- Basket inner diameter: 0.457 m (18 in)
- Height of basket: 3.05 m (10 ft)
- Backboard height: 1.07 m (42 in)
- Backboard width: 1.83 m (72 in)
- Basketball circumference: Between 0.724 m (28.5 in) and 0.737 m (29 in)
- Basketball weight: Between 5.00 N (1.124 lb_f) and 5.56 N (1.25 lb_f)
- Basketball inflation pressure: Between 51.7 kPa (7.5 psi) and 58.6 kPa (8.5 psi)

Scoring

Scoring is as follows:

- Hit backboard or any part of net – 1/2 point
- Hit rim, but miss basket – 1 point
- Make basket hitting either rim or backboard first – 2 points
- Make a "swish" (as deemed by the judges) – 3 points

Total Score – The sum of the ten throws will be added together and the team with the highest score will be the winner (maximum 30 points).

Tie Breaker – Teams that are tied after the competition will be given another attempt at ten throws in ten minutes. If the tie is not broken after this round, the competition will end in a tie.

Competition: Falling Mass Trebuchet Free Throw 2015

Trebuchet Design & Construction Constraints

- The trebuchet, when prepared for launch, **must totally fit within a rectangular prism with floor dimensions of 0.6 m (width) by 1.2 m (depth) and a height of 1.2 m.** A trebuchet larger than this will be disqualified. Judges will measure the entries before launch when the trebuchet is in "loaded to launch" position. The trebuchet may extend a reasonable amount beyond these limits during the shot.
- The trebuchet (including all operational components attached or not) must weigh no greater than 250 newtons (~56.2 lb_f). If your machine weighs more than this limit, the judges will determine if it will be allowed in the competition based on safety. If allowed to compete, there will be a weight penalty assessed. This penalty will be: 50% of the machine's overweight (in pounds) subtracted from the score (e.g. weight = 60.2 lb_f | amount over the limit = 4 lb_f | 50% of 4 = 2 pt. penalty).
- **All energy must come from gravitational potential energy** to be stored in weights that will fall downward to release the energy. Great care must taken in the design and execution of launching so that **NO DAMAGE** is done to the floor or anything else (e.g., the weights, upon falling, should be contained so they do not come off the machine and hit the floor; the throw arm cannot hit the floor, come off the machine, etc.). If any machine is deemed dangerous to people or property by the judges, it will be disqualified and withdrawn from the event.
- No springs, elastics, compressed air, motors, rockets, explosives, etc. can be used.
- The launch **must be executed with a pull cord** such that no part of the person setting the machine in action (pulling cord) is closer than 0.5 meters from any part of the machine.
- The ball may not hit the floor between being shot from the trebuchet and scoring in order for points to be given for each shot (no bounces to score).
- The safety of the contestants and the audience is our primary concern. Prior to the competition the judges will disqualify any catapult that appears unsafe or uncontrollable. No launch will be made from an unsafe device.
- A 4 foot by 8 foot (1.22m by 2.44 m) sheet of 0.5 inch (1.25 cm) OSB (oriented strand board) will be placed on top of a floor protection tarp in the "key area" of the court to protect the floor. The trebuchet must remain on the piece of OSB for all shots. The OSB may be moved inside the key to the desired location, but the base of the trebuchet must remain inside the key at all times. The trebuchet must sit on this protection board and cannot be fastened to it by glue, screws, etc. Friction between the machine and board must keep the machine from sliding. Team members can stand on the board as long as they are 0.5m from any part of the machine.
- The base of the trebuchet must remain fully behind the free throw line and inside the key at all times, as if it were a free-throw shooter in a basketball game. The trebuchet will be disqualified if it crosses the free throw line.
- The shooting **team will consist of three students** who will be allowed within the three-point arc during the shooting of basketballs and all students must remain behind the free throw line when each shot is fired. All other students, teachers, and spectators must be outside of the three-point line during the ten-minute shooting period. Safety glasses must be worn within the three-point arc.
- All parts of the trebuchet must be taken home with the competing team.

Score Card -- Trebuchet Free Throw 2015

School: _____ Team #:_____

Names:

Shot	Backboard/Net Only (0.5 pts)	Rim Only (1 pts)	Regular Basket (2 pts)	Swish (3 pts)	Comments
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
Total					

Team Score	

ENGINEERING OLYMPICS Michigan Tech