**Boeing X37 Space Plane**

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| **X-37** |
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| The [OTV-1](http://en.wikipedia.org/wiki/USA-212) X-37B in April 2010, inside its payload fairing prior to launch |
| **Role** | [Spaceplane](http://en.wikipedia.org/wiki/Spaceplane) |
| **National origin** | [United States](http://en.wikipedia.org/wiki/United_States) |
| **Manufacturer** | [Boeing](http://en.wikipedia.org/wiki/Boeing) |
| **First flight** | 7 April 2006 (drop test)22 April – 3 December 2010 (first spaceflight) |
| **Status** | Testing; two long-duration spaceflights completed  |
| **Primary users** | [NASA](http://en.wikipedia.org/wiki/NASA)/[DARPA](http://en.wikipedia.org/wiki/DARPA) (X-37A)[United States Air Force](http://en.wikipedia.org/wiki/United_States_Air_Force) (X-37B) |
| **Number built** | 2 |
| **Developed from** | [Boeing X-40](http://en.wikipedia.org/wiki/Boeing_X-40) |

The **Boeing X-37** (also known as the **X-37 Orbital Test Vehicle**) is an American reusable [unmanned](http://en.wikipedia.org/wiki/Robotic_spacecraft) [spacecraft](http://en.wikipedia.org/wiki/Spacecraft). It is boosted into space by a rocket, then re-enters Earth's atmosphere and lands as a [spaceplane](http://en.wikipedia.org/wiki/Spaceplane). The X-37 is operated by the [United States Air Force](http://en.wikipedia.org/wiki/United_States_Air_Force) for orbital [spaceflight](http://en.wikipedia.org/wiki/Spaceflight#Earth-launched_spaceflight) missions intended to demonstrate reusable space technologies. It is a 120%-scaled derivative of the earlier [Boeing X-40](http://en.wikipedia.org/wiki/Boeing_X-40).

The X-37 began as a [NASA](http://en.wikipedia.org/wiki/NASA) project in 1999, before being transferred to the [U.S. Department of Defense](http://en.wikipedia.org/wiki/United_States_Department_of_Defense) in 2004. It conducted its first flight as a drop test on 7 April 2006, at [Edwards Air Force Base](http://en.wikipedia.org/wiki/Edwards_Air_Force_Base), [California](http://en.wikipedia.org/wiki/California). The spaceplane's first orbital mission, [USA-212](http://en.wikipedia.org/wiki/USA-212), was launched on 22 April 2010 using an [Atlas V](http://en.wikipedia.org/wiki/Atlas_V) rocket. Its successful return to Earth on 3 December 2010 was the first test of the vehicle's [heat shield](http://en.wikipedia.org/wiki/Heat_shield) and [hypersonic](http://en.wikipedia.org/wiki/Hypersonic_speed) aerodynamic handling. A second X-37 was launched on 5 March 2011, with the mission designation [USA-226](http://en.wikipedia.org/wiki/USA-226); it returned to Earth on 16 June 2012.

**Development**

**Origins**

In 1999, NASA selected [Boeing Integrated Defense Systems](http://en.wikipedia.org/wiki/Boeing_Defense%2C_Space_%26_Security) to design and develop an orbital vehicle, built by the California branch of Boeing's [Phantom Works](http://en.wikipedia.org/wiki/Boeing_Phantom_Works). Over a four-year period, a total of $192 million was contributed to the project, with NASA contributing $109 million, the [U.S. Air Force](http://en.wikipedia.org/wiki/United_States_Air_Force) $16 million, and Boeing $67 million. In late 2002, a new $301-million contract was awarded to Boeing as part of NASA's [Space Launch Initiative](http://en.wikipedia.org/wiki/Space_Launch_Initiative) framework.

1999 artist's rendering of the X-37 spacecraft

The X-37 was transferred from NASA to the [Defense Advanced Research Projects Agency](http://en.wikipedia.org/wiki/DARPA) (DARPA) on 13 September 2004. Thereafter, the program became a [classified project](http://en.wikipedia.org/wiki/Classified_information_in_the_United_States), although it is not known whether DARPA will maintain this status indefinitely. DARPA promoted the X-37 as part of the independent space policy that the [United States Department of Defense](http://en.wikipedia.org/wiki/United_States_Department_of_Defense) has pursued since the 1986 [*Challenger* disaster](http://en.wikipedia.org/wiki/Space_Shuttle_Challenger_disaster).

