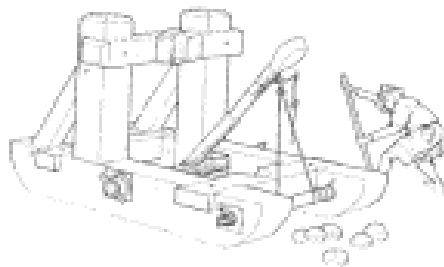


Vivid Consulting Inc.™

“The Onager Project” Group 4

*Intuitive Designs for the Future of Your
Company*



ENGINEERING PROJECT 2

The Onager Project

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Executive Summary



Our catapult is designed for the utmost accuracy and precision, with the simplicity that anyone can maintain and use. After many tests and trials, we are confident in our design and proud to place our company's name on the design. The design was based around the concept of safety, ease of use, and low cost, allowing anyone to use it without the fear of being injured. We appreciate you for considering us and are confident you will be pleased by our product.





The Onager Project

Intuitive Designs for the Future of Your Company

Introduction

When presented with this project we set a short list of goals that we wanted to accomplish in our finished design:

- Safety
- Ease of use
- Maintainable
- Accuracy and Precision
- Adjustable
- Reliability

We feel that our final product meets or exceeds all these goals. Throughout the research and development of this project we had many trials and tribulations, but we overcame all of our obstacles and are proud to present you with our final product. Our initial prototype was a let down to put it lightly, and major revisions needed to be done afterwards. However, we did stay true to our original concept of an onager style catapult that has a final design similar in looks, but is much more refined. Overall, our changes brought forth a whole new catapult ready to lay siege to whatever comes its way with a few very simple adjustments.

Over 2000 years ago, the Greeks and Romans did not know about gunpowder, yet were able to hurl projectiles over a large distance using energy storage devices. Through the years, some modifications were made to increase the accuracy and throwing distance of these machines. The first two types of throwing machines were the catapult and the ballista. The ballista started out as a large cross bow to shoot oversized arrows at an enemy. The catapult was about 10 times larger than a ballista and threw large stones.

The ballista's design consists of two pieces of wood, each fastened at one end to a torsion device rotating about a more or less horizontal axis. The free ends of the wooden pieces are connected together with a rope. The projectile to be thrown is held by the connecting rope used as a sling.

When most people think of the catapult, they are actually thinking about an onager. The strange name is derived from a wild donkey kicking with its hind legs. The onager (or gonne, mangonel or nag) was typically a single arm held in a more or less vertical position by a torsion device rotating around a horizontal axis. The projectile was located in either a pocket at the top end of the arm or in an attached sling.



Methodology

Brainstorming Sessions

Our initial brainstorming sessions lead to the decision to build an onager style catapult. In these sessions we decided that we must have a very simple design with as few working parts as possible, yet still be as complex in the sense that it could offer a wide variety of adjustments. We also decided on what materials would be used, such as the 1"x1"x3' used to structure the impact-frame and the arm of our catapult and the .5" plywood base that would be used to provide a smooth surface for us to attach our hinge and impact-frame. At this point we had also decided that it would be springs that would power our catapult.

Not only did these sessions provide us with ideas, they also allowed us to eliminate some ideas. This is where we decided that a trebuchet type design would be far too complex, and just wouldn't be as practical as an onager. We also ruled out using medical tubing as a possible power source due to its limited availability. The issue of torsion was also thrown out in this process because it was extremely hard to create a power source using this method.

Construction Figures

Total cost: \$ 15.89

Time spent building: 4 hours

Time spent testing: 1 hour 30 minutes

Parts:

- 2 – 16.5" 2x4's
- 3 – 10" 1X3's
- 1 – 13.75" x 14.75" sheet of 0.5" plywood
- 4 – 10" mini bungee cords
- 1 – Easter egg
- 1 – U chain coupler
- 1 – Standard Hook
- 1 – Shoulder hook
- 2 – Eye hooks
- 2 – L brackets
- 3 – Bricks
- 1 – Washcloth
- 1 – Door hinge

As you can see the parts are readily available and the production cost is quite low. The construction process can easily be done with minimal wood working skills and easily be automated.

