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Learning Lessons from the X-37 Project

Abstract

The X-37 was planned as an automated vehicle capable of flight-testing new aerospace technologies in combined environments that are beyond the capability of existing ground or flight platforms. Flight demonstration with the X-37 architecture and configuration in relevant environments was planned to reduce the risk of developing launch vehicle technologies for sustainable, affordable exploration and other aerospace applications. Current plans are for the X-37 Approach and Landing Test Vehicle (ALTV) to be atmospheric tested in 2005 from Scaled Composite's White Knight carrier aircraft at up to 40,000 feet over California's Mojave Spaceport, with landing and turnaround maintenance performed. The Flight Operations Control Center will conduct the mission, using a streamlined operations concept. Taxi-tow and captive-carry tests will be conducted prior to the atmospheric-test series. Sponsored by the Defense Advanced Research Projects Agency (DARPA) with NASA participation, technical objectives are to: (1) mature Computed Air Data System/Remote Pressure Sensor technology, (2) manage energy during Terminal Area Energy Management/Heading Alignment Cone maneuvers, and (3) validate the aerodatabase.

The X-37 Project began in 1999 under a cooperative agreement as an element of NASA's Future X Program and transitioned to a NASA Research Announcement under the Space Launch Initiative. In mid-2004, NASA transferred ownership to DARPA, with its heritage of performing high-risk, high-payoff research and development. NASA contributes technical expertise, including risk analysis and system integration. The Boeing Company is the prime contractor, with nationwide suppliers. This recent partnership exemplifies the synergy attainable when NASA Centers, other Government agencies, and industry work together toward a common goal — contributing to the knowledge base for U.S. exploration and other aerospace endeavors.

The X-37 team represents a range of space transportation disciplines — from engineering to management. Some members have been with the project since its inception. All have gained priceless experience during the design, manufacturing, and testing of the ALTV, as well as through developing advanced orbital flight technologies, such as state-of-the-art Thermal Protection Systems and hot structures. Throughout this process, the X-37 Project team captures lessons that are directly applicable to other such efforts. The upcoming ALTV flights offer another dimension of data and first-hand experience that will prove invaluable to those designing new generations of reusable spacecraft. And ongoing technology developments will expand the aerospace knowledge base.

Delivering prototype hardware is always a risky proposition. During the course of the X-37 effort, the team has experienced many challenging opportunities, delivering significant accomplishments and learning numerous lessons in the process. The ability to manage the risk landscape is key to overcoming obstacles, especially technical hurdles that are encountered in progressing hardware from design to flight. The approach to managing risk under this partnership is evolving but, in general, the team allocates resources to reduce the likelihood of severe-consequence risks, thus maximizing mission success and ensuring that the X-37 Project delivers value to its stakeholders. As the team sharpens its focus on operations, it continues to contribute knowledge to those who would undertake high-risk, high-payoff research and development and provides valuable experience to implement the exploration vision.

Learning Lessons from the X-37 Project

Outline

I. Introduction: Brief History
- 1. Automated vehicle
  - a. Began in 1999 as a cooperative agreement in 1999 in the Future X Program
  - b. Partners included NASA, U.S. Air Force and Boeing
  - c. Built on previous work and flew the X-40A
- 2. Changing business climate
  - a. Transitioned in 2001 to NASA Research Announcement under Space Launch Initiative
  - b. Requirements were changed and contract rescoped
- 3. Innovative partnership to continue development
  - a. Synthesis of Government agencies and industry (NASA, DARPA, and Boeing)
  - b. DARPA assumed project ownership in mid-2004, with NASA providing technical expertise
  - c. Requirements are stable and flight phase is projected in 2005

II. Current Scope and Status
- 1. Approach and Landing Test Vehicle
  - a. Automated high-altitude flight
  - b. Dropped from Scaled Composites White Knight carrier at Mojave Spaceport
  - c. Landing and turnaround operations
- 2. Technologies development
  - a. TPS
  - b. Hot structures materials
  - c. Aerodatabase

III. Top Lessons Learned by the X-37 Team
- 1. Requirement Management and Flow-down
- 2. Integrated System Schedule
- 3. End-to-End Schematics Diagrams
- 4. Systems Engineering
- 5. Interface Definition

IV. Conclusion
- 1. Apply resources to maximize benefit for risk reduction across the project
- 2. Gain real-world experience
- 3. Share knowledge to increases likelihood of mission success for other aerospace endeavors
- 4. Deliver value to stakeholders for innovation such as the X-37 to survive the cycles of change