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X–34 Program Status

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X–34 PROGRAM STATUS

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Abstract

The National Aeronautics and Space Administration (NASA) initiated the current X–34 program in 1996 as part of the U.S. Space Agency's effort to dramatically reduce the cost of access to space. The X–34 is the first in a series of "Pathfinder" vehicles designed to conduct flight testing of key launch vehicle technologies at low cost. The X–34 program has moved rapidly from the drawing board to hardware buildup, with the first flight scheduled for 1999. The development of the X–34 has been accomplished by a unique blend of industry and government organizations and personnel working closely together. The program will provide rocket-powered winged vehicles that can fly suborbital missions in support of advanced reusable launch vehicle (RLV) technology development. In addition, the X–34 vehicles will represent a hypersonic testbed for advanced experiments in the aeronautical sciences.

HISTORICAL PERSPECTIVE

Von Braun's Early Concepts

The quest for reducing the cost of space access has been ongoing for many decades. As early as 1951, Wernher von Braun (who later became the first director of the Marshall Space Flight Center (MSFC)) was defining concepts for RLV's with winged stages that flew back and were recovered at the launch site. In the last decade, key technologies, particularly in the areas of structures, thermal protection, and avionics, have matured sufficiently to allow engineers to propose viable designs for fully reusable launch systems that could turn Von Braun's vision into reality.

X–34 Origins

In 1995, NASA established a partnership, called a cooperative agreement, with Orbital Sciences Corporation and Rockwell International (now part of Boeing). The intent of the agreement was for the government and industry to cooperatively develop a rocket-powered space plane that could serve as both an RLV testbed for NASA and as a commercial small payload launcher for industry. The cooperative agreement called for a cost-sharing arrangement between government and industry to fund the development of the vehicle. After assessing the amount of time required to recover their projected development investment, the two industry partners decided to no longer participate in the project.

Redefined Program

After the industry pullout, NASA decided to use the Agency's portion of the program budget to contract with industry, through more conventional means, for the development of a suborbital rocket plane. This new program would result in a vehicle that was descoped in performance from the originally envisioned vehicle, but one that could still achieve many of the goals NASA established for the cooperative agreement.

In May of 1996, NASA issued a NASA Research Announcement (NRA) 8–14, inviting proposals for the development of a testbed vehicle for technology demonstrations. The vehicle was to be an integral part of NASA's overall RLV program, and would enable a flight demonstration that was, from a performance standpoint, between the DC–XA vehicle and the X–33 single-stage-to-orbit precursor vehicle. The NRA also solicited proposals for RLV-related flight experiments that would be integrated onto the X–34 vehicle. See Fig. 1 for the RLV technology demonstration plan.

Orbital Sciences Corporation was selected to develop the X–34 vehicle for NASA under a fixed-price contract, with a period of performance of 30 mo. The contract was awarded to Orbital on August 23, 1996.

Specific Technical Goals

Contained within the three focus areas are a host of specific technical goals. The first focus area, testing of embedded RLV technologies, will include the first flight testing of a composite RP-1 propellant tank and the first demonstration of a reusable liquid oxygen (lox) and RP-1 propulsion system. The autonomous navigation and landing system is very similar to the system employed by the X-33 vehicle, so the flight testing of this system on X-34 will be an important accomplishment that is highly desirable prior to the first flight of the X-33. The vehicle will fly an advanced ceramic thermal protection system (TPS) and will demonstrate integrated vehicle health monitoring over the life of the program. The X-34 vehicle's primary and secondary structure are made of low-cost composite materials.

The second focus area, low-cost operations and vehicle turnaround, will address the high cost of individual flights by operating at a recurring cost of $500,000 for a single flight. The X-34 will demonstrate a flight rate of 25 flights in a 1-yr period, and show a capability to surge to two flights within a 24-hr period. The program will use a small workforce to operate a mobile, integrated ground operations center and an aircraft-like propellant loading system.

The third focus area, testing of "carryon" experiments, will demonstrate the X-34's ability to operate as a host vehicle for experiments. As part of the baseline X-34 program, NASA budgeted for a set of initial experiments to be built and carried by the X-34 to develop some early technical data that would support RLV technology needs. Budgeting for these experiments will also help to stimulate interest in and awareness of the X-34's capabilities as a small experiment or payload carrier.

NASA sent out a solicitation for this first set of carryon experiments and received 27 proposals. Although all of the bidders proposed valuable experiments and technologies in support of NASA's RLV program, budget limitations resulted in only seven proposals being selected. Of the seven that were picked, five were from Boeing or McDonnell Douglas and the other two were from European companies, Daimler-Benz and Alenia Aerospace. Five of the experiments involved advanced TPS technologies and two were directed toward health monitoring systems for future RLV's.

