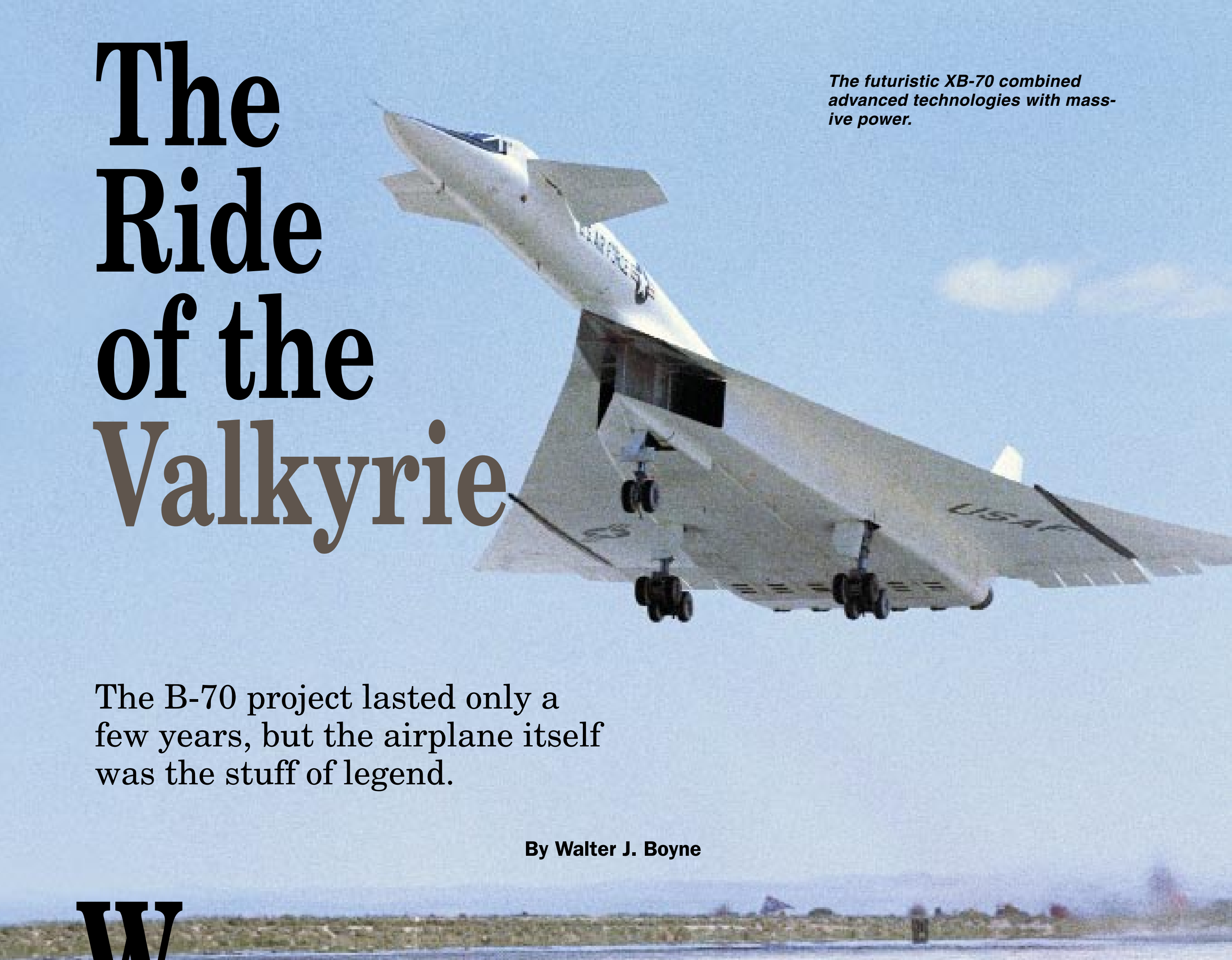
The Ride of the Valkyrie



The futuristic XB-70 combined advanced technologies with massive power.

NASA photo

The B-70 project lasted only a few years, but the airplane itself was the stuff of legend.

By Walter J. Boyne

When Strategic Air Command drew up its B-70 plans a half-century ago, the Valkyrie was projected to become the centerpiece of the most advanced fleet of manned bombers ever assembled. The North American aircraft boasted a sleek, sculpted beauty, while it was still massively powerful, the largest aircraft ever to attain the speed of Mach 3.

