Tri- State Consulting Co.

Engineering 101

Project # 2

Catapult Design

Group # 8

12-03-02

Executive Summary

The objective of our second project was to design and construct a catapult, which met certain criteria. Our catapult was designed for the sole purpose of launching a golf ball, which was intended to strike the bulls-eye of a target three meters away. In developing our final design, we took several factors into consideration to ensure an accurate, durable, and most important, safe product. Overall, our company was able to produce a catapult that is engineered with extreme quality and produces more than sufficient results.

Introduction

In this project, we at Tri-State Consulting Co. set out to design a catapult, which met certain specifications. We had to build this catapult no larger than one and a half cubic feet and we had to be able to hit a target three meters away and approximately twenty inches from the ground. Several brainstorming sessions took place throughout the design process in order for the best possible catapult to be developed. After reviewing our design specifications, we were able to develop a safe, accurate, and inexpensive product. Through many tests and modifications, we were able to "fine tune" our design for maximum results.

Materials

All thread (rod stock)
Scrap aluminum
Angle iron
Plate aluminum
Aluminum bar stock
Wood Base Hammer
Nuts
Bolts
Washers
Rubber tubing
Spring

Tools

Drill press
Wrench
Disc grinder
Tap
Diagonals
Hacksaw
Hammer

Methodology

Throughout the entire process of designing and constructing our catapult, we have engaged in rigorous activity to develop a device, which meets the specific criteria mentioned in the introduction. This specific process included a brainstorming session in which each member of the company came up with ideas that assisted in our initial designs. Overall, the session left us with several ideas to consider, but after an in depth group discussion, we made a final decision as to which basic design to move forward with. Upon making this decision, we found it necessary to establish a list of materials needed for the construction of the catapult. In order to meet the specified criteria, we conducted research to find materials that were easy to work with, while ensuring a safe and durable design. To provide quick and efficient results each group member was responsible for researching products that would best suit the design established for the catapult. These issues were debated and discussed at the first meeting geared to the construction of our catapult. It was conclusive that the primary material utilized in the design be a metal that is easy to work with. Aluminum, a soft metal, seemed to be the ideal material for our needs.

The next step in the design process focused on choosing a location that would conveniently meet our needs for assembling the product. This meant a site that supplied all the tools necessary for the construction. A garage seemed to be the only answer in this instance. It offers accessibility to needed tools and a sufficient work environment. After we establishing the aforementioned factors of the design process we were now ready to proceed with the actual assembly of our catapult.

We started by gathering the materials that we had listed for the construction of the catapult. Fortunately, we were able to gather some of the material without making a purchase. For example, we found the wood, utilized as the base, the rubber tubing, and the posts, which are simply pieces of scrap aluminum bent on both sides. As for the rest of the materials, they can be purchased at most hardware stores.

Foremost, we started with the lever, and its pivot point. We used all thread for the lever, and a 1″x1″ piece of aluminum bar stock for the pivot point. Both materials usually come in 3 feet long pieces, therefore; we had to determine certain lengths for each material. We chose to cut the piece of aluminum bar stock first so that we could establish our pivot point, thus enabling us to determine the length of the lever. In order to keep our design simple, we maintained dimensions accordingly. The bar stock was cut into a 1″x1″x2″ piece by using a hacksaw. Since safety was a major concern in developing the design, we squared the edges so that all sharp edges would be eliminated. This task required gently pushing the bar stock against the disc grinder. As for the lever, we decided to use two pieces of all thread on each end of the aluminum bar stock so that it could be easily adjusted. These pieces also had to be cut by using a hacksaw, however; there is a trick to cutting all thread so that the end threads do not get ruined. Before cutting the all thread, a nut must be placed in the desired position. This is done for two reasons: to protect the threads and to act as a cleaning mechanism. As the bolt is removed it clears away any burs, pieces of excess metal. Once the pieces of all thread are cut, two holes on both sides of the bar stock must be drilled and tapped in order to accept these pieces. It is important to identify the center of the bar stock for the pivot point, if this simple task is neglected than there is the possibility of drilling the holes for the all thread too deep. With this in mind, we decided to drill the holes ¾ of an inch deep. Once the holes are drilled then they must be tapped to accept the 3/8 -24″ rod stock. After these holes were drilled and tapped we were able to drill a clearance hole, 3/8 in diameter, in which the pivot point was placed.