The X-37 was originally designed to be carried into orbit in the [Space Shuttle](http://en.wikipedia.org/wiki/Space_Shuttle)'s cargo bay, but underwent redesign for launch on a [Delta IV](http://en.wikipedia.org/wiki/Delta_IV) or comparable [rocket](http://en.wikipedia.org/wiki/Launch_vehicle) after it was determined that a shuttle flight would be uneconomical. The X-37's aerodynamic design was derived from the Space Shuttle, hence the X-37 has a similar lift-to-drag ratio, and a lower cross range at high altitudes and [Mach numbers](http://en.wikipedia.org/wiki/Mach_number) than DARPA's [Hypersonic Technology Vehicle](http://en.wikipedia.org/wiki/DARPA_Falcon_Project).

As part of its mission goals, the X-37 was designed to rendezvous with friendly satellites to refuel them, or to replace failed [solar arrays](http://en.wikipedia.org/wiki/Solar_array) using a robotic arm. Its payload could also support Space Control (Defensive Counter-Space, Offensive Counter-Space), Force Enhancement and Force Application systems. An early requirement for the spacecraft called for a [delta-v](http://en.wikipedia.org/wiki/Delta-v) of 7,000 mph (3.1 km/s) to change its orbit.

**Glide testing**

The vehicle that was used as an atmospheric drop test [glider](http://en.wikipedia.org/wiki/Glider_aircraft) had no propulsion system. Instead of an operational vehicle's payload bay doors, it had an enclosed and reinforced upper [fuselage](http://en.wikipedia.org/wiki/Fuselage) structure to allow it to be mated with a [mothership](http://en.wikipedia.org/wiki/Mother_ship). In September 2004, DARPA announced that for its initial atmospheric drop tests the X-37 would be launched from the [Scaled Composites White Knight](http://en.wikipedia.org/wiki/Scaled_Composites_White_Knight), a high-altitude research aircraft.

The [Scaled Composites White Knight](http://en.wikipedia.org/wiki/Scaled_Composites_White_Knight) was used to launch the X-37A on glide tests.

On 21 June 2005, the X-37A completed a captive-carry flight underneath the White Knight from [Mojave Spaceport](http://en.wikipedia.org/wiki/Mojave_Air_%26_Space_Port) in [Mojave, California](http://en.wikipedia.org/wiki/Mojave%2C_California). Through the second half of 2005, the X-37A underwent structural upgrades, including the reinforcement of its [nose wheel](http://en.wikipedia.org/wiki/Undercarriage) supports. Further captive-carry flight tests and the first drop test were initially expected to occur in mid-February 2006. The X-37's public debut was scheduled for its first free flight on 10 March 2006, but was canceled due to an Arctic storm. The next flight attempt, on 15 March 2006, was canceled due to high winds.

On 24 March 2006, the X-37 flew again, but a datalink failure prevented a free flight, and the vehicle returned to the ground still attached to its White Knight carrier aircraft. On 7 April 2006, the X-37 made its first free glide flight. During landing, the vehicle overran the runway and sustained minor damage. Following the vehicle's extended downtime for repairs, the program moved from Mojave to Air Force [Plant 42](http://en.wikipedia.org/wiki/Plant_42) (KPMD) in [Palmdale, California](http://en.wikipedia.org/wiki/Palmdale%2C_California) for the remainder of the flight test program. White Knight continued to be based at Mojave, but was ferried over to Plant 42 when flights were scheduled. Five additional flights were performed, two of which resulted in X-37 releases with successful landings. These two free flights occurred on 18 August 2006 and 26 September 2006.