Yet this dream was not to be. The Air Force never did acquire the huge fleet of B-70s that it so plainly coveted. The Pentagon in fact bought only two.

The program was done in by its own ambitious goals, with the technological envelope pushed too far, too fast. What's more, the B-70 was based on an operational theology—fly faster and higher—that became obsolete in the 1960s.

The Air Force signed the contract for the Mach 3 bomber in 1959. The big bomber made its first flight five years later, and it was SAC's top priority despite numerous attempts to kill it. The Valkyrie ultimately went down in flames, literally and figuratively, when one of the two XB-70s broke up and crashed following a midair collision.

US bomber production has been dead for a long time, and so it is refreshing to remember the post-World War II era, when the jet engine was opening up new performance frontiers. Bombers appeared in swift succession and were built in relatively large numbers. Given the growing threat of the Soviet Union, with its ever stronger air defenses, the Air Force always seemed to be planning the next generation aircraft.

The B-70 was supposed to replace the B-52 Stratofortress, built primarily in the 1950s. Gen. Curtis E. LeMay, commander in chief of Strategic Air Command, envisioned an aircraft with the B-52's range and payload and the supersonic speed of the B-58 Hustler.

Powered by Nukes?

LeMay knew that Boeing, Convair, and North American were developing a variety of promising—if often exotic—proposals. In fact, he asked for a parallel bomber project in which both a chemically powered Weapons System-110A and a nuclear powered WS-125A would be investigated. There were some rosy but unfounded hopes that the two fantastically expensive systems could share some subsystems to reduce overall costs.

WS-125A drew heavily on the 1946 Nuclear Energy for the Propulsion of Aircraft program. After 15 years and more than a billion dollars in development costs, WS-125A was canceled on March 28, 1961. The program for the conventionally powered WS-110A moved ahead with amazing speed, given that the airframe, engines, and subsystems all had to be developed simultaneously.

Boeing and North American each

were awarded letter contracts in November 1955 to begin development of a piloted strategic intercontinental bombardment system capable of carrying a 20,000-pound load of high-yield nuclear weapons.

The new bomber was to have a sustained cruise speed of Mach 0.9. For a final, 1,000-mile penetrating dash, the bomber was to have "maximum possible" speed. The target date for the first operational wing was set for October 1964.

There also was a requirement for a reconnaissance version, the WS-110L, but this was canceled as a result of the secret success of the Corona satellite project.

The initial phases of the competition for the WS-110A were characterized by wild excursions by the Boeing and the North American design teams. Beset by the same difficult requirements, both firms came up with a series of complex designs reminiscent of the fanciful projections of the last days of Luftwaffe R&D. These ranged from what looked like a B-52 on steroids to Star Wars-like creations with complex, articulated "floating" wings.

On seeing one of the latter proposals, LeMay archly noted that it wasn't a bomber, but a three-ship formation.

The intractable laws of aerodynamics made both companies realize the inefficiencies of the original mission profile, which called for a subsonic cruise approach and a long supersonic dash to the target. A superior aircraft, smaller in size, could be built if the mission profile was changed to all-supersonic.

Engine manufacturers agreed and also offered the prospect of superior performance through the use of a boron-based high-energy fuel. They held out the prospect of achieving a 15 percent increase in range with such fuel.

Attractive as that concept was, it led to a long and expensive effort that not only failed to produce useful results but also was ultimately unnecessary. Years later, the availability of JP-6 jet fuel provided virtually the same boost in performance that boron-based fuel promised, while not requiring a specialized fuel system for its use.

Compression Lift

As the competition evolved, North American exploited an aerodynamic advance that gave it the determining edge. A supersonic aircraft could have its lift-over-drag ratio increased by positioning its wing to take advantage of the pressure field that occurs behind the shock wave generated by the protruding fuselage. In North American's design, this phenomenon—called compression lift—provided a 30 percent increase in lift with no drag penalty.

Compression lift appeared to contravene the engineering rule that you never get something for nothing, but it worked.

Bombers were not the only requirement at the time, for the Air Force also was seeking a long-range Mach 3 fighter. North American won that competition with its F-108 Rapier.