Next, we established where we wanted the lever to pivot on the two posts. Once this task was completed, we were able to drill two clearance holes, one on each post, for the lever to pivot. Since we have already drilled and tapped the holes on the pivot point to accept the all thread, at this point it is time to cut the all thread.

The next material we work with was the 2″x2″ piece of angle iron. Since we wanted to ensure easy adjustability for every aspect of our catapult, we included the angle iron so that the tension of the spring could be adjusted as need be. In accordance to our criteria established for our catapult, we rounded the edges of the angle iron with a disc grinder to minimize any safety issues. Once we completed that task we drill a clearance hole through the center of the angle iron to accept the 3/8 -24″ all thread. The purpose of

drilling a clearance hole was to ensure that the all thread be easily adjusted, which in turn adjusts the tension of the spring. Once both the aluminum pivot point and the piece of angle iron are properly prepared, two small holes must be drilled in one end of the all thread to accept the spring. Knowing that the pieces of all thread are round in shape and force the drill bit to slide off without making the hole, we had to use a disc grinder to grind a flat surface on both sides of each end. The flats provide an ideal surface to place the drill bit needed to make the small hole.

At this point of the construction the spring was attached to both pieces of the all thread. We found a long piece of spring and used diagonals to cut it to our desired length. We bent the end coil on each side so that we could slide them through the small holes on both pieces of all thread. Constructing the holder for the golf ball was the next topic of concern during the construction process of our catapult. We utilized a 1/2″ thick plate aluminum. We decided to use aluminum for this particular part because of its lightweight and especially soft texture for a metal. A hacksaw was utilized to cut the plate aluminum. Upon completion, we drilled and tapped a hole to accept the all thread. To cut the rather large hole in the middle where the golf ball sits, we used a drill press. To ensure a snug fit in doing so, we drilled the hole according to the diameter of the golf ball.

Finally, after every aspect of the catapult was complete we finished drilling the holes in the posts where the materials belonged. Once these clearance holes were drilled we proceeded to mount the catapult to our wooden base. In doing this, we simply measured and marked the board were we would drill the holes. We placed the board under the drill press and carefully aligned each hole as to make the incision in the proper place. After these holes were drilled we securely fastened the catapult to the board by using bolts and nuts, which locked everything into place. These extra precautions allowed for the exceptional stability that our company was striving towards. After this rather lengthy process the construction of the catapult is complete, and the finished product is ready for testing.

Results and Discussion

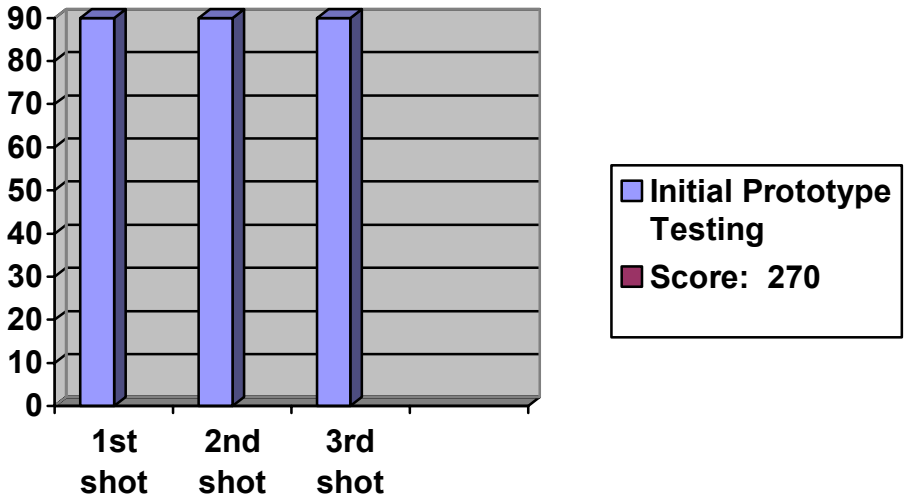
Through extensive brainstorming, testing, and modifications, we were able to develop a final product. Our final design meets all specified criteria established for this particular project. In accordance, it is within the 1.5x1.5x1.5 foot dimensions and contains a trigger mechanism. Since meeting such criteria as making the catapult safe to operate, easily adjustable, durable, stable, and accurate, certain modifications were necessary during our design process. The first changes that took place pertained to the actual design of the catapult. The initial design was fairly accurate, however; the positioning of the spring presented the only major adjustment. Foremost, on the initial design the spring was place vertically rather than horizontally. Changing this position offered more accuracy and stability due to reduced flex in the spring. In addition, we added a trigger mechanism, which created a higher level of safety to our product. Throughout the entire process, safety remained our key priority, and has provided

