Name(s)	Project Number
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Project Title

Staging vs. Clustering: Which System Will Deliver a Given Payload to a Greater Altitude when Mass and Impulse Are Equal?

Abstract

Objectives/Goals

The object of this project is to compare multi-staging and clustering in terms of maximum altitude in order to determine which is the more efficient system when carrying a given payload. Both theoretical simulation and actual experimentation were used to determine this.

The project compares the sustained, low-thrust profile of a multi-stage flight to the short, high-thrust profile of a cluster, and the outcome with variations in model mass. It explains with mathematical reasoning why clustering is more effective in launching models with large mass relative to the impulses of the individual engines, and why multi-staging is more effective when mass is low relative to the impulses of the individual engines .

Methods/Materials

To test my hypothesis, I designed and scratch-built four rockets: one 2-stage model, one 2-cluster model, one 3-stage model, and one 3 cluster model. In each pair being compared (2-cluster vs. 2-stage, and 3-cluster vs. 3-stage), the two subjects were equal in mass, diameter, and height. The models were first tested in a theoretical numerical simulation. From the simulation, I found that the 2-cluster model out-performed the 2-stage model, and the 3-cluster model out-performed the 3-stage. Actual flight data, however, was inconclusive due to errors in data collection and design flaws.

Results

From the simulation, I found that the 2-cluster model out-performed the 2-stage model, and the 3-cluster model out-performed the 3-stage. Actual flight data, however, was inconclusive due to errors in data collection and design flaws.

Conclusions/Discussion

Clustering is more effective in launching models with large mass relative to the impulses of the individual engines being employed in the model, and multi-staging is more effective when mass is low relative to the impulses of the individual engines. However, due to errors in my experiment, I am in the process of continuing my experimentation.

Summary Statement

I compared staging model rockets to clustering to see which system could carry a given payload to a greater altitude when mass and impulse are equal; this was determined by both theorectical simulation and actual experimentation.

Help Received

Teacher and uncle helped wire electronic launch controller. Teachers gave advice.