Requirements and Rules of the Competition

The rules of the competition were fairly simple and are as follows:

- Fire a 50 gram projectile (golf ball)
- No ballista style designs
- Score the most points possible in 4 attempts
- The catapult cannot jump across firing line
- Must have trigger assembly



- Must not exceed 1.5'x1.5'x1.5' in size

Target Dimensions:

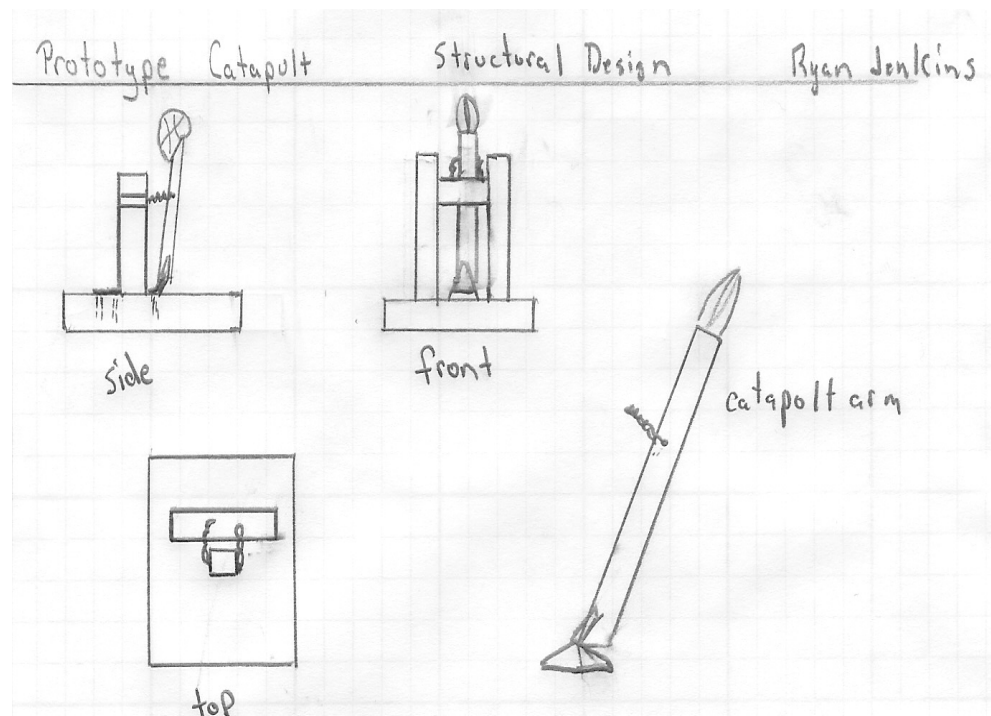
Bulls-eye	Center	100 Points
	Second Ring	90 Points
	Third Ring	80 Points
	Fourth Ring	60 Points
	Outer Ring	50 Points