This was pertinent because North American proposed the use of the same engine in both the F-108 and the WS-110, giving the company an overall cost advantage in the competition for the bomber. The designs also would share escape-capsule components.

On Dec. 23, 1957, the Air Force announced that North American had won the B-70 competition. Its design, while far less extreme than some previously proposed, was still absolutely futuristic. The B-70 featured a long protruding nose section with the canopy placed well forward. A flap-equipped canard surface, intended as a trimming device, was positioned just behind the cockpit. The huge delta wings were mounted well aft, over the fuselage underbody that contained the six engines. Two tall vertical surfaces were placed just above the engine bay.

Attaining Mach 3 speeds meant that everything about the aircraft was complex. The very structure itself had to be built to withstand not only high pressures but also the 630-degree temperatures of high-speed flight. The shape of the engine housing had to be optimized to maximize the benefits of compression lift.

In the final version of the aircraft, the wingtips folded down, not to assist with compression lift, but to provide additional stability at high speeds.

Winning a competition was one thing. Building an airplane that would do what the proposal promised was another.

The aircraft portion of WS-110A became the B-70 project in February 1958. The Air Force accelerated the program by 18 months, a move that added another $165 million to the projected program cost, according to noted aviation author Dennis R. Jenkins. And the Air Force canceled the F-108 program, with a stated requirement for 480 aircraft, eliminating projected cost savings from using the same engine.

A bewildering series of changes in requirements and specifications followed. Jenkins noted that the Air Force issued 761 requests for design alterations during program reviews.

North American's engineers constantly massaged the B-70 design. Changes included an increase in projected gross weight to more than 537,000 pounds; an additional weapons bay; a redesigned canard; and an increase in range to more than 6,500 miles.

A significant change was the relocation of the wing fold-lines, to improve aerodynamic stability at high speeds. This meant the vertical stabilizer could be reduced by half, cutting weight and drag.

Bows and Arrows

Political winds were shifting faster than North American workers could cut metal for the B-70. President Eisenhower was an advocate of the emerging intercontinental-range ballistic missile. These ICBMs, he said, made talking about building the B-70 very much like talking about bows and arrows in the era of gunpowder.

Eisenhower's opinion was doubtless shaped by the growing awareness of Soviet surface-to-air missile systems. With these new SAMs coming on line throughout the Soviet bloc, simply flying higher and faster than before would not be good enough.

The full B-70 program was canceled on Dec. 1, 1959. Pentagon officials authorized the production of a single B-70 to serve as a research vehicle, to salvage something from the $360 million already spent.

The program then entered a yo-yo phase, as hopes were dashed, then raised, then dashed again.

Disagreeing with prevailing pro-missile/antibomber sentiment of the Eisenhower Administration, top Air Force leaders, including Gen. Thomas S. Power, SAC commander, persisted in support. In August 1960, the B-70 program was reinstated to provide for one prototype plus 11 YB-70s as test units and to demonstrate the aircraft's combat capability.

The production plans were in place for less than a year. Newly elected President Kennedy was advised by Defense Secretary Robert S. McNamara not to pursue the manned bomber, and the contract was cut to three XB-70 prototypes. A final glimmer of hope was raised in March 1962, when a massive program of 210 RS-70 reconnaissance aircraft was proposed at a $10 billion cost. McNamara

Gen. Thomas Power (l), SAC commander 1957-64, was a strong B-70 proponent. He is shown here at his 1964 retirement ceremony with Gen. Curtis LeMay (c), USAF Chief of Staff, and Gen. John Ryan, Power's successor at SAC.

was unyielding, however, and ruled out any prospect of production.

Despite the numerous setbacks, North American built two aircraft. NASA offered funding for instrumentation to provide data for use in the future American Supersonic Transport (SST), intended to fly at Mach 3.

North American might have been forgiven if, by this point, it had had its fill of the program. The Valkyrie was already laden with millions of dollars in unrecoverable expenses. Even more important were the opportunity costs of pursuing a system that had lost its primary mission and was now only a research vehicle for the still-speculative SST program.

Yet North American never wavered, assigning some of its finest personnel to the program. Four Air Force and four civilian test officials immersed themselves in the program, and their combined knowledge saved the aircraft from destruction on numerous occasions as they pushed it through its flight program. For example, NASA's Joseph A. Walker contributed his knowledge from Mach 3 flights in the North American X-15.

