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The Remarkable 'X' Craft

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the remarkable x-craft

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THE UNITED STATES has seen Russia slowly close the wide air-power gap that once separated the two nations. Military experts now agree that in many areas the Soviets are quantitatively ahead of us, and as far as quality goes they are catching up rapidly.

To offset any challenge to our aerial supremacy, the United States has embarked on an ambitious experimental research aircraft program that, it is hoped, will insure the maintenance of leadership in superior quality airplanes and missiles in the years to come.

Many of the exotic spaceships of the science-fiction world were prefixed by the letter X; today many of the astonishing research missiles and planes being developed by American technology have the same introductory letter. The X-series is our preview of tomorrow's aerial weaponry.

The idea for setting up a research series of aircraft began during the course of World War II, but work was not begun seriously until the end of hostilities in 1945. The Air Force, Navy, and National Advisory Committee for Aeronautics (NACA) conceived of, and have continued development on, an advanced series of research vehicles.

Details, from few to rather complete, are available on more than a dozen X-craft. We find that there are three types of vehicles that have been given the X-designation: (1) manned rocket airplanes, (2) manned turbojet airplanes, and (3) unmanned missiles. Rather than try to look at them in numerical order (X-1, X-2, X-3, X-4, etc.) it should be more interesting to think of them by category. Since the most exciting frontiers of flight are usually associated with man as well as speed and altitude, let us look at what has been done with our piloted rocket airplanes.

The Bell X-1 was the first airplane in the world to reach supersonic speeds in level flight, crossing what was known as the "sound barrier" in October of 1947. This was an event of tremendous importance to the aeronautical sciences, and was accomplished by designing and flying a rocket-propelled airplane that was almost literally a manned missile. The plane was

Bell X-1

Bell X-1a

Bell X-1b

Bell X-2

driven by a powerful Reaction Motors 6000-pound thrust rocket engine operating on liquid oxygen and alcohol. It provided military and industrial aeronautical researchers with invaluable data about the then-virtually-unknown regions of high-speed flight, and data derived from the program were fed into later combat airplane design.

A modification of the early model was the X-1A, five feet longer than its predecessor. After thorough testing in 1952 and 1953, this larger plane amazed the world by travelling at 2½ times the speed of sound, or 1,650 miles per hour, in December of 1953. In another flight it reached a record altitude of 90,000 feet, which literally brought man to the frontiers of space. While the X-1 could only sustain powered flight for 2½ minutes, the X-1A could enjoy four minutes of full power since it carried considerably more fuel.

An X-1B was built and specially instrumented for research on high speed friction heating. As the mysteries of the sound barrier were dispelled, those of the "thermal barrier" were explored. All of these X-1 airplanes were normally air-launched from specially adapted bomber-type four-engine airplanes. This enabled the X-planes to utilize their precious fuel only for the research purposes for which they were designed, without wasting any for take-off and climb to altitude. The planes can and have, however, taken off from the ground under their own power.

It is interesting to know that the X-1A and B planes weigh about 16,000 pounds and are crammed with 1,000 pounds of instrumentation to record the variety of tests that the planes undergo at the outer reaches of the atmosphere and at extreme velocities.

Not all airplanes of the X-1 series were successful. X-1 Number 3 was destroyed during a fuel operation, a modified X-1A exploded in 1955, and a model D of the series also was destroyed.

It is well known that air in motion possesses kinetic energy. Now if we decide to bring to a halt rapidly-moving air, the energy contained in it must be converted somehow, and we find that we end up with heat and pressure energy. A simple equation tells aeronautical-design engineers and aerodynamicists what the temperature rise will be of an object encountering a rapidly-moving air stream. As airplanes and missiles roar through the atmosphere at ever-increasing speeds more and more velocity energy is converted into heat. While some of this heat is conducted through what is called the boundary layer and while, especially at extreme altitude, some is radiated out the air frame, much has to be absorbed.

Specially prepared titanium, stainless steels, and ceramics are used to protect the aircraft from this heat. Moreover, each craft has a certain heat capacity; but aircraft designers knew that sooner or later refrigeration systems would have to be incorporated if man and materials were to survive the "thermal barrier."

It is obvious that the denser the atmosphere the more acute the heat problem becomes. To study the thermal phenomenon properly, great speeds and high-altitude capability are necessary. If we were to fly too low at too high a velocity, we would burn up like a meteor. Man has found that if he wants to go substantially faster than he does today he must get beyond the thick atmospheric blanket and into the rarefied upper levels.