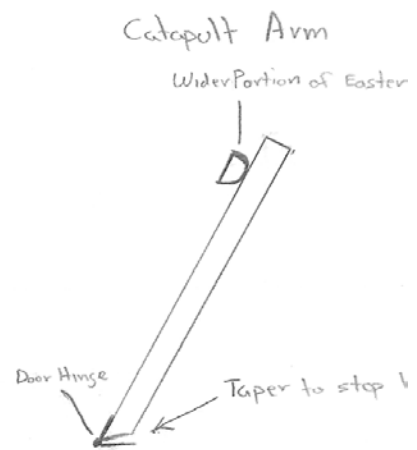
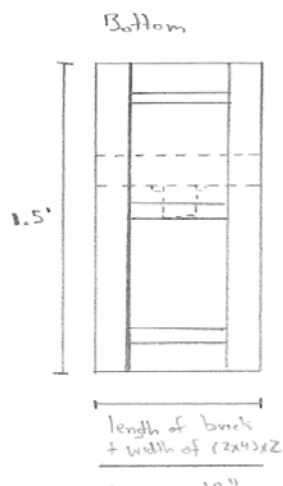
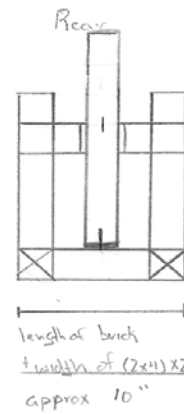
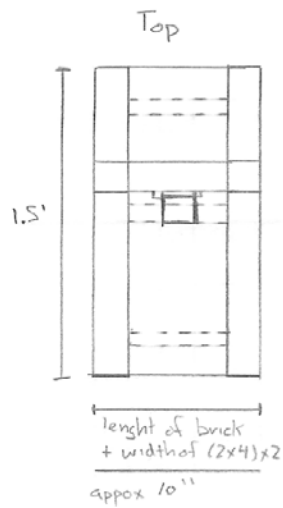
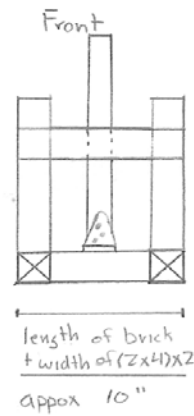
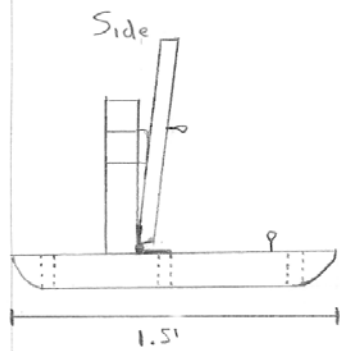
Target Diameter: 23.5"

Target Bulls-eye Height: 20.5"

Catapult Distance From Target: approx. 9'8"

Sketches

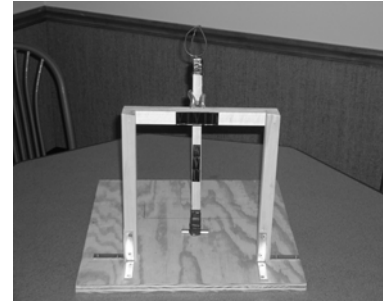




Results and Discussions

The Prototype

This catapult was a disappointment to put it at its best. The design was simple as we had set out to do, but unfortunately it was too simple and lacked the proficiency we were looking. The overall score for our catapult was 100 points which was a tie for 2nd to last place which depressed us slightly, however it did not discourage us and just gave us the drive to create an even better product. We knew from this performance that we needed a major overhaul, so it was back to the drawing boards to give this great idea the luster it deserved.



The Retrofit

We knew the concept was good but refinement was needed in order for it to achieve its true potential. There were several issues that needed to be addressed:

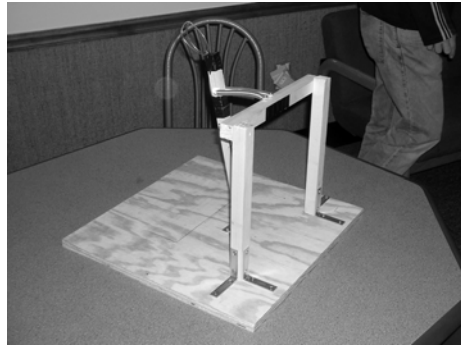
- Trigger mechanism
- Stable base that doesn't skip or jump
- Holding Device
- Power system
- Safety
- Adjustability

The two most important was non-existent trigger mechanism and a holding device for the projectile. The one that took precedence was the trigger mechanism and the lack there of. This presented an issue with safety due to the fact it had to be launched by the hand of its user. This was solved by the use of a custom made part that was consisted of a few everyday workshop items. The latter of the major problems with catapult revolved around the fact it didn't cradle the projectile as well as it should, leading to sporadic shots that constantly went off target. We solved this by using the wider end of a large Easter egg that held our projectile much tighter than the previous coat hanger cup and stop it from bouncing around.