Disbelief

The first XB-70 rolled out of its Palmdale, Calif., hangar on May 11, 1964 to an unbelieving crowd. The huge aircraft, with its 105-foot span, 186-foot length, and maximum takeoff weight of more than half a million pounds, was simply overwhelming. Nothing like it existed anywhere.

The XB-70 suffered mechanical problems from the very start. It began with difficulties in fabricating the exotic honeycomb sandwich stainless steel skin selected to withstand the tremendous aerodynamic heat. Then the new hydraulic system malfunctioned on the first taxi tests. Even learning to taxi the aircraft was difficult, as the pilot was 65 feet in front of the nose gear.

The first flight came on Sept. 21, 1964. North American's Alvin S. White was the pilot, with USAF Col. Joseph F. Cotton in the copilot's seat. Although the aircraft was "light" at 387,620 pounds, the one-hour, seven-minute flight was eventful. The Air Force had promised a $250,000 bonus if the XB-70 went supersonic on its first flight, but the complex, articulated landing gear refused to cooperate. The nose wheel retracted, but the main gear stopped midway in the process.

Fortunately, when White placed the gear handle down again, the wheels descended properly and locked.

To add a little more spice to the first flight, the No. 3 engine began to overspeed, and White shut it down.

The first landing was hazardous. White was seated about 110 feet in front of the main gears, which were designed to touch rear wheel first. When he touched down, the left main bogie did not pivot, causing a minor fire as the airplane rolled two miles down the runway pursued by fire trucks and ambulances. During this process, the No. 2 engine suffered foreign object damage and had to be replaced.

Equipment failures dogged the XB-70, with further hydraulic trouble encountered on the second flight.

The Valkyrie went supersonic on the third flight, peeling patches of its gleaming white paint away as it did so.

On flight No. 4, the Valkyrie completed its initial airworthiness testing while setting a new record for sustained supersonic speed, flying above Mach 1 for 40 minutes. It also partially lowered its wing outer panels for the first time, with the pilots noting an improvement in stability.

The XB-70 then was returned to the plant for inspection, testing, and updating and did not return to flight until February 1965. From that point on, flight testing was conducted on a regular basis, despite hair-raising incidents occurring on almost every mission.

The pilot workload was heavy, for the aircraft had different flight characteristics in subsonic and supersonic flight. The inlet duct controls had to be monitored continuously as flight conditions changed.

The XB-70 continued to set records. Mach 2.14 was reached on the eighth flight on March 24. Air vehicle No. 2 made its first flight July 17, 1965. On Oct. 14, White pushed AV-1 to Mach 3.02, its fastest speed.

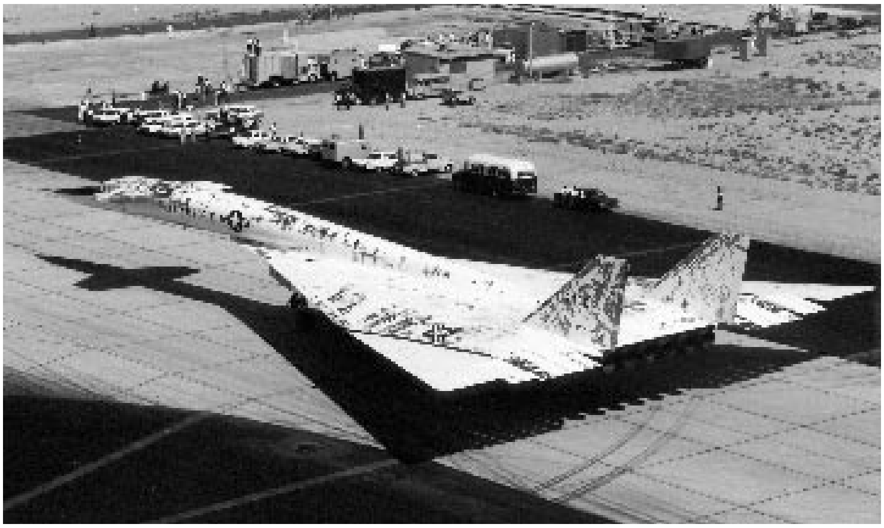
The second article, AV-2, was substantially improved with a revised hydraulic system that prevented many of the problems that had hampered the first airplane. AV-2 reached Mach 3.05 at 70,000 feet on Jan. 3, 1966.