**X-37B Orbital Test Vehicle**

On 17 November 2006, the U.S. Air Force announced that it would develop the X-37B from NASA's X-37A. The Air Force version was designated the X-37B Orbital Test Vehicle (OTV). The OTV program was built on earlier industry and government efforts by DARPA, NASA and the Air Force, and was led by the [U.S. Air Force Rapid Capabilities Office](http://en.wikipedia.org/wiki/United_States_Air_Force#Rapid_Capabilities_Office), in partnership with NASA and the [Air Force Research Laboratory](http://en.wikipedia.org/wiki/Air_Force_Research_Laboratory). Boeing was the prime contractor for the OTV program. The X-37B was designed to remain in orbit for up to 270 days at a time. The [Secretary of the Air Force](http://en.wikipedia.org/wiki/Secretary_of_the_Air_Force) stated that the OTV program would focus on "risk reduction, experimentation, and operational concept development for reusable space vehicle technologies, in support of long-term developmental space objectives."

The X-37B was originally scheduled for launch in the payload bay of the Space Shuttle, but following the [2003 *Columbia* disaster](http://en.wikipedia.org/wiki/Space_Shuttle_Columbia_disaster), it was transferred to a [Delta II 7920](http://en.wikipedia.org/wiki/Delta_II#Vehicle_description). The X-37B was subsequently transferred to a shrouded configuration on the [Atlas V](http://en.wikipedia.org/wiki/Atlas_V) rocket, following concerns over the unshrouded spacecraft's aerodynamic properties during launch. Following their missions, X-37B spacecraft land on a runway at [Vandenberg Air Force Base](http://en.wikipedia.org/wiki/Vandenberg_Air_Force_Base), California, with [Edwards Air Force Base](http://en.wikipedia.org/wiki/Edwards_Air_Force_Base) as an alternate site. In 2010, manufacturing work began on the second X-37B, OTV-2, which was first launched in March 2011.

**Design**

The X-37 Orbital Test Vehicle is a reusable [robotic](http://en.wikipedia.org/wiki/Robotic_spacecraft) [spaceplane](http://en.wikipedia.org/wiki/Spaceplane). It is a 120%-scale derivative of the [Boeing X-40](http://en.wikipedia.org/wiki/Boeing_X-40), measuring over 29 feet (8.8 m) in length, and features two angled tail fins. The X-37 launches atop an [Atlas V version 501](http://en.wikipedia.org/wiki/Atlas_V_rocket#Versions) rocket with a [Centaur](http://en.wikipedia.org/wiki/Centaur_%28rocket_stage%29) second stage, but is independently powered by a [Rocketdyne](http://en.wikipedia.org/wiki/Pratt_%26_Whitney_Rocketdyne) AR2-3 [hydrazine](http://en.wikipedia.org/wiki/Hydrazine) [monopropellant rocket](http://en.wikipedia.org/wiki/Monopropellant_rocket). The AR2-3 was the [human-rated](http://en.wikipedia.org/wiki/Human-rating_certification) rocket powerplant for the dual-power [NF-104A](http://en.wikipedia.org/wiki/Lockheed_NF-104A) astronaut training vehicle, and was given a new flight certification for use on the X-37 with [hydrogen peroxide](http://en.wikipedia.org/wiki/Hydrogen_peroxide)/[JP-8](http://en.wikipedia.org/wiki/JP-8) propellants. The X-37 is designed to operate in a velocity range of up to [Mach 25](http://en.wikipedia.org/wiki/Mach_number) upon its reentry.

At the time of its maiden launch, the X-37 (far right) was the smallest and lightest [orbital spaceplane](http://en.wikipedia.org/wiki/Spaceplane#Orbital_spaceplanes) yet flown. Both the [North American X-15](http://en.wikipedia.org/wiki/North_American_X-15) and [SpaceShipOne](http://en.wikipedia.org/wiki/SpaceShipOne) were [suborbital](http://en.wikipedia.org/wiki/Spaceplane#Suborbital_spaceplanes). Of the spaceplanes shown, only the X-37 and [Buran](http://en.wikipedia.org/wiki/Buran_%28spacecraft%29) conducted [unmanned](http://en.wikipedia.org/wiki/Unmanned_aerial_vehicle) spaceflights.

