NASA KENNEDY SPACE CENTER (KSC)

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SPACEWORKS ENGINEERING, INC. (SEI)

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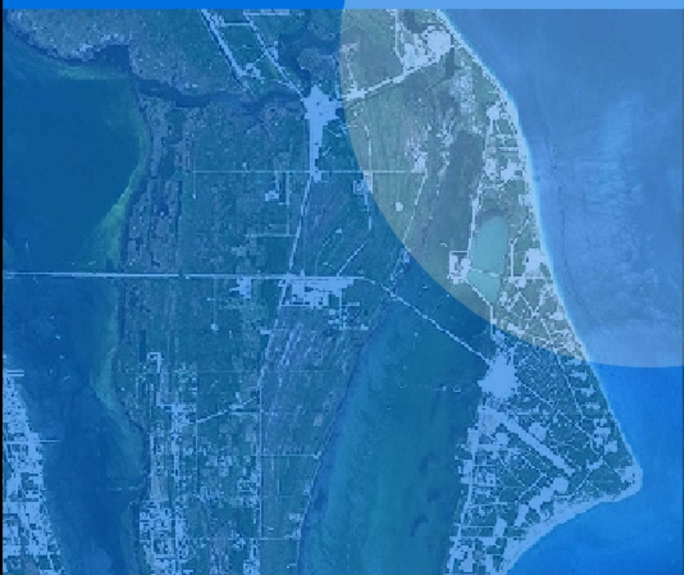
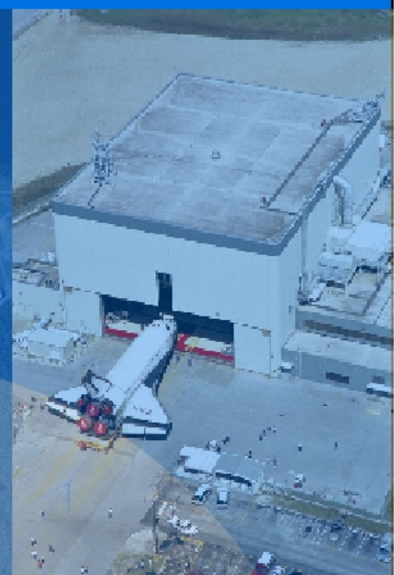
Quantify Shuttle Lessons Learned
New Operational Approaches
New Launch Architectures
Near, Mid, and Far Term
Systems Modeling
Metrics Assessment

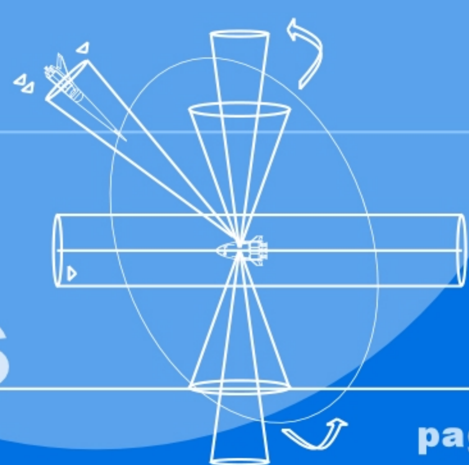




It is envisioned here that dramatically safer, lower cost, and higher flight rate access to space is possible by applying the wealth of experience gained from Shuttle launch operations. Shuttle launch operations, particularly the world's only reusable space transportation elements, the orbiters, have accumulated a vast set of ideas, lessons learned, insight and D4Ops (Design for Operations) experience. Current work such as the Shuttle Root Cause Analysis (RCA) will add further insight to quantifiably understand why previous reusable launch systems (RLS) are as costly as they are and why they take as long as they do to prepare for launch. The application of novel, not yet studied, but extremely viable and promising options for an entirely operable reusable launch system design is now feasible based on advances in operations analysis, integrating tools, models, and in understanding design margin and sub-system operational characteristics.

D4Ops

Design for Operations



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D4Ops (Design for Operations) is a nine-month study effort currently being conducted by SpaceWorks Engineering, Inc. (SEI) under sponsorship of the NASA Kennedy Space Center Systems Engineering Office. D4Ops is a ground operations-focused study designed to quantitatively determine the potential benefits of several proposed new D4Ops approaches to space vehicle configuration and operations. The study aims to determine the key compromises and trade-offs between weight, cost, operations, and safety when implementing new D4Ops approaches.

The study will leverage findings from NASA's Root Cause Analysis (RCA) project that continues to document driving maintenance tasks on the STS orbiters. Using the RCA database as an anchor point, the present study will develop at list of 11 proposed D4Ops Approaches that have a potential to positively influence the operational figures-of-merit used to evaluate next-generation space vehicle designs. Typical "D4Ops Approaches" include: reducing overall parts count, integrating functions across subsystems, eliminating hypergolic propellants, reducing numbers of tanks/fluids, etc.

To provide relevancy, three different space vehicle contexts will be used as a backdrop to the analyses conducted in the study: Orbital Spaceplane (OSP), Two-Stage-To-Orbit (TSTO) Reusable Launch Vehicle (RLV), and a new, advanced RLS concept designed for streamlined operations. These contexts were chosen based on NASA's current Integrated Space Transportation Plan (ISTP).

SEI will use its multi-disciplinary conceptual design environment comprised of in-house and government/industry standard computational design tools to evaluate each context and determine the positive and negative impacts on weights, costs, performance, ops, reliability, etc. that result from the application of the proposed D4Ops Approaches. Baseline configurations using a state-of-practice design philosophy will first be created. The numerical results will be calibrated to design information available from ongoing studies at NASA and in industry -- not to be competitive, but to ensure the results are relevant. Once a satisfactory baseline is established, sensitivities will be conducted on each of the 11 D4Ops Approaches taken individually. In addition, a single roll-up of all applicable D4Ops Approaches will be conducted for each context.

Using multi-attribute decision making methods, the candidate D4Ops Approaches will be assessed and ranked based on quantitative benefits to several key figures-of-merit. The study will draw conclusions and prioritize the most promising D4Ops approaches across the three spaceplane contexts in terms of their potential to positively impact ground operations costs and cycle times without detrimentally affecting weight, non-recurring cost, or vehicle safety. The study will conclude by January 2004. The results and the associated D4Ops rankings will be made available to current space vehicle design teams to be used as a decision-support resource for ongoing activities.

PHASE I: Approaches

Root Cause Analysis (RCA) Database

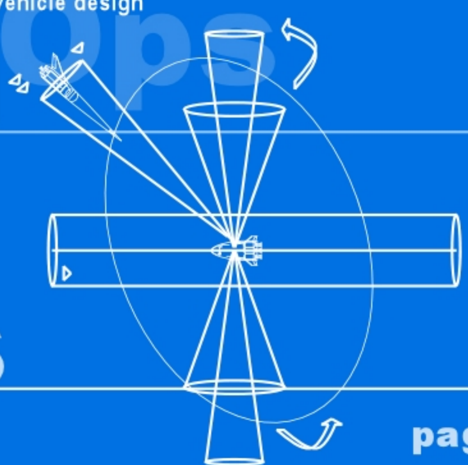
New Ops Approaches

PHASE II: Contexts

Near Term: OSP

Mid Term: TSTO RLV

Far Term: New RLV



D4Ops

Design for Operations