Because of the relatively low cost of the X-34 vehicle, as compared to the X-33 or the Space Shuttle, the program can demonstrate a number of higher risk technologies and operational techniques that would not be prudent to demonstrate on more expensive systems. The X-34 vehicle will eventually be capable of operating in inclimate weather, including subsonic flights through rain and fog and landings with crosswinds in excess of 20 kn. A flush air data system integrated in the ceramic TPS nose cap will operate in a closed-loop mode to help control the vehicle during flight. The vehicle will also be capable of flying robust mission abort profiles under stressing contingency conditions. See Fig. 3 for the landing of the X-34.

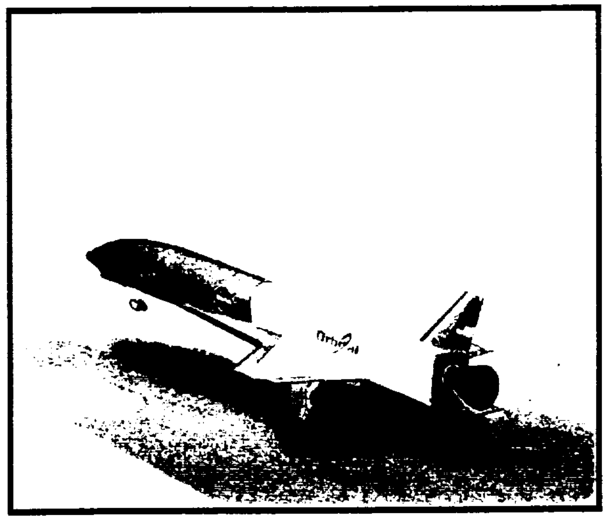

Fig. 3. X-34 landing.

X-34 CAPABILITIES AND CHARACTERISTICS

Capabilities

The X-34 is designed to operate often and at low cost. The vehicle will be capable of flight speeds to Mach 8, and operational altitudes of 250,000 ft. The vehicle's payload capacity will be in excess of 400 lb. without any degradation in performance, utilizing the wing strake area. If a payload operator is willing so accept some degradation in vehicle performance, additional payload capacity is available.

Characteristics

The X-34 vehicle operates as a two-stage, suborbital launch system, with the L-1011 carrier aircraft operating as the first stage. It is fully reusable and unmanned, with a gross operating weight of 45,000 lb. Empty weight of the vehicle is 15,000 lb. The vehicle length is 58.3 ft, and the wing span is 27.7 ft. The airframe is an all-composite structure and skin. The wing is a single-piece design with a center carry-through structure. The vehicle uses elevon

