Catapult Project

By

STAR

Group Members

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Executive Summary

A catapult was to be designed and constructed in order to hit a bull’s eye target. Both the catapult and the target had specific specifications in which the catapult had to abide by. Through the process of brainstorming, sketching, constructing, and testing, we were able to design a sturdy, simple, and consistent catapult that met all of the specifications. The cost to construct the catapult was close to $10 which makes it a very profitable design and easily available to mass-produce.
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Introduction

The goal of this project was to use the process of design to construct a catapult with certain specifications. We were to keep track of every step that we took up until the completion of our catapult. Our grade would be based on how accurate our catapult could launch a specific object at a target. The target consisted of circular rings, which consisted of different values, ultimately leading to a bully’s eye, which would earn the most points. There were certain limits in spending and certain materials that could not be used in the construction of the catapult as well.

The first thing our group did was brainstorm and make sketches for the possible design. Next, we constructed the catapult, recording changes as needed. We did trial testing and recorded results before and after our changes. Finally, we made a presentation of our project to the class.

Each step that we took in the design process will be described in separate sections of this report.
Specifications

Catapult:
- Must fit into a 1.5’ by 1.5’ by 1.5’ cubic space
- Any materials could be used except for machinery
- Keep cost of materials as low as possible
- Needs to be able to launch a golf ball 9 feet into center of target
- Must be accurate and adjustable
- Safe design
- Cost efficient design

Target:
- Bull’s eye target with each ring spaced 3 inches apart
- 27” by 27” square frame
- 7.5” from ground to bottom of frame
Brainstorming Process

The first thing our group did was get out some scratch paper and list ideas on what types of materials could be used to build the catapult. Here is a list of some of the materials we came up with:

- Wood
- Springs
- Medical tubing
- Logos
- Bricks
- K-nex
- Rubber bands
- Screws
- Bolts
- Nails
- Brackets
- Cups
- Tied cloth
- Ashtray
- Bungee chord

One of the main things our group discussed during the brainstorm session was the type of holder we would use to set the golf ball in. It was important for the friction between the ball and the holder to be the same for every launch to ensure a consistent release point. We debated that a cup would not work well since the ball would have too much room to roll around. The ashtray and the tied cloth didn’t turn out to be very feasible ideas either once our catapult took shape during the construction phase.

We were concerned with where these materials could be found and for what price. Could we get them for free? Would they be expensive? These are some of the questions we asked and we came up with a few locations such as Lowe’s Home Improvement stores, a group member’s house, and a junkyard. Most of the materials we figured could be found at one of the group member’s houses.

Another thing we discussed was the location in which to build the catapult. We thought of using an outside location, a basement or a garage. We wanted a wide-open place to work with available tools. The best place for this project was a garage.
Preliminary Sketch

On a few scratch pieces of paper, a couple of our group member’s drew sketches of how we wanted our design to look. As we talked about what materials could be used for certain parts of the catapult, a basic design started to develop. After comparing the sketches and deciding on measurements, we had our first design. Here is what it looked like:

One of the things our group members agreed upon unanimously in the preliminary sketch was the type of base we wanted to use. Since the catapult could not move past a marked line after releasing the golf ball, we knew we needed a sturdy base. In order to maximize the friction between the catapult’s base and the ground, we decided to use the total allotted space available, which was 1.5’ by 1.5’. Any design built on top of the base would increase the weight, which would increase the surface friction. Not only would this keep the catapult stable, but it would also provide for a maximum design area on top.
The preliminary sketch was not what our final design ended up looking like. The final sketch followed a similar design as the preliminary sketch, but the only difference was the type of trigger mechanism we ended up using. We finally agreed on a golf ball holder and decided to drill a hole in the catapult “arm” a little smaller than the golf ball itself. The golf ball would fit snug and provide a consistent release point. Here is what the final sketch looked like:
Construction

Here is a list of materials used in our project for our final design:

- ¾ inch plywood
- 7 inch bolts
- locknuts
- screws
- medical tubing
- eye-bolts
- L-brackets