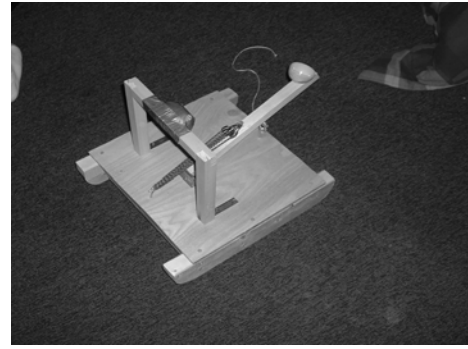
Safety was one issue we mad sure addressed in our revision. With the invention of the trigger mechanism the majority of the safety issue was solved, but we still had to worry about a few sharp points and ends of screws that protruded through the surface of the wood. We fixed these problems by rounding a few edges and using the proper length screws.

The minor issues such as the base, power system, and adjustability were initially separate, but we found as the separate pieces came together they not only solved one another but actually made for an even better product. The first minor change was the base in which we decided to add 2"x4"s and 1"x3"s to form a structure that would fit snugly over 3 bricks. We also added screws to make adjustable feet to raise the pitch of our catapult slightly, which inherently brought adjustability with them. The second change was a swap out from springs to mini-bungee cords. These cords allowed for much smoother operation and did not stretch out when used excessively. With the use of these cords, we were then able to choose from 1 to 4 bands as a power source thereby aiding in the solution of adjustability.





Before Revision



After Revision

Trigger Mechanism

The trigger mechanism is composed of a U-chain coupler, two eye hooks, and 1 shoulder hook. It is designed to allow for maximum safety by attaching a cord of any length to the U coupler, thereby keeping the launcher away from the arm apparatus. The cord is then pulled, unlatching the coupler from the shoulder hook and allowing the arm to travel forward.

Power System

The power system is composed of 4 mini-bungee cords. Each one has approximately the same force and can easily be added or removed from the catapult. This provides an incremented power system that can further be tuned by adjusting the pitch screws on the base of the catapult.

The Base

The base is specially designed to fit over 3 bricks snugly. These bricks add both friction and stability to the base by not allowing it to jump or wobble in any direction. The bricks go in a 2 brick slot and a 1 brick slot.

Conclusion

In conclusion, with a trigger mechanism, launching is now easier and safer. Our projectile holder allows for accuracy and greater precision. The adjustable power system allows for incremented power adjustments. The padded arm rest reduces wear and tear from everyday use. With it being designed to fit snugly over three bricks, it now stays in place when launched. Adjustable feet in the front allow for minor height adjustments. Overall this provides greater accuracy and better structural integrity guaranteeing you get the most enjoyment and reliability from your catapult.



West Virginia University

Presents

Creation of a Catapult

Vivid
Consulting

Introduction

- Eight groups received an assignment to create a catapult that would hit a bulls eye 3 meters away.
- Our group tied for second to last place in the initial competition with a score of 100 points.
- With this revised catapult, we can keep our heads high as we take part in the design competition and compete with some of the finest that West Virginia University has to offer.
- We have made it a point to keep the design simple, safe, and effective because that is what we know you the consumer is interested in.

Vivid Consulting Associates

- Matthew Allday
- Scott Boas
- Garrett Donohue
- Ryan Jenkins
- Bryce Trushel



Rules and Regulations

- Dimensions: cant exceed 0.46 meters X 0.46 meters X 0.46 meters.
- No weight limit
- Cannot be a ballista type catapult
- Must be 3 meters away
- Try to hit the bulls eye that is located .53 meters off the ground

Target



- 100 Points!!
- Our goal is to hit the bulls eye of a target 3.0 meters away and at a height of 0.53 meters with a golf ball. The bulls eye is worth 100 points, the second ring 90, the third 80, the fourth 60, and the outer worth 50.

History of Catapults

Throughout history, humans have applied innovative ideas and designs to devices for throwing weapons.

- Slings to overcome the limitations of hand aims
- Hunters and soldiers devised the bow and arrow to improve aim and velocity
- Finally, in the midieval, its power and accuracy were achieved with the design of machines called catapults.

