Spacecraft Separation Analysis Tool

Team Members: Michael Clopton, Viviana Gallardo-Cardiel, Alejandro Hernandez, Julianna Hernandez, Kishan Patel
Faculty Advisor: Ray Manning
The Aerospace Corporation Liaison: Edgar Herrera
Department of Mechanical Engineering
College of Engineering, Computer Science, and Technology
California State University, Los Angeles

Project Background

The most critical function of a launch vehicle is placing a payload into its proper mission orbit. The Aerospace Corporation is interested in developing a rapid turnaround software tool for the analysis, optimization, and uncertainty analysis of the separation system and its effects on the resulting payload trajectory.

Project Objective

- Provide a software tool that performs rapid and parametric analysis of a spacecraft separation system.

Project Requirements

Requirement		Performance Objectives
Software Framework	Customer Software Cost	Minimum cost suggests open source framework
	User Interface	Does not need to run over internet
	Simulation Architecture	Single upper stage and single payload
	Optimization	Separation system spring radius, angle, constant, undeformed length
	Uncertainty Analysis	Payload & upper stage mass, inertias, center of mass offsets
Separation Rate	Min Axial Separation	0.6 m/s
	Max Pitch Rate	0.01 rad/s
	Max Yaw Rate	0.01 rad/s
Documentation	User Manual	Details instructions on how to use simulation analysis tool

