CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
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Project Number
J0129

Project Title
Development and Utilization of a Model to Predict Rocket Velocity, Acceleration, Altitude, and Distance

Abstract

Objectives/Goals
The objective of my project was to design and build a functional rocket engine test apparatus to collect engine thrust data from rocket engines subjected to different masses.

Methods/Materials
I designed and built a chart recorder to collect data from the rocket engine test device that I designed and built. As the burning engine displaced a wood doweling, a permanent trace was recorded on graph paper attached to the turning drum unit. I tested two different types of engines, slow burning engines and fast burning engines. Each type of rocket engine was test fired against 3 different total masses: 65 grams, 145 and 198 grams.

Results
Data collected from this series of tests demonstrated that Estes rocket engines have 2 distinct phases. The first burn phase is a brief, high thrust generation period. The burn period for B4-4 engines lasted approximately 0.26 seconds while the initial burn period for B6-2 rocket engines was 0.24 seconds. The second burn phase is a low thrust generation period. The length of this phase was 0.83 seconds for slow burning engines and 0.53 seconds for fast burning engines. The maximum and total thrust generated during the initial burn phase of both types of rockets was approximately. The second burn phase for slow burning engines generated less thrust but for a longer period of time compared to the fast burning engines which generated more thrust but for less time. Finally, fast burning engines were able to displace each mass more than slow burning engines.

Conclusions/Discussion
The first burn phase identified is short in duration, but high in thrust generation. This high thrust generation is critical for accelerating the rocket from the resting state. During the second phase slow burning engines produce less thrust but for a longer period of time while fast burning engines produce more thrust but for a shorter period of time. Therefore, I predict that the fast burning engine should be able to launch rockets of greater total mass more efficiently than slow burning engines. In contrast, the slower burning engine should be more efficient at propelling rockets of lower total mass over greater distances because they produce thrust for a longer period of time. My data suggests that the optimal rocket flight parameters such as velocity, altitude and total distance traveled can only be achieved by optimizing the total mass of the rocket to the thrust generated per time period.

Summary Statement
I designed and built a rocket engine test device that I used to collect the data needed to develop a model to predict optimal rocket designs.

Help Received
Dr. Tim Neuberger, Dr. Mike Otto