How the Trebuchet Changed History

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I. Descriptions of Catapults

The word catapult originated from the Latin word Catapulta, *kata*- down, and *pullein*- hurl or through. The first recorded catapults were invented by the Greeks and were used as field artillery as well as siege weapons. The earliest catapults were based on large bows and instead of launching arrows they would use spears. These spear launchers were are called Ballistas. The Romans later invented more powerful weapons that were easier to construct. The Mangonel was invented on the same principle as the Ballista except it was a little simpler. It was lighter than the Ballista and was very mobile. The Mangonel is what most people would think of when imagining a catapult. It would shoot both stones, burning objects, and even on some rare occasions would launch clay pots filled with poisonous animals such as snakes and scorpions.

A trebuchet is a type of catapult that has a sling at the end of the throwing arm (see figure 1). The trebuchet was first invented in China around 300bc, but was not seen in Western Europe until the 12th century. The Europeans first saw the trebuchet during the Crusades. There are two different types of the trebuchet. The **Traction Trebuchet** (figure 2) and the **Counterpoise Trebuchet**. The Traction Trebuchet used man power to launch large objects. This type threw small size objects over smaller distances. The Counterpoise Trebuchet replaced the manpower with a combination of counter-weight

and leverage, it could launch larger stones farther than the Traction Trebuchet. The Europeans scaled up the trebuchet to throw 250 pound stones over 200 yards. This was enough mass and power to break down castle walls.

II. A Model of a Trebuchet

I made a Trebuchet to experiment with the physics of its action. I wanted to see if I could build a scaled down trebuchet that would work over a scaled down distance. I based my design on photos that I found on the internet. I used a large piece of ply-wood as a base to make it sturdy. I made the fulcrum two feet high, and braced it with one by twos on each side. I used a coffee can for my counterweight. The can was hinged with a metal rod to the throwing arm. I then filled the coffee can with 8.5 pounds of pennies.

I first tried to launch a golf ball but it didn't come out of the sling. The pocket of the sling was too deep and I had to change the sling before it would launch correctly. I also had trouble with the pin that the sling was attached to. It was releasing the sling too early and the golf ball would go straight up in the air. Once the pin was bent forward the trebuchet launched the ball about 10 feet. Items lighter than the golf ball went much farther.

After working with my trebuchet I watched Nova's *Secrets of Lost Empires II* (weapons of siege). In the documentary, two engineers built two full size working trebuchets. Their designs came from ancient drawings and descriptions. One builder was

also a mechanical engineer. I learned that their trebuchets would throw 200 to 300lb stone balls and that the counter weight for one was 6.5 tons. Both trebuchets would throw the balls over 200 yards.

The reason that they made two trebuchets was to test two different types of counterweights. One trebuchet (figure 1) used a large bucket filled with rocks and earth as a counterweight. The counterweight was on a hinge so that it could swing as the trebuchet was launched. The second Trebuchet (figure 3) had a fixed counterweight and wheels so that the entire trebuchet would rock back and forth when it was fired. The hinge on the bucket and the wheels on the other both helped trebuchet to throw the balls farther. It is still unknown which type of counterweights were most popular.

I adjusted my trebuchet arm to match the ratio in the documentary. My arm is 38" long. I made it 7.6 inches from the weight to the fulcrum and 30.5 inches from the fulcrum to the end of the sling. This is the four to one ratio that I measured from the video picture. I also changed the ratio a couple of times during the tests to try in find the optimal distance ratio.

My counterpoise weight is 9.1 pounds in a coffee can. As a counterweight I used both pennies and lead balls from by dad's flintlock rifle. After watching the Nova documentary, I calculated that my throwing weight should be 2.8oz - which is around the weight of a golf ball. I calculated the weight as follows:

Real Trebuchet

13,000 lbs/ 250lbs = 52 this is the multiplier of the throwing weight to the counterweight

My Scale Trebuchet

9.1 pounds / 52 = my throwing weight (2.8oz) or approximately a golf ball.

Results of firings: how far did it throw different weights.

My trebuchet was throwing golf balls, and ping pong balls that were wrapped in tape for extra weight. The golf ball was thrown consistently between 15 and 20 yards. The ping-pong ball was consistently thrown between 20 and 25 yards or 60 to 75 feet. The longest throw for the golf ball was 21 to 22 yards. The longest throw for the ping pong ball was 25-26 yards. Although I was happy with these distances I had hoped for longer throws. My model is a 1/8 size of the models in the documentary and I had calculated that 1/8 of 200 yards was 25 yards which is just where my trebuchet was shooting the ping pong ball!

One thing that really surprised me was how straight the trebuchet could shoot. If I shot five golf balls, they would all be within two feet of each other. The trebuchet's accuracy was partially because it had a trigger mechanism. It was always cocked and released exactly the same way. For a trigger I drilled a hole in the base of my trebuchet and put a string through it. I then tied a loop in the middle of the string to wrap around the pin at the top of the throwing arm.

