SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
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REDUCING SPACE TRANSPORTATION COST: REUSABILITY, MODULARITY AND SIMPLICITY

Abstract

Re-usability is widely accepted as one of the most effective ways of lowering space access cost. However, the only partially re-usable launch vehicle (LV) that has seen operation to date (the US Space Shuttle) had launch costs far greater than similar expendable LV's. Although the Shuttle (and equally the Russian Buran) was a major technical achievement, its complexity resulted in the operational cost being two orders of magnitude higher than originally planned. In addition, many new reusable LV concepts have been proposed, but none have yet reached operational capability. This may be due to the high development cost of a new LV, combined with the low expected launch rate in the existing and forecasted market.

Evidently, hardware re-usability alone may not be sufficient to lower the cost of space access. It is therefore proposed that, in order to be feasible, a re-usable LV must also be Modular and Simple. Modularity leads to (a) lower development cost by reducing the complexity (mass) of the modular units, (b) distribution of the development cost over a higher number of unit flights and (c) LV configurations that are able to cover a much larger part of the transportation market. Simplicity is required to keep operational costs low and to further reduce the development cost.

This paper presents the conceptual design of a new LV to which these principles were applied. The following aspects of the design are presented:

- The importance of development cost and its relationship to vehicle characteristics - mass, modularity and complexity
- Analysis of launch and retrieval methods
- Selection of vehicle stage(s) that are to be re-used
- A study of the recent historical launch vehicle market to identify the launch vehicle architecture that would be most commercially viable
- Preliminary reusable elements sizing down to the level of subsystems
- Trajectory simulation

The resultant design is a multistage vehicle that, in various configurations, will be able to cover a range of payloads forecasted to be launched in the next decade. The study concentrates on the reusability aspects of the modular first stage of the vehicle. The first stage was chosen since it represents the major portion of the operational cost, while at the same time is only subjected to relatively benign environmental conditions. This results in a relatively simple vehicle architecture, with significant use of low cost aviation hardware.