After 30 minutes, the temperatures of the aircraft structure and systems stabilized, so that with a full fuel load, the XB-70 could have flown for 2.5 hours at Mach 3. However, there were unique problems flying the aircraft at that speed, as the altimeter and rate of climb instruments fluctuated as the aircraft sped through different atmospheric pressure fields.

Disaster Strikes

Disaster struck on June 8, 1966. With White as pilot and copilot Maj. Carl Cross making his first flight, the second XB-70 rendezvoused at 20,000 feet with four aircraft for a formation flight. The flight was arranged to photograph five military airplanes powered by General Electric engines.

The Valkyrie led the formation with a Lockheed F-104N piloted by NASA's Joe Walker on its right wing. To the right and to the rear of Walker was an F-5A. Off the XB-70's left wing was an F-4B Phantom II, and a



T-38A Talon, flown by Capt. Peter C. Hoag, was to the left and rear of the Phantom. Cotton, who had flown so many flights with White, was in the back seat of the Talon.

The formation moved up to 25,000 feet, flying a racetrack pattern between Mojave and Barstow, Calif. The photographers asked for the formation to close up several times, to obtain better photos.

With the photography completed, the formation was flying east when, aboard the Valkyrie, White and Cross heard a thump and the cry "Mid-air, mid-air" came across the radio.

The T-tail of Walker's F-104 had contacted the drooped XB-70 wingtip. The F-104 pitched up, then rolled out of control, passing inverted along the XB-70's wing. The collision sheared off part of the bomber's right vertical stabilizer and most of the left stabilizer.

Walker was killed almost instantly, and his F-104 plunged in flames to the desert floor.

The XB-70 continued to fly straight and level for 16 seconds, then began to roll. White attempted to correct, but the XB-70 was mortally wounded and yawed violently to the right. The veteran White, with more than 60 flights in the XB-70 under his belt, fought to control the airplane with power, but it rolled, breaking up. Cotton, helpless in the backseat of the Talon, yelled, "Bail out!"

The XB-70 featured an advanced escape system in which the pilots were individually encapsulated before ejecting.

White's arm was trapped in the encapsulation process, but he eventually managed to eject. His chute opened, but he slammed into the ground with tremendous force, estimated at 44 times the force of gravity. The collapse of the capsule structure absorbed enough of the force for him to survive, terribly bruised, but without any broken bones.

Cross was apparently unable to actuate the encapsulation procedure successfully, in part due to the forces from the spinning aircraft and in part because a mechanical component failed. He crashed to his death with the aircraft.

AV-1 resumed flying that November and completed 34 more flights, most of them with NASA. The aircraft was delivered to Wright-Patterson AFB, Ohio, in 1969 for installation in the National Museum of the US Air Force. The final flight brought the total flying time for XB-70 aircraft to 252 hours and 38 minutes.

The XB-70A program cost the Air Force $1.48 billion. No military systems, such as bombsights or electronic countermeasures, were ever carried.

Nonetheless, the aircraft bestowed a technical legacy on a number of disciplines. The program advanced the large-scale use of exotic metals, such as titanium, in aircraft, and it demonstrated the need for en-route atmospheric predictions for long-range supersonic aircraft. The XB-70 also demonstrated sustained Mach 3 flight without the benefit of modern digital flight-control and engine management computers.

The Valkyrie was a glorious experiment, redolent of a time when funds were plentiful, horizons were broad, and adventure was in the air. The B-52 it was to replace remains in service to this day, and the Air Force did not field another new heavy bomber until the B-1B entered service in 1986. ■

AFFTC History Office photos via Dennis R. Jenkins

The XB-70 went supersonic on its third flight, peeling away much of its paint in the process (top). When the No. 2 Valkyrie flew for in-flight publicity photos, the F-104 (in photo, with red tail) collided with the bomber, causing both aircraft to crash.

Walter J. Boyne, former director of the National Air and Space Museum in Washington, D.C., is a retired Air Force colonel and author. He has written more than 400 articles about aviation topics and 40 books, the most recent of which is Roaring Thunder. *His most recent article for* Air Force *Magazine, "The Rise and Fall of Donald Douglas," appeared in the March issue.*