Why catapults?

- Gave attackers a balance of advantage over defenders
- Allowed for a support fire over the large walls usually placed by defenders, thereby making sieges easier.



Evolution of Catapults



Ballista

- Developed shortly after 200 B.C.E.
- Designed to hit rocks and arrows long distances



Onager

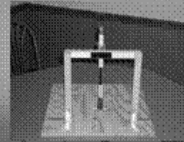
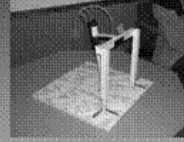
- Developed around 1st century C.E.
- Designed to throw greater ranges and over objects with arc



Trebuchet

- Developed at the end of the sixteenth C.E.
- Designed with power and range in mind

The Prototype



- Very simple onager design.
- Some safety issues (proximity to arm, inconsistency with projectiles)
- Not very cost efficient, as other groups spent less for a more polished product.

Success and Failures

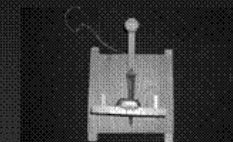
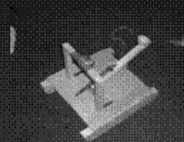
Successes

- Hit and Far Between
- Accurately Hit the Target
- Adjustable Arrows
- The Ballista provided an accurate projectile
- Strong back structure provided more power
- Hit the target
- Hit the target in the middle of the target

Failures

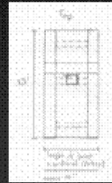
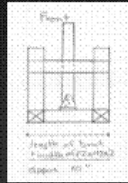
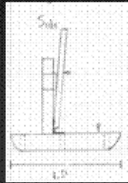
- No Triggering System
- Power not built enough so the ballista was not accurate
- No way to adjust the angle of the projectile
- No way to adjust the range of the projectile
- No way to adjust the speed of the projectile
- The score of 100 points was a shame to ourselves and our peers. Back to the drawing board we went!!

The Revision



- New and Improved base
- New power system
- New trigger assembly
- New padded stop

Designs and Sketches

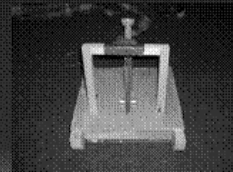


Design and Building Process

Total cost: \$ 15.89
 Time spent building: 4 hours
 Time spent testing: 1 hour 30 minutes

Parts:

- 2 - 10.6" 2x4's
- 2 - 10" 1x2's
- 1 - 13.75" x 14.75" sheet of 0.6" plywood
- 4 - 10" mini bungee cords
- 1 - Easter egg
- 1 - U chain coupler
- 1 - Shoulder hook
- 2 - Eye hooks
- 2 - L brackets
- 3 - Brackets
- 1 - Weir photo



Improvements

- With a trigger mechanism, launching is now easier and safer
- The projectile holder allows for more accuracy and greater precision
- Adjustable power system allows for incremented power adjustments
- Padded arm rest reduces wear and tear from everyday use
- Designed to fit snugly over three bricks for greater stability
- Adjustable feet in the front allow for minor height adjustments
- Overall greater accuracy and better structural integrity

Test Footage



Conclusions

- As we have proved through this presentation, we have learned from our mistakes and eliminated them in our revised design. We are now able to put out a product that is cheap, competitive, safe, and reliable for the consumer. We now open up the floor for the discussion and any questions you may have!!





Index

Executive Summary – 2

Introduction – 3

Methodology – 4

- ❖ Brainstorming Sessions – 4
- ❖ Construction Figures – 4
- ❖ Restrictions and Rules of the Competition – 4
- ❖ Sketches – 5, 6

Results and Discussions – 7

- ❖ The Prototype – 7
 - Prototype Picture – 7
- ❖ The Retrofit – 7
 - Before Revision Picture – 8
 - After Revision Picture – 8
- ❖ Trigger mechanism – 8
- ❖ Power System – 8
- ❖ The Base – 8

Conclusion – 8

Power Point Presentation – 9, 10, 11

Index – 12

Appendix – Product Picture

