Virginia Aviation History Project

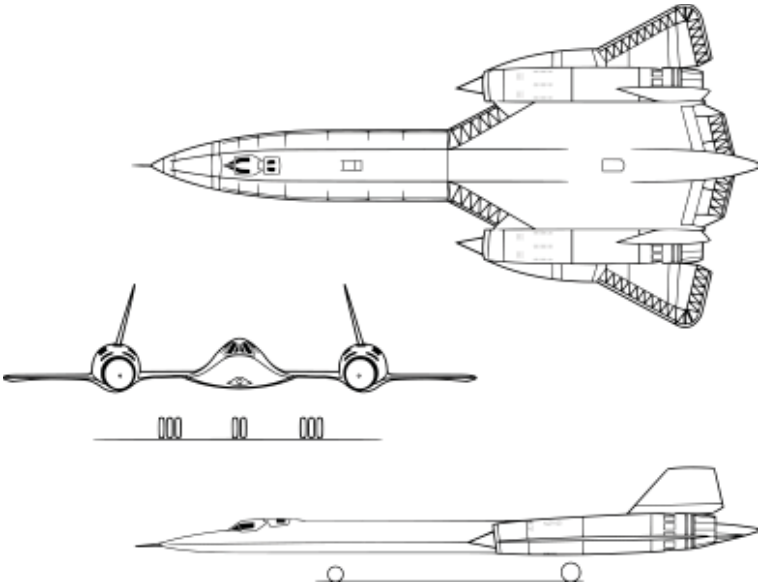
Blackbird Singing in the Dead of Night

There are few aircraft that the average person will recognize immediately – the Wright Flyer, a Boeing 747, perhaps the SST. But one of the most iconic aircraft, one that even children recognize, is the Blackbird, Lockheed's SR-71. One of these eerily beautiful aircraft sits in front of the Virginia Aviation Museum and is an outstanding calling card for the facility. How many people give directions to the Museum as "turn onto the road to the Richmond Airport and look for the spy plane"? Yet many people are unaware of the very interesting history of this airplane.

SR-71 flying across the snow-covered southern Sierra Nevada Mountains of California after being refueled by an Air Force tanker during a 1994 flight. This picture shows the corrugation on the wings and the angle of the vertical fins.

Most assume that the Blackbird was a very recent development and would be surprised to find that the program was actually begun in March of 1954. At this time the Central Intelligence Agency was heavily utilizing the U-2 for Cold War intelligence gathering missions over the USSR and its satellite countries. The U-2 provided amazing capabilities for the U.S. but there was some overall concern about its continued success. The advanced sensor systems under development were considerably heavier than earlier models and led many within the CIA to question whether the days of the U-2 direct over flights were waning.

At the same time, unknown to the CIA, the Summers Gyroscope Company in Santa Monica, California, was developing an unsolicited proposal to be submitted to U.S. Air Force's Air Research and Development Command calling for the development of a three-stage propeller-turbine-powered aircraft that would utilize liquid hydrogen and liquid oxygen for fuel. In October 1955 ARDC acquired the rights to the Summers Company's propulsion concepts and contracted the Garrett Corporation to study the systems involved.



Air Force drawing of the SR-71.

Realizing that one major component of the use of these propulsion systems was the aircraft design, Garrett subcontracted to Lockheed-California Company to do a study to develop an airframe design making use of the liquid hydrogen plants. Their proposed design, known as the CL-325-1, had a thin, straight wing and a very slim fuselage and was to be propelled by two Rex III Liquid Hydrogen power plants generating 4,500 lbs thrust each. The CL-325-1 had a span of almost 80 feet, a length of 153 ft 4 inches, a gross take-off weight of 45,705 lbs, and was expected to cruise at Mach 2.25 at 100,000 feet over a range of 3,500 miles. The company continued to refine the design over the next couple of years, but by mid-1957 the Air Force's interest in the program had waned because they concluded that the development of the liquid hydrogen power plants would be more difficult than earlier thought.

