

# NASA Advanced Concepts Office, Earth-To-Orbit Team Design Process and Tools

## Abstract

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The Earth-to-Orbit Team (ETO) of the Advanced Concepts Office (ACO) at NASA Marshall Space Flight Center (MSFC) is considered the pre-eminent “go-to” group for pre-phase A and phase A concept definition. Over the past several years the ETO team has evaluated thousands of launch vehicle concept variations for a significant number of studies including agency-wide efforts such as the Exploration Systems Architecture Study (ESAS), Constellation, Heavy Lift Launch Vehicle (HLLV), Augustine Report, Heavy Lift Propulsion Technology (HLPT), Human Exploration Framework Team (HEFT), and Space Launch System (SLS).

The ACO ETO Team is called upon to address many needs in NASA’s design community; some of these are defining extremely large trade-spaces, evaluating advanced technology concepts which have not been addressed by a large majority of the aerospace community, and the rapid turn-around of highly time critical actions. It is the time critical actions, those often limited by schedule or little advanced warning, that have forced the five member ETO team to develop a design process robust enough to handle their current output level in order to meet their customer’s needs. Based on the number of vehicle concepts evaluated over the past year this output level averages to four completed vehicle concepts per day. Each of these completed vehicle concepts includes a full mass breakdown of the vehicle to a tertiary level of subsystem components and a vehicle trajectory analysis to determine optimized payload delivery to specified orbital parameters, flight environments, and delta v capability. A structural analysis of the vehicle to determine flight loads based on the trajectory output, material properties, and geometry of the concept is also performed.

Due to working in this fast-paced and sometimes rapidly changing environment, the ETO Team has developed a finely tuned process to maximize their delivery capabilities. The objective of this paper is to describe the interfaces between the three disciplines used in the design process: weights and sizing, trajectory, and structural analysis. The tools used to perform such analysis are INtegrated Rocket Sizing (INTROS), Program to Optimize Simulated Trajectories (POST), and Launch Vehicle Analysis (LVA) respectively. The methods each discipline uses to streamline their particular part of the design process will also be discussed.