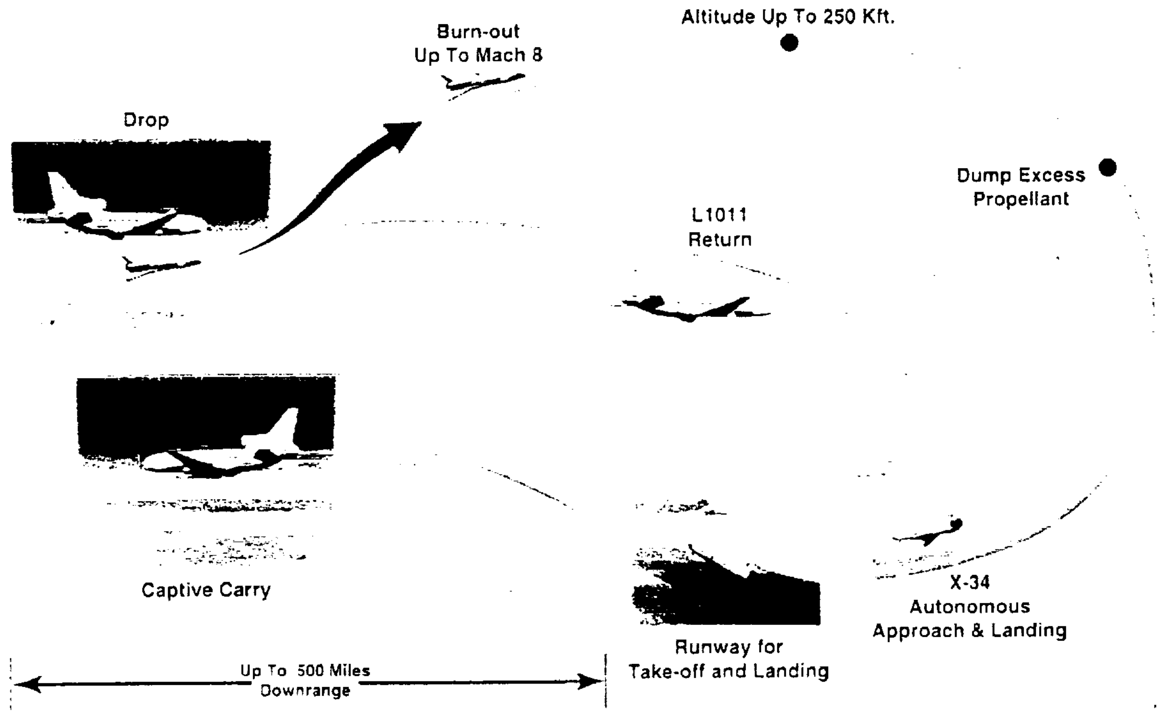

Fig. 5. Typical mission profile.

A TYPICAL PROGRAM

The X-34 program is not only a technical experiment but a management experiment as well. The intent is to demonstrate new management techniques that can enable programs to be accomplished at a lower cost and on a faster pace

Small Program Office

Historically, most NASA programs have used a large number of NASA personnel to oversee and validate the work being done by the contractor. In the case of the X-34 program, NASA maintains insight into the activities of the prime contractor, but no oversight of program execution. The X-34 Government Program Office has only six personnel assigned, including three that are co-located on site at the X-34 factory. There are no formal reports required of the contractor. This arrangement places much greater responsibility on the prime contractor, and requires the government to depend, to a much larger degree, on the contractor being successful in accomplishing the program's goals.

Small Contractor Team

The Orbital prime contractor team is also very small, with about 70 personnel assigned to the Dulles factory operations. Orbital has outsourced most of the component and subsystem fabrication, allowing the Dulles factory team to concentrate primarily on the vehicle integration and testing activities.

Tight Schedule

The program has a tight development schedule, with the first flight scheduled to occur less than 3 yr after NASA gave Orbital authority to proceed on the contract. Captive carry flights of the X-34 vehicle will begin less than 2 1/2 yr after authority to proceed.

Government as Subcontractor

Through a series of task agreements, Orbital has "contracted for" the technical services of a number of NASA centers and other government organizations. This unique relationship places the government in the role of being a "subcontractor" to an industry customer (Orbital).

In support of Orbital and the X-34 program, NASA has developed a number of crucial systems and components, and provided critical technical design work. The Ames Research Center in California designed the thermal protection system for the vehicle and manufactured the silicone impregnated reusable ceramic ablator (SIRCA) material that will protect the X-34 nose and leading edges.

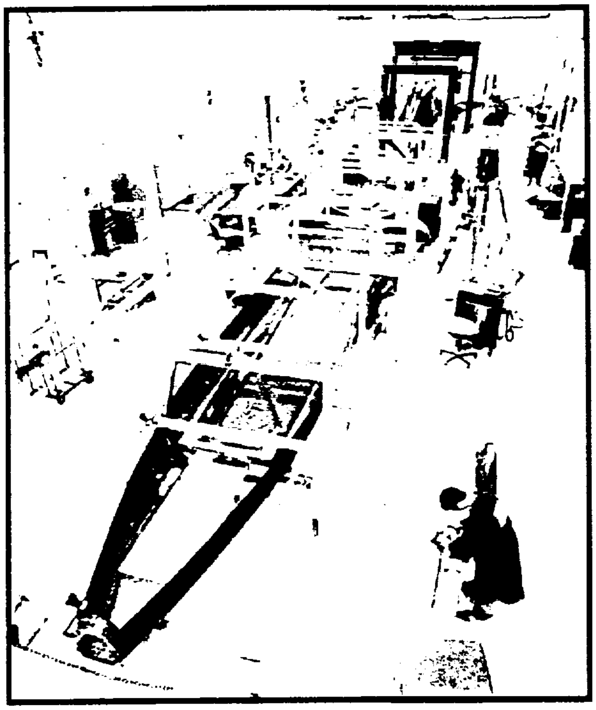

Fig. 8. A–2 vehicle fuselage skin panel assembly.

SUMMARY

The X–34 program is breaking new ground in technical and management arenas that will significantly contribute to NASA's efforts to lower the cost of access to space. A unique synthesis of industry and government people and organizations have worked together to make X–34 a reality. The X–34 vehicle will provide a valuable testbed for both RLV technologies and aeronautical science technologies. It is the first in a series of Pathfinder X–vehicles that will set new standards in low cost, rapid execution, and technology robustness.