

Grade 9 Integrated Technologies

Trebuchet Design Process (Revised November 15, 2010)

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Background

The trebuchet is a very good design challenge because it requires one to make many adjustments through trial and error. From the design point of view the trebuchet has two different areas of consideration that depends on each other, structure and mechanics. It has to be structurally strong to support a moving counter balanced throw arm; and it has to have well coordinated mechanics in order to successfully throw the projectile (object).

Challenge

Your task will be to construct a wooden 'table-top' gravity-driven catapult, also known as a trebuchet. Your goal is to design and construct a trebuchet of your choice so that it can a squash ball at a predetermined distance. Everyone will be provided with the same standardized parts for their construction:

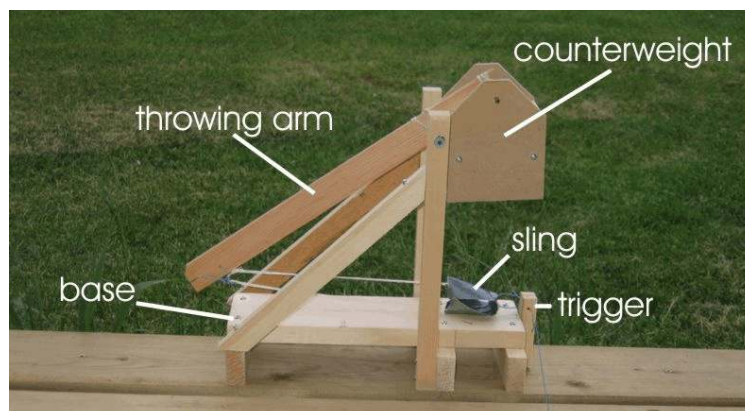
- 1/4" by 1/4" (approx 0.6 cm by 0.6 cm) wood
- two metal axles/fulcrum
- Counterweight box – approximately 5" high x 7" long x 3 1/4" wide
- string for a sling
- sling material
- throwing arm/beam - approximately 29 inches long
- various screws and eye-hooks

Background (Research)

Trebuchets are simple machines that combine structures and mechanics. The DVD we watched provides lots of background on trebuchet construction but if you feel you need more information on trebuchets, check the following websites.

- <http://members.iinet.com.au/~rmine/gctrebs.html>
- http://www.butlercc.edu/engineering/en115/en115_basic_treb_design.cfm
- <http://www.ripcord.ws/>
- Wikipedia
- Google video – search "hilaroad trebuchet"

Parts of a Trebuchet:



Details

When the trebuchet is complete the following physical characteristics must be met:

- the firing pin/trigger must be able to release the throwing beam from a remote distance (i.e. with a string)
- the trebuchet must have a “firing pin/trigger” that allows the throwing beam to be held in the loaded position mechanically (without assistance from a human)
- the sling must stay attached to the throwing beam (it cannot be part of the projectile)
- the counterweight box must swing freely through the upright supports
- during the competition/assessment, the trebuchet must be able to consistently fire a predetermined distance without needing to be tweaked, repaired or adjusted in between shots.

Object	Design Guidelines and Hints
Counterweight	-75 to 100 times heavier than projectile
Throwing Arm/Beam	-angle should be about 45 degrees when cocked; upper part of arm should be 3 to 5 times longer than the lower end
Base and framework	-must be heavy enough to support arm and counterweight and for precision, yet light enough to have a high material efficiency
Sling or rope	-should be slightly shorter than upper part of the throwing arm (for starters, that is); too short will release the projectile too early, higher trajectory; too long will drag the ground, lower trajectory
Sling release pin	-a more hooked prong will hold the sling loop longer than a straighter one. i.e. a prong-less hooked or in line with beam gives an earlier release, higher trajectory; a prong more hooked or forward-pointing gives a later release, flatter trajectory
Projectile	-a heavier projectile tends to pull the loop off the prong earlier than a lighter projectile does. heavy projectile gives earlier release, higher trajectory; light projectile gives later release, flatter trajectory
Trigger	-you need some way to release the projectile in a repeatable way
Base/Trough	-the projectile needs to slide down some type of guide; friction will be important here

Solutions (Brainstorming)

Come up with three unique designs for a trebuchet.

- Draw a series of three 3-view sketches (top, front and right view) for each design (nine sketches total)

Best Solution (Choosing a possible and probable solution)

Pick the best idea and create a 3-view drawing of your trebuchet on graph paper. Be sure to include all dimensions.

Planning

Have a copy of the final 3 view drawing when constructing the final plan. Measure and cut the pieces accordingly, starting with the longest pieces and move to the smaller pieces.

Production (Making your design)

Safety

Safety glasses are to be worn by the person who is using with the glue gun.

Test Firing

Safety is the most important aspect with test-firing your trebuchet. Once you have loaded your counterweight be very careful. The throwing arm can swing with enough force to seriously injure.

All test firing should be done away from other groups and following the safety procedures already established in class. **Failure to follow these procedures will result in the loss of test firing privileges.**

Trouble-Shooting Problems

See: <http://www.ripcord.ws/tuning.html>

Evaluation

If you were to redesign your trebuchet, what would you do differently? Discuss with regards to the design challenge.