IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Interactive Presentations - IAF MATERIALS AND STRUCTURES SYMPOSIUM (IP)

Author: Mr. sadben khan
C6 Launch Systems, Corporation, Canada

Mr. Scott Lindsay
C6 Launch Systems, Corporation, Canada

MULTI-OBJECTIVE OPTIMIZATION OF A SMALL LAUNCH VEHICLE AERODYNAMIC PAYLOAD FAIRING FOR MINIMUM DRAG AND MASS.

Abstract

Small launch vehicles suffer greatly from the tyranny of the rocket equation due of the poor scaling of components. Therefore, it is necessary to greatly optimize all components. A component of interest is the aerodynamic payload fairing, which reduces the launch vehicle drag , and contributes to the overall launch vehicle mass. A Genetic Algorithm (GA) is used to create a preliminary design of a composite aerodynamic payload fairing to minimize the aerodynamic drag and structural mass. The algorithm targets minimum drag and mass over the entire flight-path from lift-off to atmosphere-exit at various Mach numbers and altitudes relevant to those Mach numbers for a predicted flight trajectory. By considering the entire flight path, rather than a single point, it is possible to have a more fuel-efficient design, thereby reducing the total mass and cost of the launch vehicle. A Genetic Algorithm was justified as it will help balance the conflicting design considerations for generating an optimal fairing. The fairing geometry is reduced to a parametrically defined curve, the parameters of which were defined as an input to the GA. CFD (Computational Fluid Dynamics) calculations are done using ANSYS FLUENT and structural FEA (Finite Element Analysis) are done using ANSYS Mechanical. The resulting aerodynamic loads from FLUENT are transferred onto a structural model in Ansys Mechanical which optimizes the thickness of the core material, number of plys and laminate directions for minimum mass. The GA uses an objective function comprising of the total drag profile and the structural mass of a single design, and compares the design against the population to determine the best fit. Additional members and mutations are generated by modifying the parameter set for the fairing geometry of the fittest members of the population. The result of the optimization shows a marked improvement on the flight profile compared to the fairing optimized at a single design point..