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SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
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BOOSTED DART VEHICLE DEVELOPMENT AND OPTIMIZATION

Abstract

A suborbital vehicle is an important asset for research activity because it gives researchers the opportunity to perform a wide variety of experiments at a lower cost than on an orbital flight as well as testing various components before sending them on an expensive orbital flight. It covers the altitude range between maximum high altitude balloon altitude and the minimum usable satellite altitude. Maximizing the altitude using current rocket engines becomes important in this context and the procedure named boosted dart offers this capability obtaining additional altitude when compared to conventional rockets by reducing the drag during coasting phase. Optimization of the mass of the boosted dart given a fixed dart diameter and characteristics of the booster engine is performed using a six degrees of freedom numerical model. The characteristics of an already built and tested 120 mm solid rocket engine are presented as the booster characteristics. It is shown that increasing the mass up to a certain point increases the altitude by a significant amount. Further the optimization of both the dart mass and the diameter is performed given the same booster characteristics. It is shown that a certain combination of mass and diameter yields the maximum altitude considering the same booster carrier. Further we analyze relevant flight dynamics parameters for a potential sounding flight using the mass/diameter optimized dart: acceleration, velocity, dart-booster separation altitude. The acceleration variation is important in assessing both the maximum acceleration stress for the equipment's composing the experiments inside the dart as well as to assess the potential zero-g capability of the vehicle on a certain trajectory. Various inclination trajectories are studied for the downrange impact point assessment and flight safety and dart recovery procedures. Inclinations used are: 88, 86, 84, 82, 80 and 70 degrees with respect to the horizontal.