Overall Design Approach

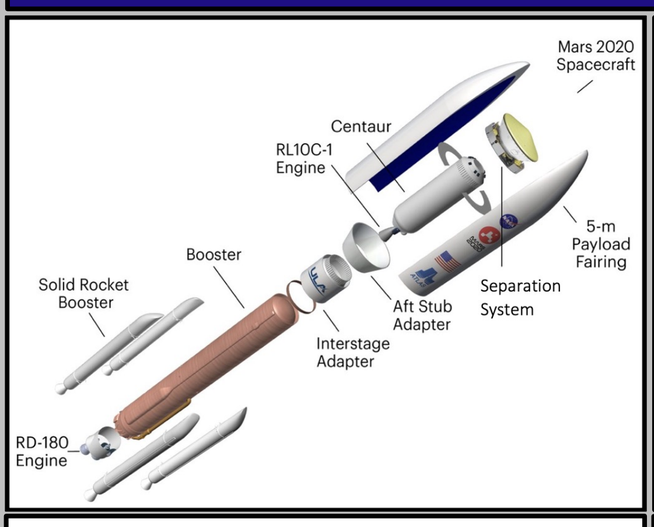


Figure 1.
Atlas V Launch Vehicle

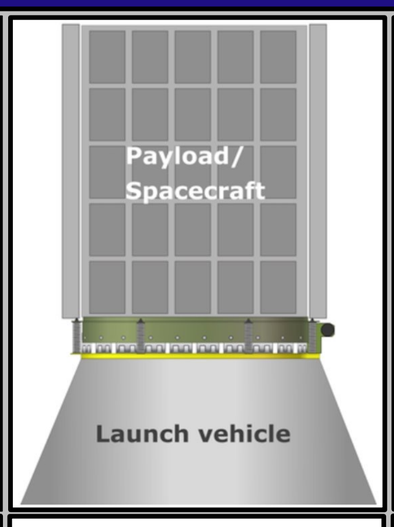


Figure 2.
Vehicle Integration

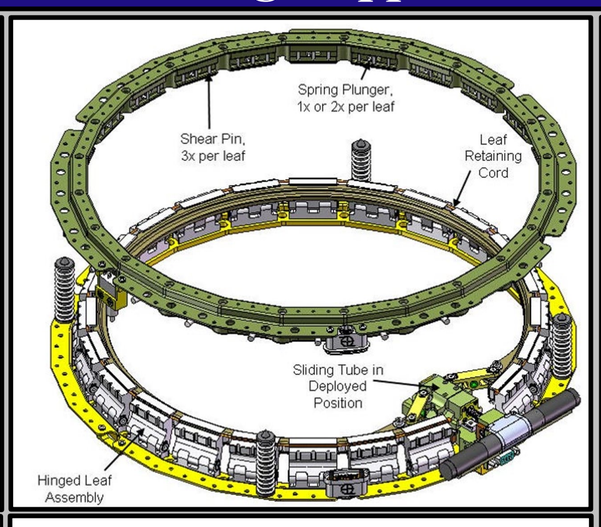
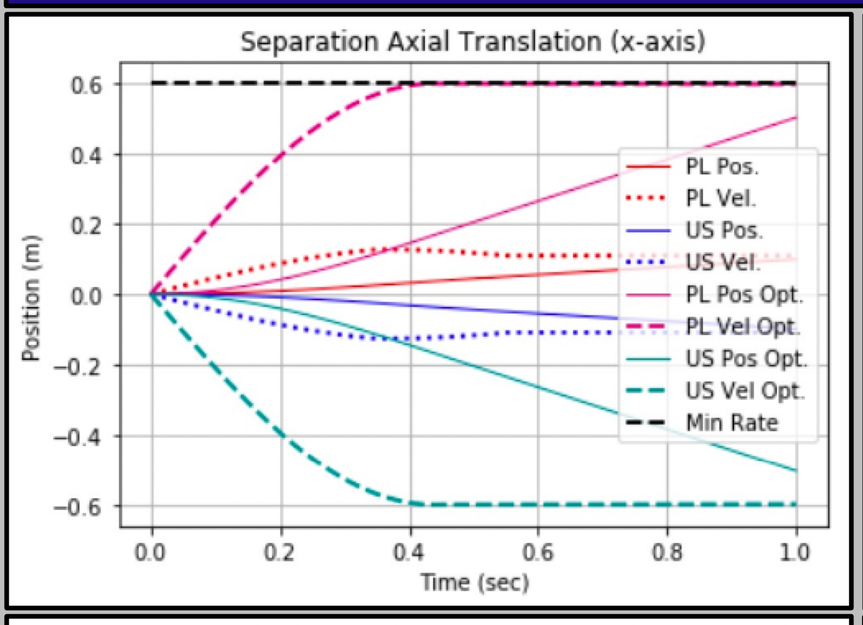
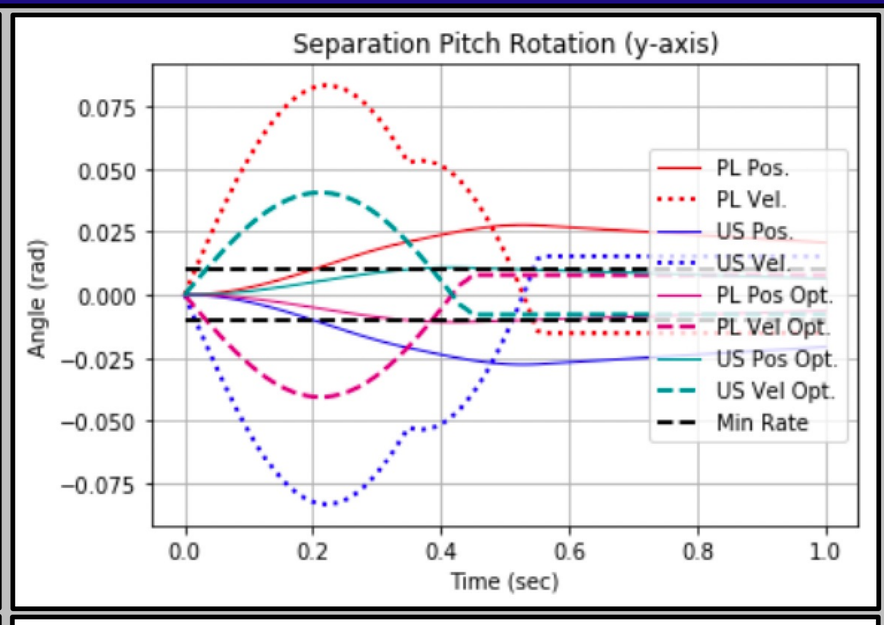


