10th Wernher von Braun Memorial Symposium
October 24 – 26, 2017

Development of a User-friendly System Model and Simulation for an Amateur Liquid-Fueled Rocket

Daniel Corey, Thomas Bennett, Brendan Luke, James Biaglow
College of Engineering

Overview

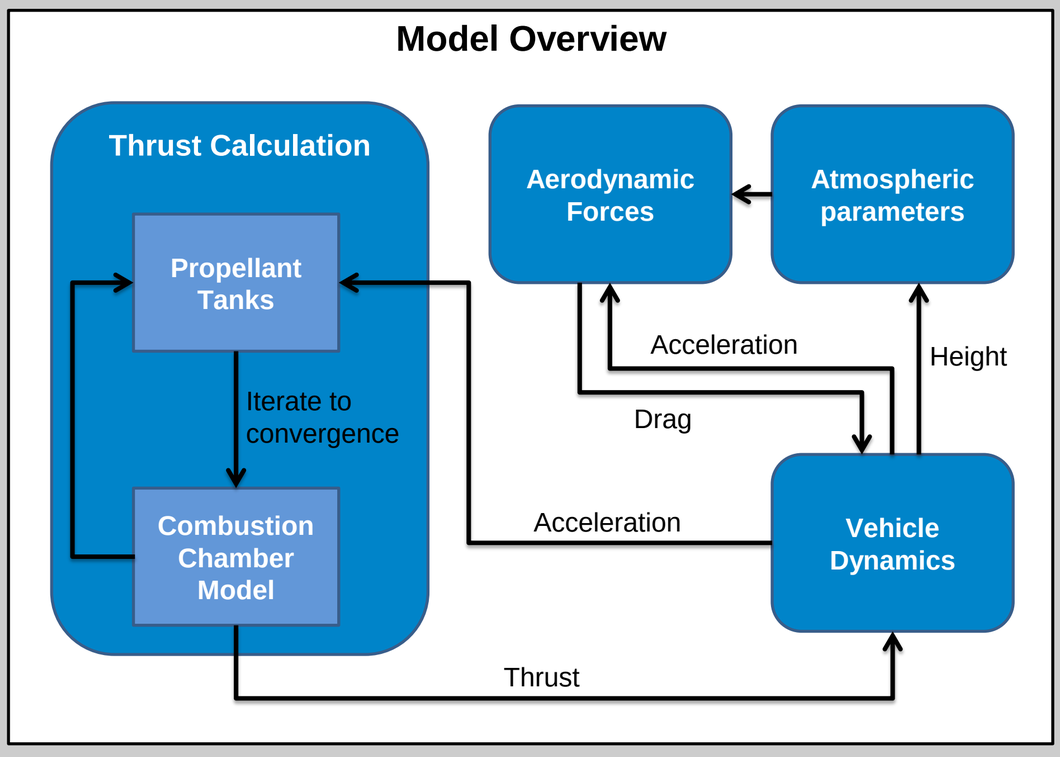
The UAH Space Hardware Club is developing a liquid-fueled rocket to fly to 30,000 ft. for the 2018 Spaceport America Cup. A simulation was developed that allows for any team member to determine the effect of a design variation on the overall system.

Rocket Basics

- Self-pressurizing nitrous oxide and ethane propellants
- 6.125 in. outer diameter
- 13 ft. tall
- Targeting 30,000 ft. apogee per competition requirements
- Must carry a 9 lb. payload
- Onboard guidance and control algorithms will continuously predict apogee and shut down engine to reach target altitude

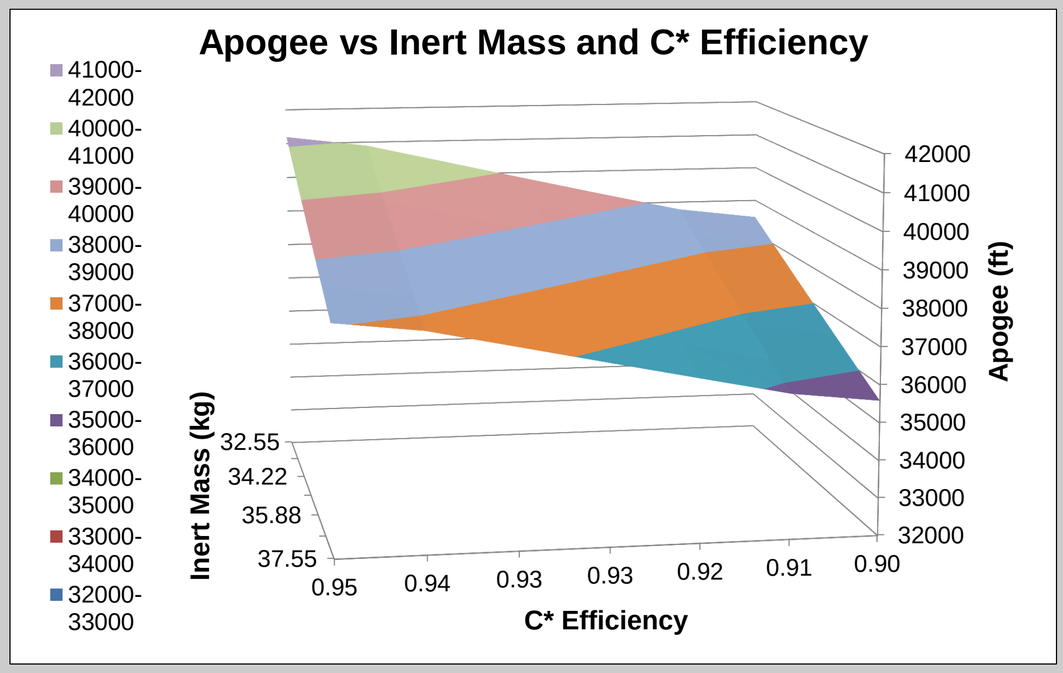
Simulink Model

Vehicle dynamics, propellant flow, tank state, and engine performance are all modeled in Simulink.



System Analysis and Trades

The simulator can accept and compare inputs across a range of values, allowing for assessment of appropriate launch conditions and the effect of design changes on overall performance. Additionally, Monte Carlo simulations can be used to assess the likelihood of the calculated results.



Interface and Usability

- Input parameters can be entered into Excel as fixed values, values with Gaussian noise, or a range of values
- Simulation runs for every combination of input parameters or a specified number of runs for Monte Carlo simulations
- Results output into Excel tables

Impact/Conclusions

The simulation has been used to assess project viability and make initial design choices. Going forward, it allows for informed decisions to be easily made over large, diverse trade spaces, as well as development and testing of GNC algorithms. This will result in a higher-performing, more successful rocket, which will help promote engineering within UAH and the greater Huntsville community.

Acknowledgements

Dr. Francis Wessling, MAE Department, UAH; Alabama Space Grant Consortium; UAH College of Engineering; The Space Hardware Club; UAH Office of the Vice President for Research and Economic Development; and the members of the UAH Spaceport America Cup team, particularly Adam Bower and Dalton Hicks