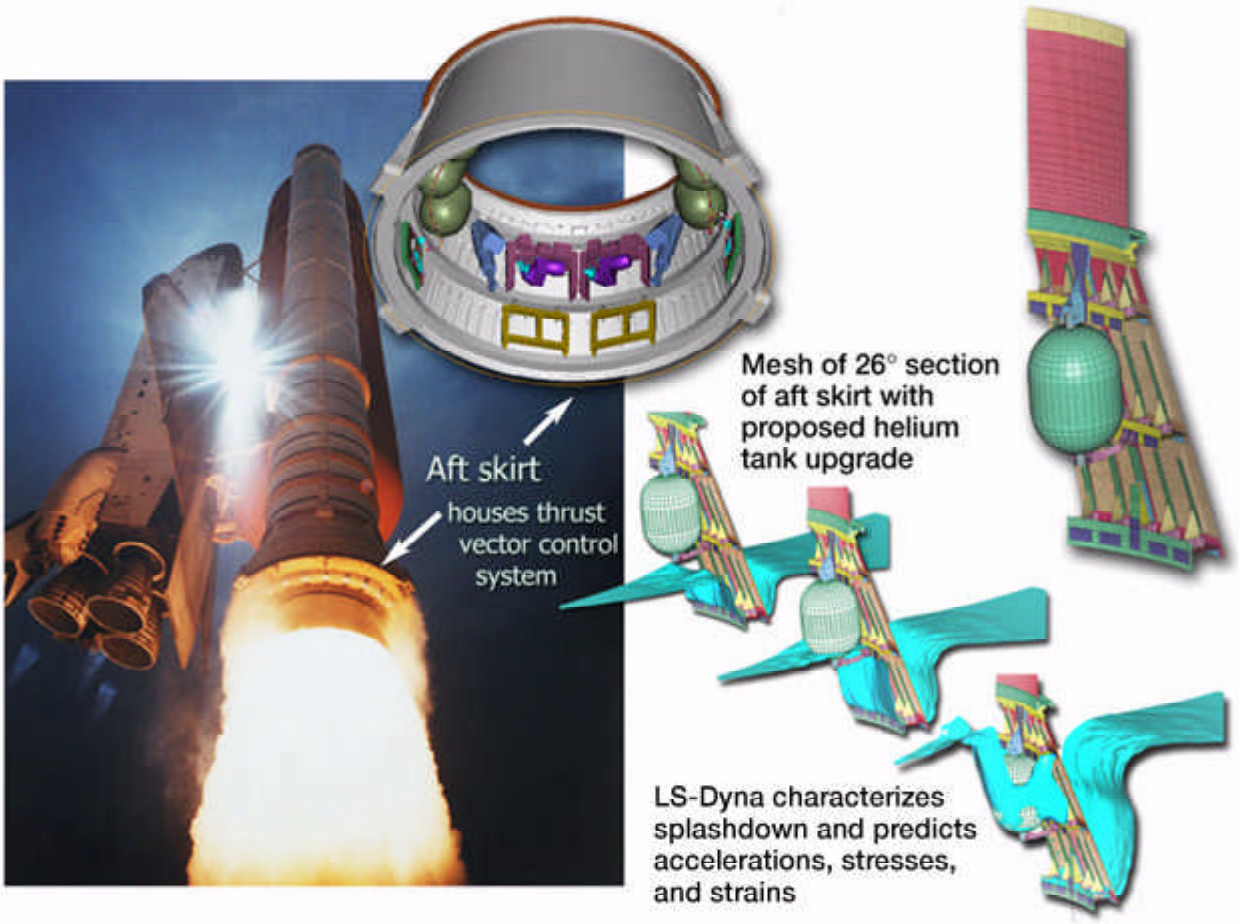
# Explicit Finite Element Techniques Used to Characterize Splashdown of the Space Shuttle Solid Rocket Booster Aft Skirt

NASA Glenn Research Center's Structural Mechanics Branch has years of expertise in using explicit finite element methods to predict the outcome of ballistic impact events. Shuttle engineers from the NASA Marshall Space Flight Center and NASA Kennedy Space Flight Center required assistance in assessing the structural loads that a newly proposed thrust vector control system for the space shuttle solid rocket booster (SRB) aft skirt would expect to see during its recovery splashdown.




*Thrust vector control system located in the aft skirt of the space shuttle SRB, finite element model of proposed helium tank/aft skirt used to analyze water impact, and three representative images of a predicted splashdown event of this model.*

Long description of figure. This photograph shows the location of the aft skirt on a solid rocket booster and shows the thrust vector control system location within the aft skirt. In addition, it shows an image of the finite element model used to analyze the new helium tank upgrades to the thrust vector control system along with three representative images,

depicting the water impact, taken at different time steps during the analysis.

The new design was to replace existing hydrazine propellant tanks with helium propellant tanks. The intent of this was to eliminate hydrazine, a toxic and hazardous substance, from the system, making it safer from a propellant standpoint. The proposed helium tanks, however, required nearly six times the volume of hydrazine tanks, resulting in significantly more tank area exposed to water impact during SRB splashdown. It would be crucial to understand what the new impact loads would be as a result of a design change to the thrust vector control before any such change could be implemented to a flight system.

LS-Dyna (Livermore-Software Technology Corp. (LST), Livermore, CA) was employed to perform the analysis, using its multimaterial arbitrary Lagrangian-Eulerian (ALE) methodology to represent water-structure interaction during impact. Impact loads were predicted for the proposed tank upgrades on a 26° section of a full-scale aft skirt, providing insight to the water impact event.

The efforts of this work contribute to the improvement of flight safety for the space shuttles, which is paramount to NASA's strategic mission.

**Find out more about ballistic impact research at Glenn**
**http://ballistics.grc.nasa.gov/.**

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