Past NASA Program Experiences Enable Future Government & Industry Successes

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NASA Experiences Often Impacted Future Programs

• Many innovations in rocket engine and vehicle design have their roots in NASA programs
  • NASA-initiated/developed technologies were made available to US companies
  • Industry often used initial NASA investments, maturing or modifying them as needed to supplement their own efforts

• There are several benefits to programs and initiatives gaining a start from NASA
  • The government assumes the initial risk in a new or innovative item
  • Initial expenditure by NASA is indicative to industry of things in which the government might be interested on future proposals
  • Experiences and lessons learned from successes and terminations can be shared broadly with industry and other government entities
NASA’s historical initiatives covered a wide range of constructs
- Programmatic considerations
- Design Considerations and Emphasis
- Technology maturation and infusion

Many lessons have been and continue to be learned from NASA investments

NASA experiences can provide a foundation for the future
Additive Technology: Parallel DDT&E and Materials Efforts Rapidly Advance Understanding

Defining the Development Philosophy for the Future

Advancing the Technology Readiness for Complex Parts

Bridging the gap between the present and future projects

Transferring Material Property Data & Technology to U.S. Industry

Paving the way for Future Affordable Systems

Building Experience / “Smart Buyer”

Fundamental Additive Manufacturing M&P Development

Push

Material Properties & Non-Destructive Evaluation

Standards & Specifications

Certification Rationale

Pull
Reusability Debate and Shuttle Lessons Learned

• Shuttle provided a wealth of data from the beginning of the program to the end to better understand reusability, its benefits, and its costs

A Recoverable Payload / Avionics Module Has Been Successfully Demonstrated

(AIAA Paper 97-1513)

SSME Successfully Tested after Recovery

• There are many benefits to reusability of launch vehicles and/or engines
  • Positive influence on design
  • Increase in reliability over time

• The benefits of reusability come at a cost
  • More expensive and challenging to design and build
  • Significant challenge to recoup the costs associated with reusability

* Reference: AIAA-2011-7159 "Space Shuttle Main Engine — The Relentless Pursuit of Improvement" by Van Hooser & Bradley
Relevance to Current and Future Programs

• Significant Investments are being made in Additive Manufacturing
  • Space Launch System Engines Element is investigating using additively manufactured parts on new RS-25 engines
  • Commercial Crew Providers are planning to fly additively manufactured parts
  • Aircraft Industry is just one of many US industries to invest in additive for the future

• Several entities are currently considering reusability for their flight programs
  • Space Exploration Technologies (SpaceX)
    • Falcon 9 recovery of the core stage
    • Falcon Heavy recovery of two boosters
  • Airbus recovery of the engine compartment from their Adeline (Advanced Expendable Launcher with Innovative Engine Economy) vehicle
  • United Launch Alliance (ULA) recovery of Blue Origin BE-4 engines from Vulcan rocket

We Must Continue to Share Experiences and Lessons Learned To Enable Future Successes