NASA Facts

National Aeronautics and
Space Administration

Dryden Flight Research Center
P.O. Box 273
Edwards, California 93523
Phone 805-258-3449
FAX 805-258-3566

FS-DFRC-95(09)-011

E 21115

Three of the five heavyweights -- X-24A (L), M2-F3 (C), & HL-10 (R)

The Lifting Bodies

A fleet of lifting bodies flown at the NASA Dryden Flight Research Center, Edwards, CA., from 1963 to l975 demonstrated the ability of pilots to maneuver and safely land a wingless vehicle designed to fly back to Earth from space and be landed like an aircraft at a pre-determined site.

These unique research vehicles, with their unconventional aerodynamic shapes, were the M2-F1, M2-F2, M2-F3, HL-10, X-24A, and the X-24B.

The information the lifting body program generated contributed to the data base that led to development of today's space shuttle program.

Aerodynamic lift -- essential to flight in the atmosphere -- was obtained from the shape of their bodies. The addition of fins and control surfaces allowed the pilots to stabilize and control the vehicles and regulate their flight paths.

All but the M2-F1 were powered by the same type of XLR-11 rocket engine used in the famed Bell X-1 -- first aircraft to fly faster than the speed of sound. The M2-F1, a lightweight prototype, was unpowered.

Background

The original idea of lifting bodies was conceived in 1957 by Dr. Alfred J. Eggers Jr., then the assistant director for Research and Development Analysis and Planning at the NASA Ames Research Center, Moffett Field, CA.

NASA had earlier been investigating the problems associated with reentry of missile nose cones. H. Julian Allen, another Ames engineer, determined that a blunt nose cone was a more desirable shape to survive the aerodynamic heating associated with reentry from space. Eggers found that by slightly modifying a symmetrical nose cone shape, aerodynamic lift could be produced. This lift would enable the modified shape to fly back from space rather than plunge to earth in a ballistic trajectory.

These studies led to the design known as the M-2, a modified half-cone, rounded on the bottom and flat on top, with a blunt, rounded nose and twin tail fins.

The Pioneering M2-F1

In 1962, Dryden management approved a program to build a lightweight, unpowered lifting body as a prototype to flight test the wingless concept. It would look like a “flying bathtub,” and was designated the M2-F1. It featured a plywood shell, built by Gus Briegleb, a sailplane builder from Mirage Dry Lake, Calif., placed over a tubular steel frame crafted at Dryden. Construction was completed in 1963.

The first flight tests were over Rogers Dry Lake at the end of a tow rope attached to a hopped-up Pontiac convertible driven at speeds up to about 120 mph. These initial tests produced enough flight data about the M2-F1 to proceed with flights behind a NASA C-47 tow plane at greater altitudes. The C-47 took the craft to an altitude of 12,000 where free flights back to Rogers Dry Lake began. Pilot for the first series of flights of the M2-F1 was NASA research pilot Milt Thompson.

Typical glide flights with the M2-F1 lasted about two minutes and reached speeds of 110 to l20 mph.

The M2-F1 is towed to launch altitude

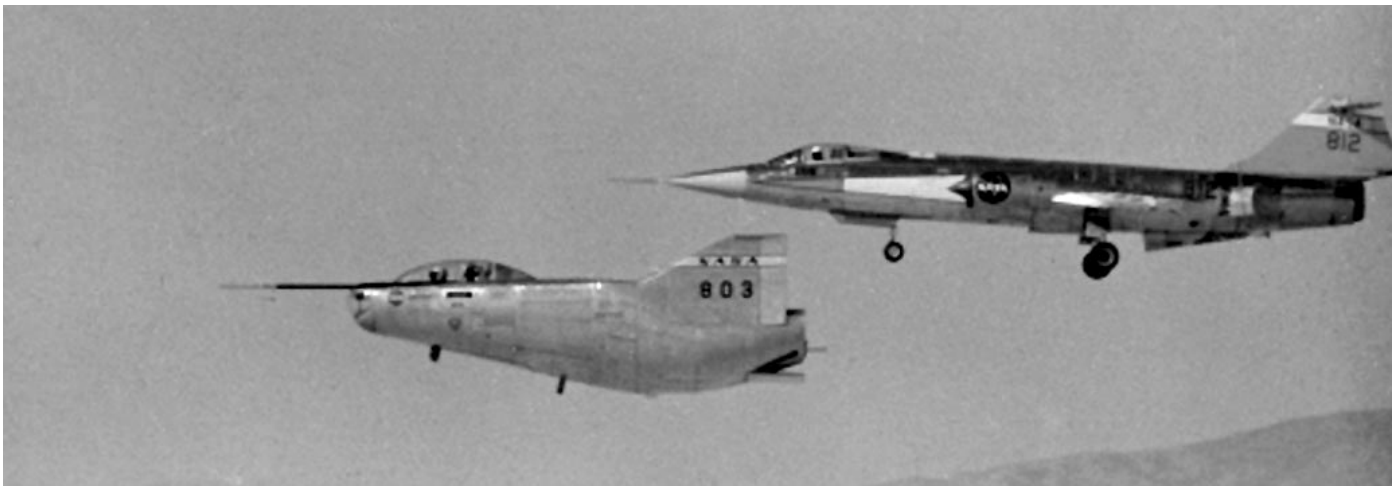
More than 400 ground tows and over 100 aircraft tow flights were carried out with the M2-F1 before it was retired and gave way to more advanced versions of lifting bodies.