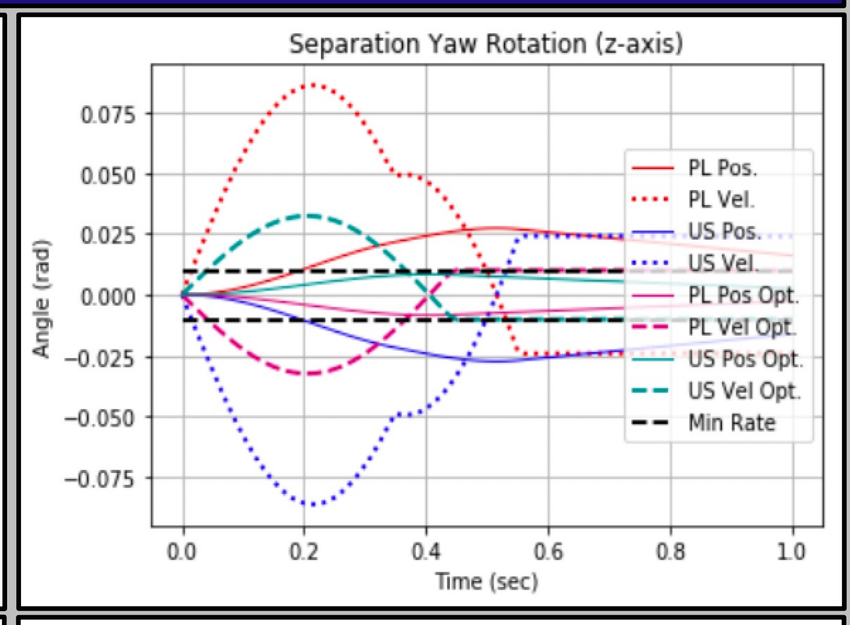
Figure 3.
Mark II (Planetary Space Corp)

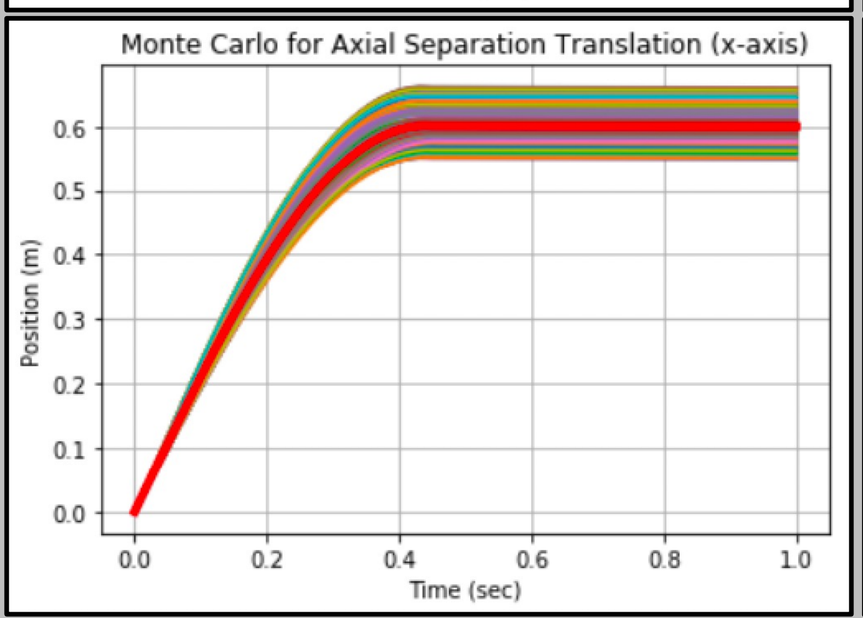
Read	Read Input Parameters • Payload, Upper stage, Separation system, Optimization & Time history
Perform	Perform Initial Analysis • Time stepping of Initial trajectory
Derive	Derive Optimum Separation System Design • Formulate constraints and generate objective function
Complete	Complete Monte Carlo Analysis Around Optimum Design • Determine deviated parameters, generate overall trajectories
Display	Display Results • Initial & optimum trajectories, design variable bar chart, spaghetti plots for Monte Carlo

