CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
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Project Number
J0330

Project Title
Mace vs. Flail: A Comparative Study of Impact Forces between Two Medieval Weapons

Abstract

Objectives/Goals
The purpose of my experiment was to see whether a medieval mace or a medieval flail had the most impact force. My hypothesis was the flail would have a higher impact force because the second segment of the flail would whip ahead and result in a higher velocity and therefore higher impact force.

Methods/Materials
An experimental apparatus made from Lego Mindstorms was used to repeatably swing a Lego mace or Lego flail and record the impact forces.
A 3-beam balance was used to measure the mass of the mace and flail and make sure they were equal. A free online double pendulum simulation was used to refine my hypothesis and see if the second segment of the flail would whip ahead or lag behind and result in higher or lower impact forces.
The mace and flail were swung 20 times each and the impact forces were measured.
Microsoft Excel was used to plot data in a histogram and do a statistical t-test analysis to see if the two data sets were the same or different.

Results
The mean impact force of the flail was 67 counts higher than the mace. However, the mace data had more variation than the flail data and the mace had the highest single impact force. A statistical t-test showed that the mace and flail had no significant difference in impact force.

Conclusions/Discussion
My conclusion was that my hypothesis was incorrect. Even though the physics of the flail and its ability to whip led me to believe that its impact force would be greater, the data showed the mace winning sometimes and the flail winning other times. The flail was consistently scoring the 800s, while the mace was more scattered, but had a maximum force of 900 counts. There was no statistically significant difference in impact forces.

Summary Statement
I showed that there was no statistically significant difference in impact forces between two medieval weapons, the mace and flail, that had equal lengths, masses, and velocities.

Help Received
I built and programmed the experimental apparatus, conducted the experiment, and performed the data analysis and plotting. My father taught me the physics equations and how to use a t-test in Excel.