The X-37 lands automatically upon returning from orbit, and is the second reusable spacecraft to have such a capability, after the [Soviet](http://en.wikipedia.org/wiki/Soviet) [Buran](http://en.wikipedia.org/wiki/Buran_%28spacecraft%29) shuttle. The X-37 is the smallest and lightest [orbital spaceplane](http://en.wikipedia.org/wiki/Spaceplane#Orbital_spaceplanes) flown to date – it is more than 27 meters (89 ft) shorter lengthwise, and 90,000 kilograms (200,000 lb.) lighter fully loaded, than both the [Space Shuttle](http://en.wikipedia.org/wiki/Space_Shuttle_orbiter) and [Buran orbiters](http://en.wikipedia.org/wiki/Buran_program#Technical_data).

**Technology demonstration**

Among the technologies demonstrated in the X-37 were an improved [thermal protection system](http://en.wikipedia.org/wiki/Atmospheric_reentry#Thermal_protection_systems), enhanced [avionics](http://en.wikipedia.org/wiki/Avionics), an autonomous [guidance system](http://en.wikipedia.org/wiki/Guidance_system) and an advanced [airframe](http://en.wikipedia.org/wiki/Airframe). The spaceplane's thermal protection system built upon previous generations of [atmospheric reentry](http://en.wikipedia.org/wiki/Atmospheric_reentry) spacecraft, incorporating [silica](http://en.wikipedia.org/wiki/Silica) [ceramic](http://en.wikipedia.org/wiki/Ceramic) tiles. The X-37's avionics suite was used by Boeing to develop its [CST-100](http://en.wikipedia.org/wiki/CST-100) manned spacecraft. According to NASA, the development of the X-37 will "aid in the design and development of NASA's [Orbital Space Plane](http://en.wikipedia.org/wiki/Orbital_Space_Plane), designed to provide a crew rescue and crew transport capability to and from the [International Space Station](http://en.wikipedia.org/wiki/International_Space_Station)".

**Operational history**

**OTV-1**

OTV-1 sits on the runway at Vandenberg AFB after landing, 3 December 2010.

OTV-1, the first X-37B, launched on its first mission – [USA-212](http://en.wikipedia.org/wiki/USA-212) – on an [Atlas V](http://en.wikipedia.org/wiki/Atlas_V) rocket at [Cape Canaveral Air Force Station](http://en.wikipedia.org/wiki/Cape_Canaveral_Air_Force_Station), Florida, on 22 April 2010 at 23:58 GMT. The spacecraft was placed into [low Earth orbit](http://en.wikipedia.org/wiki/Low_Earth_orbit) for testing. While the U.S. Air Force revealed few orbital details of the mission, amateur astronomers claimed to have identified the experimental spacecraft in orbit and shared their findings. A worldwide network of amateur astronomers reported that on 22 May the spacecraft was in an inclination of 39.99 degrees, circling the Earth once every 90 minutes on an orbit 249 by 262 miles (401 by 422 km). They furthermore reported the spacecraft's track went over [North Korea](http://en.wikipedia.org/wiki/North_Korea), [Afghanistan](http://en.wikipedia.org/wiki/Afghanistan), and other regions of interest to U.S. military intelligence. The X-37B also reputedly passed over the same given spot on Earth every four days, and operated at an altitude of 255 miles (410 km), which is typical for a military surveillance satellite.

Vandenberg AFB personnel inspect OTV-1 after its return to Earth.

The U.S. Air Force announced on 30 November 2010 that the X-37B would return for a landing during the 3–6 December timeframe. As scheduled, OTV-1 de-orbited, reentered Earth's atmosphere, and landed successfully at [Vandenberg AFB](http://en.wikipedia.org/wiki/Vandenberg_Air_Force_Base) on 3 December 2010, at 1:16 PST (09:16 UTC), conducting America's first autonomous orbital landing onto a runway; the first spacecraft to perform such a feat was the Soviet [Buran](http://en.wikipedia.org/wiki/Buran_%28spacecraft%29) shuttle in 1988. In all, the X-37B spent 224 days in space. OTV-1 suffered a tire blowout during landing and sustained minor damage to its underside.

