Lifting body

The Martin Aircraft Company X-24 built as part of a 1963 to 1975 experimental US military program

The **lifting body** is an aircraft configuration where the body itself produces lift. It is related to, but the opposite of, a flying wing, an aircraft whose fuselage is contained by the wing.

In 1921 pioneering aviator and aircraft designer Vincent Justus Burnelli patented the simple concept of an airfoil shaped airframe to increase the lift and load capacity of airplanes. [1] Despite a number of business and political setbacks, Burnelli continued to refine and license his designs making a number of refinements to the concept up until his death in 1964. [2] [3]

Aerospace related lifting body research arose from the idea of spacecraft re-entering the Earth's atmosphere and landing much like a regular aircraft. The traditional capsule-like spacecraft had very little control over where they landed once they re-entered the Earth's atmosphere. A steerable spacecraft with wings could significantly extend the landing envelope. Wings would have to be built that could withstand stresses and temperatures at hypersonic speeds. A proposed answer was to eliminate wings altogether: design the body itself to produce lift. The Space Shuttle contains some of the lifting body principles, although it relies more on the delta wing concept.

NASA's refinements on the lifting body concept in 1962 with Dale Reed of NASA's Dryden Flight Research Center. The first full-size model, the NASA M2-F1, was made of wood. Initial tests were performed by towing the craft along a dry lakebed behind a modified Pontiac Catalina [4]. Later the craft was towed from behind a C-47 and released. Since the **M2-F1** was a glider, a small rocket motor

was added in order to extend the landing envelope. The **M2-F1** was soon nicknamed the "Flying Bathtub".

In 1963, NASA began experimenting with heavier rocket powered craft dropped from a B-52 Bomber. (Of the Dryden lifting bodies, all but the NASA M2-F1 used an XLR-11 rocket engine like the famous Bell X-1.) A follow-on design was the Northrop HL-10, developed at NASA's Langley Research Center. The X-24A and X-24B were based on the M2 concept originated by Alfred Eggers in 1957 at NASA Ames Research Center (called the Ames Aeronautical Laboratory in 1957), Moffett Field, Mountain View, California. The M-2 competed in the design of the Space Shuttle.

A major difficulty with these designs was *air flow separation*; the air stream would become very turbulent causing loss of control and lift. The HL-10 attempted to solve part of this problem by angling the port and starboard vertical stablizers outward and enlarging the center one. This air flow problem caused the crash of the Northrop M2-F2 lifting body. The rebuilt **M2-F2** (now called the Northrop M2-F3) added a central rudder to correct the aerodynamic flaw of its predecessor.

Much of the general public had never heard, or seen, anything about these lifting body designs until watching the 1970s television show *The Six Million Dollar Man*. The introduction footage showed the M2-F2, piloted by Bruce Peterson, crashing and tumbling violently along the runway. The cause of the crash was attributed to the onset of *Dutch Roll*. Bruce Peterson survived to fly again and, the craft was rebuilt as the **M2-F3**.

The X-38 was a program under leadership of NASA Johnson Space Center to build a series of incremental flight demonstrators for the proposed Crew Return Vehicle (CRV) for the International Space Station. The X-38 was a lifting body based on the outer mold line of the X-24A.

The lifting body concept has been considered for many other aerospace programs, including the Lockheed Martin X-33, BAC's Multi Unit Space Transport And Recovery Device, Europe's EADS Phoenix and the Russian-European cooperation Kliper spaceship. This is mainly because of the three basic shapes usually analyzed for such projects (capsule, lifting body, airplane) the lifting body offers the best trade-off on terms of maneuverability and thermodynamics. Lifting bodies, though, tend to pose complex structural and internal configuration issues.

Lifting bodies have appeared in some science fiction works, including the book *The Mote in God's Eye* and the Discovery Channel TV series *Alien Planet*.

List of Dryden Flight Research Center lifting body vehicles (1963 to 1975)

- M2-F1
- M2-F2
- M2-F3
- HL-10
- X-24A
- X-24B

Lifting body pilots and flights

Pilot	M2-F1	M2-F2	HL-10	HL-10 mod	M2-F3	X-24A	X-24B	Total
Milton O. Thompson	45	5	-	-	-	-	-	50
Bruce Peterson	17	3	1	-	-	-	-	21
Chuck Yeager	5	-	-	-	-	-	-	5
Donald L. Mallick	2	-	-	-	-	-	-	2
James W. Wood	*	-	-	-	-	-	-	*
Donald M. Sorlie	5	3	-	-	-	-	-	8
William H. Dana	1	-	-	9	19	-	2	31
Jerauld R. Gentry	2	5	-	9	1	13	-	30
Fred Haise	*	-	-	-	-	-	-	*
Joe Engle	*	-	-	-	-	-	-	*
John A. Manke	-	-	-	10	4	12	16	42
Peter C. Hoag	-	-	-	8	-	-	-	8
Cecil W. Powell	-	-	-	-	3	3	-	6
Michael V. Love	-	-	-	-	-	-	12	12
Einar K. Enevoldson	-	-	-	-	-	-	2	2
Francis Scobee	-	-	-	-	-	-	2	2
Thomas C. McMurtry	-	-	-	-	-	-	2	2
TOTAL	77	16	1	36	27	28	36	221

- **Wood**, **Haise** and **Engle** each made a single, car-towed, ground flight of the M2-F1.