reasoning for some of the modifications made on our design. Our initial design did not contain a trigger mechanism, so in order to meet our safety criteria, we developed this particular mechanism. Once our catapult was completed, we realized that the position of the stopper was interfering with the projectile of the golf ball. In order to correct this problem, we drilled two holes farther back on the posts. This modification allowed our catapult to launch the golf ball along the intended projectile path. Finally, there was only one more problem that was needed corrected, to ensure the best accuracy for our product. The initial mounting of the catapult to the wooden base created this problem. It was distorting our accuracy by about 10%. However by re-mounting the catapult to a new board, which was precisely measured and marked to ensure proper adjustments, we were able to solve this complication. This task has increased the overall accuracy of our catapult, thus generating a better product.

In developing our design there were several aspects that we, Tri-State Consulting Company, felt necessary to include. These aspects include, creating a device that was completely safe to operate, while ensuring durability, stability, accuracy, and consistency. In order to develop a catapult that met this criteria, many objectives throughout the entire design and construction process were taken into consideration. For our design we utilized metal for entire catapult. The purpose of utilizing this particular material was to create a device that could withstand the constant force of the spring as well as provide stability for the overall apparatus. We chose to use aluminum as our preferred metal as much as possible, due to its rather soft metal texture. Aluminum provided the easiest metal to work with as far as drilling and cutting, other metals would have increased the complexity of the construction process. Also, making our design easily adjustable was another major concern when designing our catapult. We wanted to produce an apparatus that could be adjusted on location to provide the most efficient results. The key to this objective was utilizing several pieces of all thread. The all thread allowed every aspect of our design to be adjusted. The lever consists of two pieces, and the spring is also attached to a piece of all thread so that the tension may be adjusted. By simply turning this material you can adjust each portion to the desired length and/ or tension. Once we established the materials we felt would produce the ultimate success for our catapult we established a location that would satisfy our needs. After several suggestions we decided to construct and assemble our catapult in John's brother's garage. This particular location provided easy access to all the tools needed to properly construct our design and allowed room for testing. Overall, though the design process and construction of our catapult we were able to create a device, which meets, the criteria set out to accomplish. Furthermore, an investment in our product will ensure the best results on the market.

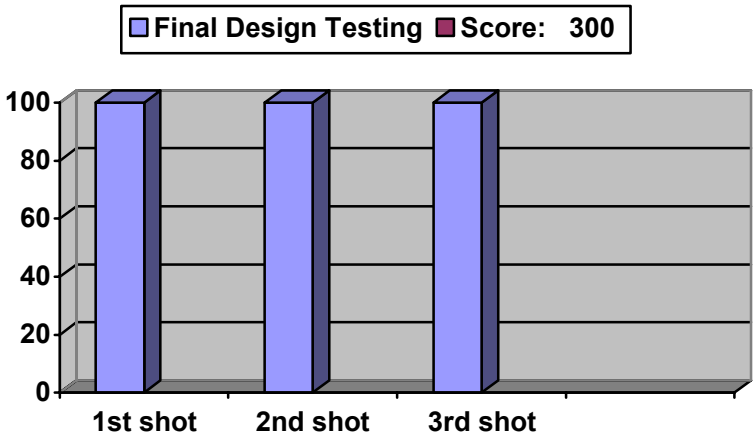
Initial Design (1ST Prototype)

Results



Final Design

Results



Conclusion

We at Tri-State Consulting Company set out to build a safe, durable, and inexpensive catapult, which hit the target accurately and consistently. We were able to do so through a process of much debate, brainstorming, and testing. Our catapult has been built to the proper specifications and, after several tests and adjustments, is able to hit the center of the target on a consistent basis. We believe that our design and choice of materials make our catapult the best on the market.