A historical artifact belonging to the Smithsonian’s National Air and Space Museum, the M2-F1 is located at Dryden.

The Heavyweights

The success of Dryden's M2-F1 program led to NASA's development and construction of two heavyweight lifting bodies based on studies at NASA's Ames and Langley research centers -- the M2-F2 and the HL-10, both built by the Northrop Corporation. The "M" refers to "manned" and "F" refers to "flight" version. "HL" comes from "horizontal landing" and 10 is for the tenth lifting body model to be investigated by Langley.

The Air Force later became interested in lifting body research and had a third design concept built, the X-24A, built by the Martin Company. It was later modified into the X-24B and both configurations were flown in the joint NASA-Air Force lifting body program located at Dryden.



The M2-F2 and its F-104 chase aircraft on final approach for landing

M2-F2

The first flight of the M2-F2 -- which looked much like the "F1" -- was on July 12, 1966. Thompson was the pilot. By then, the same B-52 used to air launch the famed X-15 rocket research aircraft had been modified to also carry the lifting bodies into the air and Thompson was dropped from the B-52's wing pylon mount at an altitude of 45,000 feet on that maiden glide flight.

The M2-F2 weighed 4,620 pounds, was 22 feet long, and had a width of about 10 feet.

On May 10, 1967, during the sixteenth glide flight leading up to powered flight, a landing accident severely damaged the vehicle and seriously injured the NASA pilot, Bruce Peterson.

M2-F3

NASA pilots said the M2-F2 had lateral control problems, even though it had a stability augmentation control system. When the M2-F2 was rebuilt at Dryden and redesignated the M2-F3, it was modified with an additional third vertical fin -- centered between the tip fins -- to improve control characteristics.

A reaction jet control system, similar to thrusters now used on orbiting spacecraft, was also installed to obtain research data about their effectiveness for vehicle control.

First flight of the M2-F3, with NASA pilot Bill Dana at the controls, was June 2, 1970. It was a glide flight to evaluate changes in the vehicle's performance due to the modifications. The modified vehicle exhibited much better lateral stability and control characteristics than before.

Over the next 26 missions, the M2-F3 reached a top speed of l,064 mph (Mach 1.6). Highest altitude reached by the vehicle was 71,500 feet on Dec. 21, 1971, the date of its last flight, with NASA pilot John Manke at the controls.

As the M2-F3's portion of the lifting body program neared an end, it evaluated a rate command augmentation control system, and a side-arm control stick similar to side-arm controllers now used on many modern aircraft.

The M2-F3 is now on display in the National Air and Space Museum, Washington, D. C.

HL-10

The HL-10 was delivered to Dryden by Northrop in January 1966. Its first flight was on Dec. 22 of the same year. The pilot was Bruce Peterson, later to be injured in the M2-F2 accident.

The HL-10 was flown 37 times and it set several program records. On Feb. 18, 1970, Air Force test pilot Maj. Peter Hoag flew it to 1,228 mph (Mach 1.86), fastest speed of any of the lifting bodies. Nine days later, NASA's Bill Dana flew the HL-10 to 90,303 feet, the highest altitude reached by any of the lifting body vehicles. The HL-10 was also the first lifting body to fly supersonic.

The HL-10 featured a flat bottom and rounded top -- much like an airfoil -- and it had a delta planform. Three vertical fins, two of them canted outwards from the body and a tall center fin, gave the craft directional control. A flush canopy blended into the smooth rounded nose.

Like the M2 vehicles, it was 22 feet long, but at 15 feet it was wider. Its empty weight was 5,265 lbs.

Flights with the HL-10 contributed substantially to the decision to design the space shuttles without air-breathing engines that would have been used for landings. Its final flight was on July 17, 1970.

The HL-10 is now on public display at Dryden.

X-24A

Built for the Air Force by Martin, the X-24A was a bulbous vehicle shaped like a tear drop, with three vertical fins at the rear for directional control. It weighed 6,270 pounds, was just over 24 feet long, and had a width of nearly 14 feet.

First unpowered glide flight of the X-24A was on April 17, 1969. The pilot was Air Force Maj. Jerauld Gentry. Gentry also piloted the vehicle on its first powered flight Mar. 19, 1970.