The X-2, another Bell—Air Force—NACA rocket research airplane, was specifically designed to explore this thermal barrier. In July of last year it had reached a top speed of three times the speed of sound or about 2,200 miles per hour. To get this extra performance a Curtiss-Wright liquid-propellant rocket engine, developing 15,000 pounds of thrust, was used. Perhaps even more astounding than the speed produced was the record altitude flight of 126,000 feet, or nearly 24 miles straight up.

The powerful rocket engine allowed data to be gained of airplane performance at high angles of attack. When speeds

of Mach 2 to 3 are reached, the temperature of the skin may rise from 250°F to 650°F at high altitudes. Designers have therefore fitted the X-2 with temperature-resistant glass and a heat-insulated cabin to provide protection for the pilot. Furthermore, special alloys were used in critical parts of the plane. In case of airplane malfunction, the cabin could be ejected and parachute-lowered to an altitude where the pilot could separate and complete the descent with his own parachute.

One of the X-2's exploded and was intentionally jettisoned from its mother launching aircraft in May 1953. The last X-2 crashed because of stability problems, killing the pilot, Capt. M. Apt. So the X-2 program is officially over.

To carry on the work started by the X-1 and X-2 airplanes (as well as the rocket-powered Navy D-558-2, not a part of the X-program), one other manned rocket craft is being developed, the X-15. The Bell X-1E will be used for Mach 2 research until these new planes are ready. Its first flight occurred in June of this year.

Details are shaping up about the North American X-15, which is sponsored by the Air Force, Navy and NACA. It will investigate the unknown velocity regions at five, six, or more times the velocity of sound, and it will probe 100 miles above the surface of our planet. *We can almost consider the X-15 as a manned spaceship, and it will probably be this progression outwards in velocity and "distance from the earth" that will bring us to full-fledged manned space flight.*

We saw that the old X-1 planes produced 6,000 pounds of thrust, while the X-2 built up 2½ times that; as much power as put out by a typical Navy cruiser. The X-15's rocket engine, to be built by Reaction Motors of New Jersey, will release 60,000 pounds of thrust, and will fire from 1 to 3 minutes.

Despite this enormous amount of power, despite the fact that the airplane is designed to explore areas where no man has yet been, and despite the fact that friction heat generated may rise to 1500°F to 2500°F, the plane is considered quite safe. Depending on the circumstances, the pilot, in case of a mishap, will have a 90 to 100 per cent survival chance. The airplane has been carefully designed from the human engineering point of view, with aeromedical scientists of the Air Force and Navy cooperating closely with the manufacturer. It will be heavily instrumented to record conditions of reentry from space into the earth's atmosphere, heating, stability at high speeds and altitudes, and control. The X-15 will be the first, true hypersonic boosted glider. The initial flight test is expected in 1958.

Although less spectacular, highly important work is being, and has been, accomplished by turbojet-powered research aircraft such as the X-3, X-4, X-5, X-13, X-14 and X-18. All manned, these planes have probed a variety of aeronautical unknowns, and results are rapidly and efficiently being "ploughed back" into industry.

Douglas X-3

The X-3 has often been referred to as the "Flying Pencil" because of its long (nearly 67 feet), thin shape. Powered by two Westinghouse jets, it produces 14,000 pounds of thrust and lands at a brisk 215 miles per hour. The wing loading (a term denoting the gross weight of the airplane divided by the area presented by its wings) is some 200 pounds for each square foot, a very unusual figure.

This mid-wing airplane carries 1,200 pounds of research instrumentation and a refrigeration system for cooling the cockpit and instruments. An interesting fact is that it uses some of its fuel to circulate in the nose area for cooling. The airplane was designed to test out *sustained*, very high speed flight, and was a joint Air Force, Navy and NACA project. Much of the craft was made of titanium.

Northrop X-4

The Northrop X-4 and Bell X-5 represent a different sort of airplane in that they are not primarily designed for speed and altitude testing. The X-4 is characterized by a tailless configuration with swept wings, being patterned after the well-known "flying wing" design. Elevons on the trailing edge of the wing act as ailerons and elevators. It is a small plane, weighing only 7,000 pounds and measuring less than 27 feet long. Much valuable information has been gained on stability and flight characteristics from this airplane in the subsonic speed region.

Meanwhile, the X-5 is a plane featuring a variable sweep wing; that is, the backward slant of the wings can be adjusted *during* flight. While landing and taking off the sweep is about 20 degrees, and in flight it can be positioned back to 60 degrees. The wing-setting mechanism is coupled to an apparatus that immediately compensates for the shift in the center of gravity of the 10,000-pound airplane as the wings are changed. The use of swept-back wings both delays and reduces transonic effects, but the exact degree of sweep is often a problem. Associated with sweep, however, is a number of difficulties such as the thickening of the so-called boundary layer near the tips, flow velocities along the wing, necessity of large angles of attack at high lift, and dynamic stability. The X-5 was designed to investigate the aerodynamic effects of sweepback and change of sweep-back. Two airplanes have crashed in the test program.