Our design consisted of a ¾ inch piece of plywood cut into a square base. On top of the base we cut two pieces of this same plywood into a similar shape as the catapult arm would make when launched. These two pieces of plywood stand upright on either side of the catapult arm. The catapult arm is simply a piece of plywood attached to a rotating hinge. A stopper is attached to two columns of plywood on either side of the arm. This prevents the arm from rotating past a 90-degree angle, which would send the golf ball to the ground. Screws, locknuts, and bolts, as well as L-brackets, hold the catapult together for a compact design, which is very sturdy. The trigger mechanism is attached to an eyebolt and can be released with a simple push. Medical tubing wraps around two eyebolts on either column and is what provides the force to launch the golf ball.
Building Complications

Building Location:
- needed a spacious location to work
- had to be fairly isolated

Solution:
- group member’s basement

Locating Materials:
- material and tool availability
- free usage of equipment if possible

Solution:
- group member’s garage

Low Budget:
- needed expenses to be as low as possible

Solution:
- found materials around house and already had tools available in garage
Changes to Design

**Bungee Chord to Medical Tubing:**

Originally we used a bungee chord for the “sling system” in our catapult design. However, the bungee chord proved to be too inconsistent when firing the golf ball at the target. It would normally fire the golf ball over the target and with too much force. Two bungee chords were attached to the catapult, which also made the launch inconsistent.

Changing to medical tubing, the launch was nearly perfect. It was more consistent and hit the bull’s eye on many attempts. Instead of using two pieces of bungee chord, only one piece of medical tubing was used which caused the “pull force” on either side of the catapult arm to remain consistent. This is what we ultimately ended up using.

**Different Trigger Mechanism:**

At first, our trigger mechanism was going to be some kind of rod that we could stick through the catapult arm and the holes we would make on either piece of the plywood on each side of the catapult arm. There would be a series of holes in order to adjust the force of the launch. This idea never came to be as construction went along. During construction, the only trigger mechanism we had was simply pulling the arm back with one’s hand and releasing. This proved to be very inconsistent and the idea was discarded.

The new trigger mechanism was a curved piece of metal simply slipped through an eyebolt. Pushing the piece of metal through the eyebolt would release the catapult arm. This mechanism was much more consistent.

**New Stopper:**

Our first idea for a stopper, to stop the catapult arm’s motion, was to use a large piece of square plywood and bolt it down into the front of the catapult. During construction, this idea was eliminated.

The new stopper was an H-bar, which was less bulky and more efficient. It allowed for less congestion and kept catapult easily accessible.

**Golf ball holder:**

We were not sure about the type of holder we would use during the brainstorm session. Originally we had thought about using a cup, tied cloth, or an ashtray. None of these ideas were used during construction.

A hole, slightly smaller than the golf ball, was drilled into the wooden catapult arm. This was all that was needed and the golf ball fit snug in it.
Trial Results

Before Changes:

- bungee chords caused an inconsistency in distance and accuracy
- release mechanism was inconsistent
- stopper took up too much space
- out of 20 attempts, 75% of the time the golf ball shot too high

After Changes:

- medical tubing improved accuracy and consistency
- release mechanism was more consistent
- stopper was less of a bulk
- out of 20 attempts, the golf ball hit the bull’s eye nearly 90% of the time

From these results, it is easy to see how the changes improved our accuracy and consistency. Our scores were better and gave us the type of results we wanted to achieve.
Gantt Chart

Here is a chart showing how our time was used during the design process:

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Conclusion

At the beginning of this project our group was given specific restrictions on the type of catapult we were to make. We used the process of design to create and construct our catapult. Brainstorming was the first thing we did, followed by sketching designs of how we wanted the catapult to look. Each member of our group contributed his or her thoughts and the simplest design was constructed. Eventually we came up with what we thought was the best design and constructed it. As construction proceeded, we made changes as needed.

Our design is sturdy, consistent, safe, and cost efficient. Most importantly, it can be mass-produced. We feel that we achieved the goal we set out to accomplish. We met all of the standards and improved our catapult as we went along. This is why we feel it is a very successful design.