**OTV-2**

A second X-37B mission, designated [USA-226](http://en.wikipedia.org/wiki/USA-226), was launched aboard an Atlas V rocket [Cape Canaveral Air Force Station](http://en.wikipedia.org/wiki/Cape_Canaveral_Air_Force_Station), Florida on 5 March 2011. The mission was classified and described by the U.S. military as an effort to test new space technologies. On 29 November 2011, the U.S. Air Force announced that it would extend the mission of USA-226 beyond the 270-day baseline design duration. In April 2012, General [William L. Shelton](http://en.wikipedia.org/wiki/William_L._Shelton) of the [Air Force Space Command](http://en.wikipedia.org/wiki/Air_Force_Space_Command) declared the ongoing mission a "spectacular success".

On 30 May 2012, the Air Force stated that OTV-2 would complete its mission and land at Vandenberg AFB in June 2012. The spacecraft landed autonomously on 16 June 2012, having spent 469 days in space.

**Controversies**

In April 2010, the [*China Daily*](http://en.wikipedia.org/wiki/China_Daily) newspaper wrote that the X-37B program raised concerns about an arms race in space, a sentiment that was echoed by [China](http://en.wikipedia.org/wiki/China)'s [Xinhua News Agency](http://en.wikipedia.org/wiki/Xinhua_News_Agency). Tom Burghardt wrote for [Spacedaily.com](http://en.wikipedia.org/w/index.php?title=Spacedaily.com&action=edit&redlink=1) that the X-37B could be used as a [spy satellite](http://en.wikipedia.org/wiki/Spy_satellite) or to deliver weapons from space. [The Pentagon](http://en.wikipedia.org/wiki/The_Pentagon) has denied claims that the X-37B's mission supports the development of space-based weapons. In January 2012, allegations were made that the X-37B was being used to spy on China's [Tiangong-1](http://en.wikipedia.org/wiki/Tiangong-1) space station module. Former U.S. Air Force orbital analyst Brian Weeden later refuted this claim, emphasizing that the different orbits of the two spacecraft precluded any practical surveillance fly-bys.

**Variants**

**X-37A**

The X-37A was the initial NASA version of the spacecraft; the X-37A Approach and Landing Test Vehicle (ALTV) was used in drop glide tests in 2005 and 2006.

**X-37B**

The X-37B is a modified version of the NASA X-37A, intended for the U.S. Air Force. It conducted orbital test missions in 2010 and 2011.

**X-37C**

In 2011, Boeing announced plans for a scaled-up variant of the X-37B, referring to the spacecraft as the X-37C. The size of the X-37C would be approximately 165 to 180% of the X-37B, allowing it to transport up to six astronauts inside a pressurized compartment housed in the cargo bay. The X-37C's proposed launch vehicle is the [Atlas V](http://en.wikipedia.org/wiki/Atlas_V) [Evolved Expendable Launch Vehicle](http://en.wikipedia.org/wiki/Evolved_Expendable_Launch_Vehicle). X-37C may compete with Boeing's [CST-100](http://en.wikipedia.org/wiki/CST-100) space capsule

**Specifications**

**X-37B**

*Data from* USAF, Boeing, *Air & Space Magazine*, and *PhysOrg*.

**General characteristics**

* **Crew:** None
* **Length:** 29 ft 3 in (8.9 m)
* [**Wingspan**](http://en.wikipedia.org/wiki/Wingspan)**:** 14 ft 11 in (4.5 m)
* **Height:** 9 ft 6 in (2.9 m)
* **Loaded weight:** 11,000 lb. (4,990 kg)
* [**Powerplant**](http://en.wikipedia.org/wiki/Aircraft_engine)**:** 1 × [Rocketdyne](http://en.wikipedia.org/wiki/Pratt_%26_Whitney_Rocketdyne) AR2-3 rocket engine (hydrazine), 3,300 lbf (14.7 kN)
* **Power:** [Gallium arsenide](http://en.wikipedia.org/wiki/Gallium_arsenide) solar cells with [lithium-ion batteries](http://en.wikipedia.org/wiki/Lithium-ion_battery)
* **Payload bay:** 7 × 4 ft (2.1 × 1.2 m

**Performance**

* **Orbital speed:** 28,044 km/h (17,426 mph)
* **Orbit:** [Low Earth orbit](http://en.wikipedia.org/wiki/Low_Earth_orbit)
* **Orbital time:** 270 days (design)