We now turn to another type of turbojet-powered research airplane known as the VTOL (meaning Vertical Take-off and Landing), represented by the X-13, X-14, and X-18. All three planes have come into

Bell X-5

the news very recently, and all three offer different approaches to the same end.

The X-13 is popularly known as the Vertijet, and its approach to vertical take-off is very direct: set the plane in a tail-downward, nose-upward position, and take off. It is launched from a trailer bed which is hydraulically raised into the vertical position. The plane hangs from a hook on a stretched cable, and when ready to fly builds up power from its Rolls-Royce Avon engine until the thrust exceeds the weight of the airplane. In April the first "transition" flight was made when the plane vertically took off, "converted" to the horizontal position, flew at a respectably high speed, again converted and made a vertical landing. A jet reaction control system is employed during periods of rising, lowering or just hovering; the pilot deflects the jet exhaust by throttle control. Only 24 feet long, the plane has directionally-controlled bleed jets on the wingtips, and excellent performance characteristics (good climb, maneuverability, etc.). The Air Force, Navy, and NACA have all supported the program at one stage or another, although the Air Force supports the X-13 as such.

Ryan Vertijet X-13

A supersonic VTOL fighter has reportedly been designed based on the X-13 which, it is claimed, could climb to 15,000 feet during the time a conventional fighter is becoming airborne. This and other VTOLs will probably revolutionize the concept of aerial warfare in that no elaborate (and vulnerable) landing fields and carriers will be necessary. Give the VTOL a little space in the back yard and that is all it asks.

The shrouds of military secrecy have only just been lifted from the Bell X-14 which might be called a horizontal VTOL. Its two Armstrong-Siddeley ASV. 8 Viper jet engines produce hot discharge gases which are diverted downward during take-off to push the airplane upwards. The total

Bell X-14

thrust is 3,500 pounds. As the plane rises, the exhaust gases are directed by special vanes more and more rearward and horizontal flight can commence. Three compressed air jets are used to control altitude when the plane hovers. The plane has already completed preliminary flight tests both conventionally and under VTOL conditions.

The final X-VTOL plane about which we know something is Hiller Helicopters' tilt-wing X-18, which features four turboprop engines, with two counter-rotating propellers. This approach to the VTOL art relies on tilting the wings from the horizontal to the vertical position and allowing

the turboprops to literally screw the plane up into the air. Small turbojets in the tail provide control during hovering operations. This plane will probably be used to transport troops and supplies to and from areas where no airfields are available. Reports are that it can move along rather rapidly.

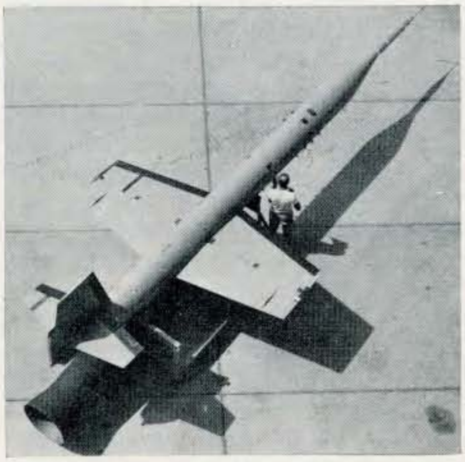
Hiller X-18

We now come to the third and final category in our survey of the X-series, unmanned missiles, the X-7, X-10 and X-17. Each is powered by a different type of engine; each has its own specific research purpose. Lockheed has two, the X-7 and X-17, and North American one, the X-10. All are called test vehicles.

The X-7 is powered by two ramjet engines, being what is called a test bed for the type of power plant that propels the Bomarc intercepter missile. The missile has been under development and test for approximately ten years and will continue at least one more. It is usually air-launched and boosted by a rocket engine to accelerate the missile to the point where the ramjets, which need ram air to sustain their operation, can take over.

Unlike most missiles, X-7 is not expendable, and can be parachute-recovered for continued use and evaluation. It often lands nose first on a nose spike. Data are transmitted to the surface by a radio telemetry system.