I had to do a lot of tweaking with the angle of the pin at the top of the throwing arm when changing the weight of the object that was being thrown. To see my trebuchet in action go to: http:// HYPERLINK (http://homepage.mac.com/fogwell/iMovieTheater11.htmlhomepage.mac.com/fogwell/iMovieTheater11.html. My dad helped me by using our digital camera to take video clips of me both explaining, and launching the trebuchet. They are posted on the internet so that you can watch them. (If you have any trouble seeing it then you can just let me know and I will email you the video clips.)

III. How Counterpoise Trebuchets Were Used in the Middle Ages

The Counterpoise Trebuchet was a powerful siege weapon that was used to throw stones, flaming objects and even dead animals and humans into the besieged castle. It was not until the early 1300's that the trebuchet became powerful enough to break through the strong castle walls. Trebuchets were built on location and took a lot of manpower. King Edward used 50 carpenters to build his trebuchet and in the documentary it took 12 men just to pull the pin to launch the trebuchet. It was not an easy task to build a trebuchet so they were not constructed unless it was absolutely necessary.

Trebuchets were designed to be set up out of range of the archers which was roughly 200 yards. This kept those building and firing the trebuchet safe. However this

meant that the trebuchets had to be designed to throw objects over 200 yards. The use of trebuchets called for experts to make calculations and designs as well as expert carpenters to build these massive machines.

Some castles even had trebuchets inside the walls for defense. These trebuchets were used to keep the besiegers from building a trebuchet. They would not shoot at the enemy, but would instead try to destroy the enemy's trebuchet before it could do any damage to the castle.

IV. How Trebuchets Affected History

In 1304 Edward I of England besieged Stirling Castle in Scotland. Initially, trebuchets were used to launch burning objects as well as small stones into the Castle. After a few weeks Edward became impatient and decided to have 50 of the top carpenters in England make the largest and most destructive siege weapon ever seen. As this weapon was being constructed the inhabitants of Stirling castle became terrified and nicknamed this massive weapon "Warwolf". Although only a vague description of the weapon was given in historical records Warwolf is believed to have been a massive trebuchet. As the completion of Warwolf neared, the Scottish rebels surrendered. However, Edward I did not accept their surrender because he wanted to test his new siege machine. When Warwolf was completed, it was launched only once. It threw a 250 ponds ball that leveled an entire section of the thick stone castle wall. Warwolf

demonstrated that a trebuchet could be built that could breach a castle wall from a safe distance. This changed the significance of castles as a foolproof defensive strategy.

Another example of the use of the trebuchet took place in Kaffa in what is now Crimea in the Ukraine. This was an important trading post in 1300's. In 1346 Turkish warriors besieged the city which had Italian merchants living there. As the siege dragged on the plague broke out among the Turkish troops. The generals ordered the surviving troops to load their comrades' corpses onto trebuchets and launch them into the city to spread the plague. The inhabitants of the city hurried to drag the plague ridden bodies and throw them into the black sea, but it was too late. The plague had already spread into the town. The Italian merchants hurriedly set sail back to Italy, and with them came the plague. The plague quickly spread through Italy and up into northwestern Europe. By the end of the plague roughly 30% of the population of Europe had died! Entire towns were wiped out and abandoned because of the plague. Although the plague would have most likely found it's way to western Europe regardless of the trebuchet, there is no doubt that the trebuchet sped up the spreading of the plague, accompanied with death and destruction leaving Europe in shambles and a dark mark on history.

I believe trebuchets increased the power of kings. If noblemen ignored the king, they could no longer rely on the protection of their castle. Trebuchets were a vital weapon of siege until they were replaced in the 15th century by the invention of gunpowder and cannons. Cannons were portable and more powerful than trebuchets.

Although trebuchets were a dominant threat for 200 years, very little is now known about these awesome machines of war.

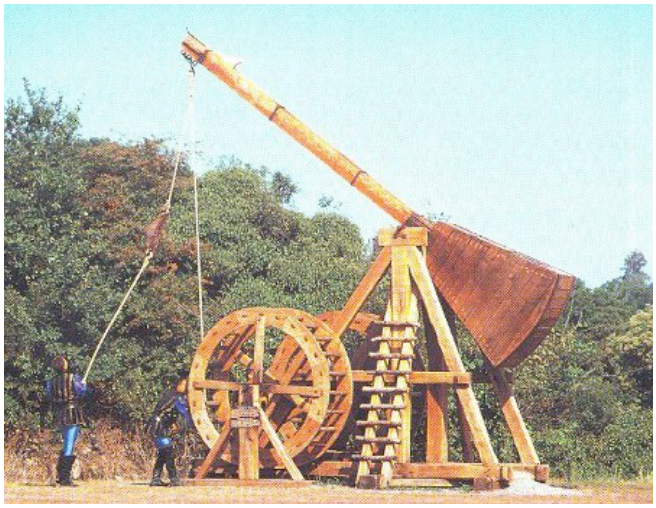

Figure 1

Figure 2

Figure 3

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