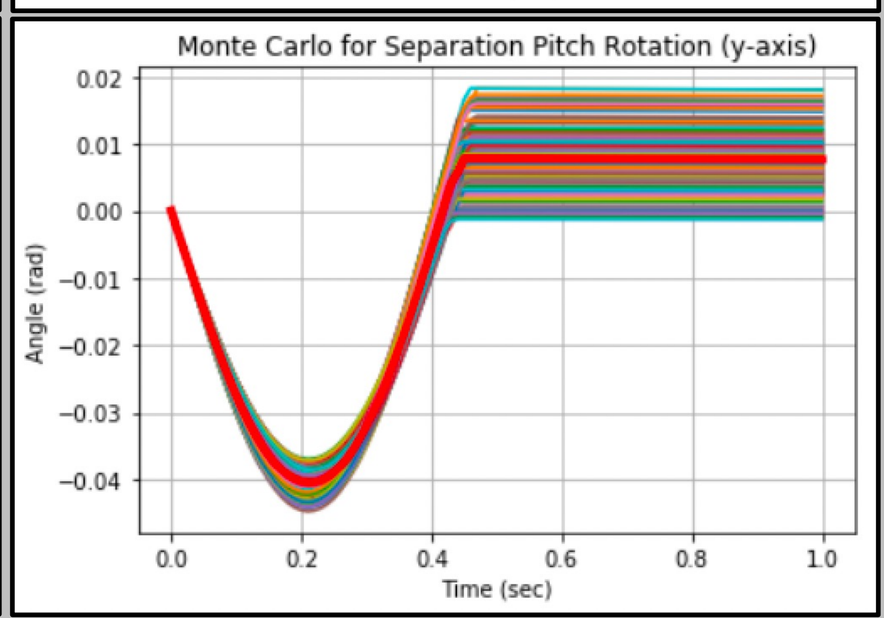
Results

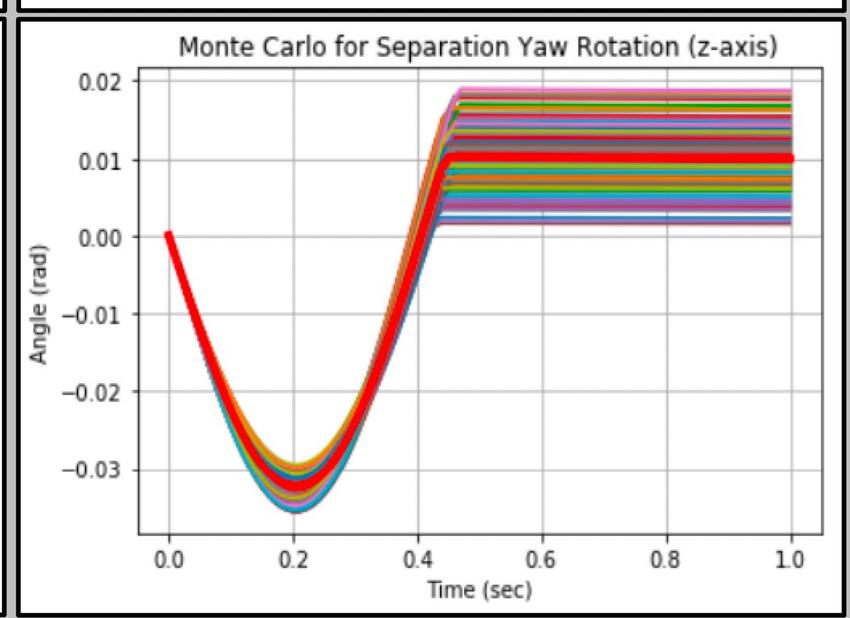


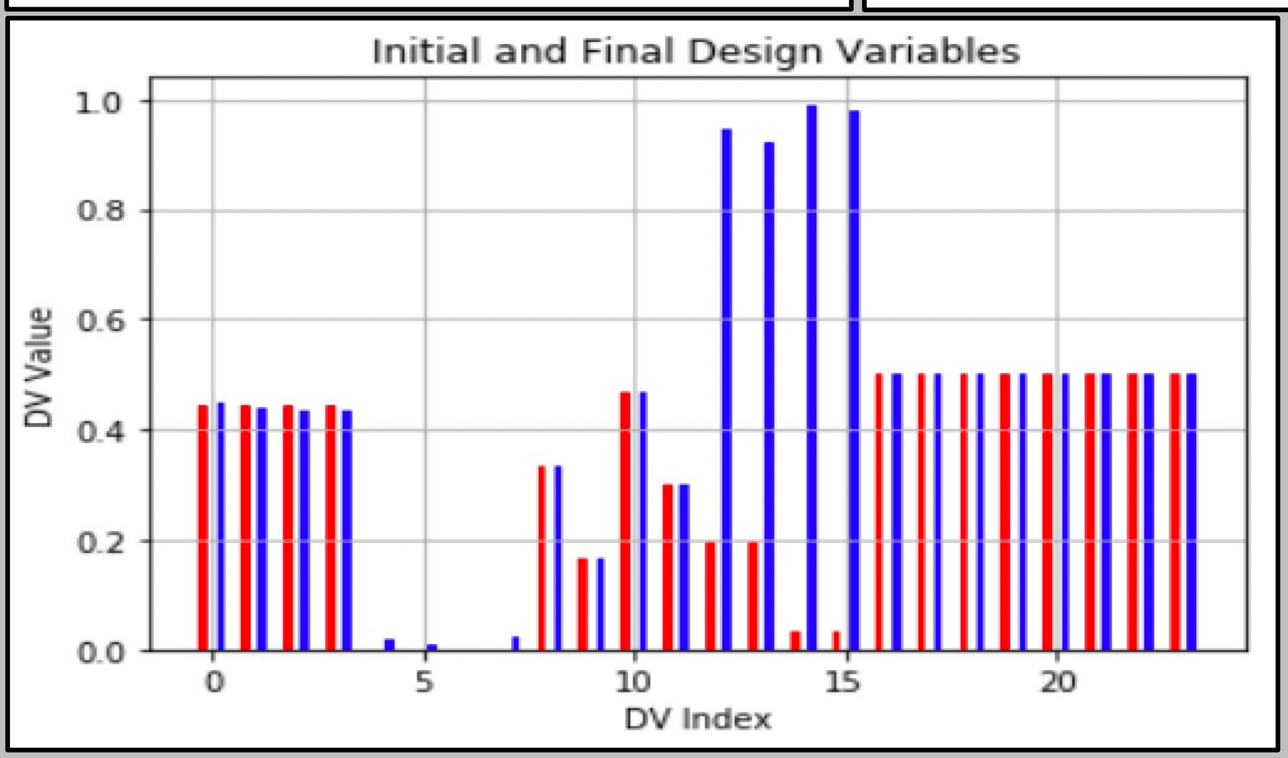












Conclusion

A fast and user-friendly separation system simulation and optimization software tool was developed and implemented in Python. The tool reads user inputs, performs an initial system simulation, optimizes the separation system design, and performs an uncertainty analysis around the optimum design. The optimization derives separation system parameters that meet desired minimum separation rates while staying within maximum allowed pitch and yaw rates.

Acknowledgments

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