The X-17 is a more ambitious rocket, being a three-stage affair, 40 feet long. Normally, the rocket will take off and fly through the atmosphere into space (approximately 200 miles) then tilt and, with motors still firing, enter the earth's atmosphere at fifteen times the speed of sound. All this is done to test re-entry problems



Lockheed X-7

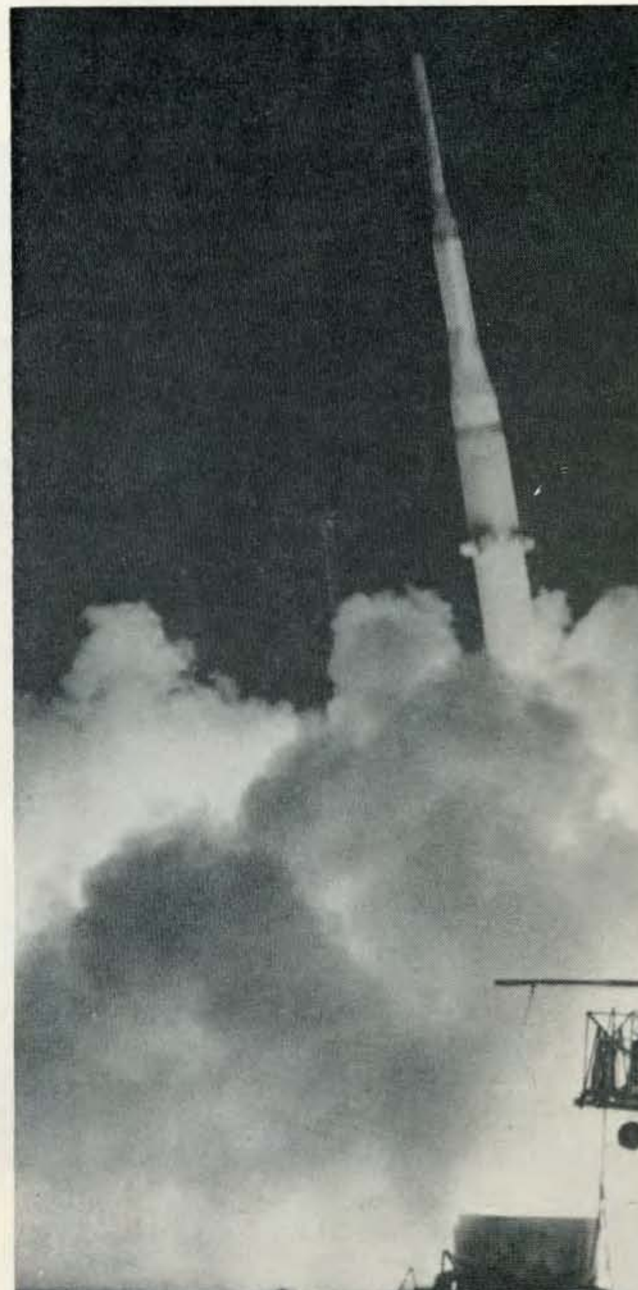
and the vital nose-cone aspect of the forthcoming intercontinental and intermediate-range ballistic missiles. On one flight, when the tilting mechanism did not function, the missile flew to an altitude of more than 600 miles and a range of more than 700 miles. During flights in April and July speeds of 9,000 miles per hour were reported and later confirmed.

More than 20 of the 6-ton, solid-propelled rockets have been fired from the Air Force Missile Test Center, most with good results. While the findings to date have been applied by the Air Force to its Atlas, Titan and Thor ballistic missile projects, the Navy may continue to fly the X-17 as a test vehicle for its submarine-based Polaris IRBM.

Whereas the X-7 and X-17 use ramjets and rockets respectively, the X-10 is provided with two turbojet engines. It is a test vehicle for the recently-cancelled Navaho XSM-64A intercontinental-range cruise

North American Navaho X-10

Lockheed X-17



missile, and it is employed to check out aerodynamic problems, electronic components, and guidance features. Flight testing of the X-10 has been successfully completed according to the Air Force. It has a landing gear and can be recovered after flight for re-use, offering a great saving in money. Navaho, the end product, was to have been powered by ram jets and boosted by three 120,000-pound liquid rockets.

Having briefly looked at these spectacular X-craft, we may ask: "What next? What will happen 10 to 15 years hence?" *The Air Force has already predicted manned rocket aircraft flying at ten times the speed of sound within this time period.* If the X-15 reaches 100 miles, a later X-plane, which may then be called a spaceship, may reach 500 miles, 1,000 miles, or more. The popular distinction between airplanes and missiles may fade as they blend into tomorrow's space vehicles. *Military planners are already thinking of the possibility of wars fought in the space surrounding the earth and its atmospheric blanket.*

At the same time our cruise, interceptor, and ballistic missile programs will become highly sophisticated, and again, if peace continues, techniques evolved could lead to rocket and ramjet-propelled commercial airliners carrying passengers at thousands of miles per hour at the outer fringes of the atmosphere and, of course, spaceships. *There seems little doubt that ballistic missiles and rocket airplanes will be mated and developed into manned vehicles that will one day reach the moon.*