

NASA Facts

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X-5



NASA Photo E-648. X-5 on ramp.

The Bell X-5 was built to test the feasibility of changing the sweep angle of an aircraft's wings in flight. This had advantages from both an operational and research point of view. An operational aircraft could take off with its wings fully extended, reducing both its take off speed and the length of the runway needed. Once in the air, the wings could be swept back, reducing drag and increasing the aircraft's speed. For an experimental aircraft, the ability to vary the wing's sweep angle would greatly expand the research possibilities. Existing swept wing experimental aircraft, such as the D-558-II, XF-92A, X-2 and X-4, could each provide aeronautical data at only a single wing angle. A variable swept wing aircraft would be equivalent to a series of such experimental aircraft, as it could change the wing angle to the desired research objectives.

Although the NACA conducted independent wind tunnel research on variable sweep wings in 1945, the X-5 originated with the Messerschmitt P.1101 experimental aircraft. This was a small jet with wings that could be adjusted on the ground to three fixed angles between 35 and 45 degrees. The P.1101 had not flown before it was captured by U.S. troops in April 1945. The aircraft was examined by Bell Aircraft engineers following its



NASA Photo E-799. X-5 on ramp - side view.

arrival in the U.S. Robert Wood, head of Bell's design team, proposed in July 1948 that a modified and enlarged version of the P.1101 be built. Unlike the original aircraft, the proposed Bell aircraft could change its sweep angle in flight, rather than being set on the ground before takeoff. The NACA, which had continued to make studies of variable sweep aircraft, supported Bell's proposal. This was a major reason why Air Force Headquarters approved the project on February 4, 1949.

A pair of X-5s were built, serial numbers 50-1838 and 50-1839. They were similar in shape to the P.1101 design, with a nose-mounted intake, a bubble canopy, an underslung engine, and a boom-mounted tail. The wings pivoted from a 20 to 60 degree angle in flight. The mechanism used to swivel the wings was very complex. As the X-5's wings were swept back, its center of gravity and center of pressure changed. To compensate, the entire wing assembly simultaneously moved forward on rails inside the fuselage. Sweeping the wings from a 20 degree angle to the full 60 degree angle required that they also be moved about 27 inches forward from their starting position. The change from 20 to 60 degrees required about 20 seconds. In the event of an electrical failure, the pilot could hand crank the wings back into landing position. (The X-5 could not safely land with a sweep angle greater than 40 degrees.)

The first X-5 (50-1838) was delivered to Edwards Air Force Base, Calif., on June 9, 1951. It made its first flight 11 days later, on June 20. Bell company test pilot Jean "Skip" Ziegler made the initial Phase I flights, to prove the airplane's airworthiness. On the X-5's ninth flight, made on July 27, Ziegler tested the wing sweep mechanism for the first time. The Phase I flight continued through July and August 1951, with the 20th and final Phase I flight made on October 8, 1951. Maj. Frank Everest made six Air Force flights in the aircraft during December 1951 and January 1952. After a final flight by Everest on January 8, 1952, the first X-5 was turned over to the NACA. The second X-5 (50-1839) had, by this time, also been delivered and was flown by the Air Force.

NACA research pilot Joe Walker was assigned to the X-5 program. He made a pilot checkout flight on January 9, 1952, the day after the first X-5 was transferred to the NACA. The initial research flights involved static and dynamic longitudinal and lateral stability and control. Walker also tested the X-5's stability and control with the wings swept back 45 and 60 degrees, as well as its response to gusts with the wings in the 20 and 60 degree position. In April 1952, two more NACA pilots joined the X-5 program, A. Scott Crossfield and Walter P. Jones. Jones made eight flights in the X-5 before leaving the NACA, while Crossfield flew a total of 10 missions from 1952 through 1954. Walker remained the primary X-5 pilot through mid-1954.



NASA Photo E-810. X-5 multiple exposure photo showing wing sweep.

The X-5 research program, in contrast to that of the X-3 and XF-92A, was quite extensive. Although the focus remained on stability and control, other areas of research included vertical tail loads in maneuvers, gust loads at various sweep angles, wing twisting and bending tail loads, the effects on trim from shifting the wings, the response of strain gages to temperature, and the effects of dynamic pressure on buffeting. The ability to set the desired sweep angle was also used. A flight by Walker on February 10, 1954, for instance, collected lateral and longitudinal stability and control data with the wings at a 59 degree sweep angle. Other tests with the X-5 included drag studies behind an F-80 and B-29, and acting as a chase plane for a B-47 flight.

The NACA flights in the X-5 also showed the design's shortcomings. Crossfield noted later, "The X-5 was not a comfortable airplane to fly. It had a low-slung engine. So there was a misalignment of the drag axis, and the principal axis, and the thrust axis, and all of that. So it could get into some interesting maneuvers and motions, and that sort of thing." Its biggest problem, he added was that "...it was a terrible airplane in a spin. It took a long time to get that airplane out of a spin." On October 21, 1952, Walker entered a spin at 36,000 feet, and required 18,000 feet to recover. Crossfield also got into a spin during an X-5 flight, but recovered safely. Tragically, Maj. Raymond Popson was lost in a spin accident with the Air Force's X-5 (50-1839) on October 13, 1953. The wings were in the 60 degree position, and, unlike the others, Popson could not recover in time.

On April 23, 1954, Walker made his last X-5 flight, and two new pilots were assigned to the program. They were Stanley P. Butchart and John B. "Jack" McKay. They continued making stability and control research flights from June 1954 into October 1955. Butchart later said about the X-5's poor spin characteristics, "You just had to know that and stay away from it." He also noted a special characteristics of the aircraft, "The speed brakes on the X-5 were up front [on the nose]. When you opened the speed brakes, you got quite a nose down pitch. Well, now it would be very unacceptable. But in a research airplane you put up with it because it's all you've got." The final NACA

X-5 flight was made on October 25, 1955, by a new High-Speed Flight Station pilot, Neil A. Armstrong. During the pilot checkout flight, a landing gear door separated. The aircraft was subsequently grounded. In all, the first X-5 had made 122 NACA flights. The aircraft was sent to the Air Force Museum in March of 1958.

The results of the X-5 were mixed. It provided verification of wind tunnel predictions about drag reductions and performance improvements from variable sweep wings. The X-5 pilots also found that the variable sweep wings gave a tactical advantage over conventional aircraft. The poor stall/spin characteristics were due to the aircraft's design, rather than the variable wing sweep. But while the concept of changing the wings' sweep angle was shown to have promise, the mechanism itself, which required the wings move back and forth as their angle changed, was not practical. The solution to this, developed by NACA engineers at Langley, was to move the pivot points of the wings outside the fuselage.

Variable sweep wings became a design feature in aircraft beginning in the 1960s and continuing into the 1980s. These included the F-111, the F-14 and B-1 in the U.S., the Su-22 and Su-24 attack aircraft and the Tu-22M and Tu-160 strategic bombers built in the (then) Soviet Union, and the European Tornado strike aircraft and interceptor.



NASA Photo E-17351. The X-5, which proved the viability of variable-sweep wings.