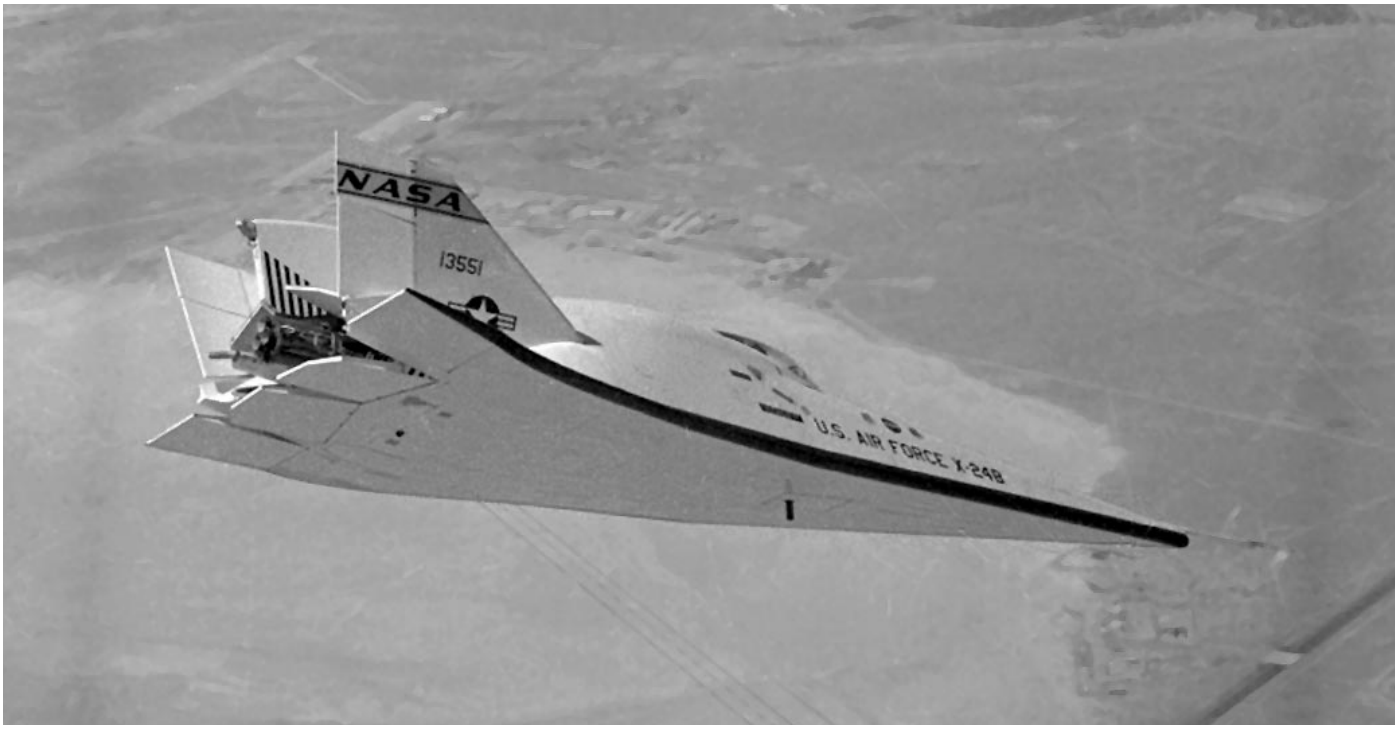
It was flown 28 times in a program which, like the HL-10, helped validate the concept that a space shuttle vehicle could be landed unpowered.

Fastest speed in the X-24A was 1,036 mph (Mach 1.6). The pilot was Manke, who also reached the highest altitude in the vehicle, 71,400 feet. He was also the pilot on its final flight June 4, 1971.

X-24B

The X-24B's design evolved from a family of potential reentry shapes, each with higher lift-to-drag ratios, proposed by the Air Force Flight Dynamics Laboratory.

To reduce the costs of constructing a research vehicle, the Air Force returned the X-24A to Martin for modifications that converted its bulbous shape into one resembling a "flying flatiron" -- rounded top, flat bottom, and a double delta planform that ended in a pointed nose.



The X-24B on a steep approach to a lakebed landing

First to fly the X-24B was Manke, a glide flight on Aug. 1, 1973. He was also the pilot on the first powered mission Nov. 15, 1973.

Among the final flights with the X-24B were two precise landings on the main concrete runway at Edwards which showed that accurate unpowered reentry vehicle landings were operationally feasible. These missions were flown by Manke and Air Force Maj. Mike Love and represented the final milestone in a program that helped write the flight plan for today's space shuttle program.

After launch from the B-52 "mothership" at an altitude of about 45,000 feet, the XLR-11 rocket engine was ignited and the vehicle accelerated to speeds of more than 1,100 mph and to altitudes of 60,000 to 70,000 feet. After the rocket engine was shut down, the pilots began steep glides towards the Edwards runway. As the pilots entered the final approach leg, they increased their rate of descent to build up speed and used this energy to perform a "flare out" maneuver and slow their landing speed to about 200 mph -- the same basic approach pattern and landing speed of today's space shuttles.

The final powered flight with the X-24B was on Sept. 23, l975. The pilot was Bill Dana, and it was also the last rocket-powered flight flown at Dryden. It was Dana who also flew the last X-15 mission about seven years earlier.

Top speed reached with the X-24B was 1,164 mph (Mach 1.76) by Love. The highest altitude reached was 74,100 feet, by Manke.

The X-24B is on public display at the Air Force Museum, Wright-Patterson AFB, Ohio.

-nasa-

August 1995