However Lockheed, with the renowned Clarence L. "Kelly" Johnson as the director of the Advanced Development Projects office, refused to give up and continued to develop additional advanced hydrogen fueled designs. Among these was the CL-400. This aircraft was even larger than the earlier design with a wingspan of almost 84 feet, a length of almost 165 feet, and a gross take-off weight of about 70,000 lb. Its dedicated reconnaissance platform offered a cruising speed of Mach 2.5 over a range of approximately 2,500 miles. Lockheed took these designs to the Air Force and managed to secure a contract for the development and construction of two prototype CI-400's under the ultra-secret Suntan liquid-hydrogen-fueled airplane program, which apparently was funded in part by the Central Intelligence Agency.

SR-71 cockpit, showing flight instrumentation. This Blackbird is located at Evergreen Aviation Museum, Arizona.

Although the contract allowed eighteen months for the completion of the first two aircraft and construction progressed rapidly, Kelly Johnson began to develop serious doubts about using liquid hydrogen as an aircraft fuel. Finally in October 1957,

he recommended to the USAF that the program be cancelled and replaced by one of the more conventional designs for propulsion.

This pushed the whole project toward the joint CIA/Air Force program code named Oxcart. As mentioned before, the CIA was considering a replacement for the U-2 and solicited proposals from various companies for a new reconnaissance platform. Three companies complied. In addition to Lockheed's design (sans the liquid hydrogen propulsion), General Dynamics submitted plans for a Mach 6 two-seat, ramjet-powered aircraft called Fish and Kingfish and the Navy submitted plans for a radical inflatable rubber machine that was balloon-launched and ramjet powered. The General Dynamics design promised the better performance, but was admittedly such a new and drastic design that it also carried the greatest risk of failure. The contract went to Lockheed, based on the risk factor as well as Lockheed's prior work on the U-2 and the CL-400 line.

And so the development of the new plane began in 1959 and the first of the aircraft were delivered in December 1961. Called the A-12, the aircraft were the first Mach 3 cruise-capable aircraft in the world. The first airplane was delivered by truck and trailer to the Air Force's Groom Lake flight test facility and reassembled in a hangar there. The first official flight was successfully completed by Lockheed test pilot Lou Schalk on 16 April 1962. Even though the designs called for the airplane to be powered by two Pratt & Whitney J58's, the initial flight testing was done with the less powerful J75's. After seven months of testing the airplane with the J75's, one J58 was installed in the starboard nacelle and after successful testing, the second J58 was installed and the final product was tested. The J58's were unique because they were a hybrid jet engine. The engines operated as turbojets at low speeds but at high speeds could transition to a ramjet engine.

NASA 844, an SR-71A flown by NASA's Ames-Dryden Flight research Facility (later, Dryden Flight Research Center), Edwards, California, cruises over the Tehachapi Mountains during a September 1992 flight. The aircraft is one of two SR-71As initially loaned to NASA by the Air Force for use as high-speed, high-altitude testbeds for research in such areas as aerodynamics, propulsion, structures, thermal protection materials, and instrumentation. Data from the SR-71 research program could aid designers of future supersonic-hypersonic aircraft and propulsion systems.

Keeping in mind that this was a rather revolutionary design for the time, it is not surprising that the first two years of flight testing and operational evaluation resulted in some major issues. The team had to address issues with the engine/intake interface at the higher Mach numbers, unique construction materials, fuels, lubricants, sensor systems, structure, landing gear, and finally, the crew environment, especially considering the physical aspects of flight involving extreme altitudes, speed, and extended flight time. The rigors of flight at such extremes definitely took its toll on the crew who were required to wear astronaut-type flight suits to withstand such high altitude flight.

Meanwhile, the CIA accepted the first 10 aircraft in late 1962. However these were one-seat aircraft, like most of the predecessors. The CIA then requested an additional five aircraft, designated YF-12A, which included some advanced sensors and even provision for Hughes GAR-9 air-to-air missiles in three of four fuselage bays, but the main difference was that this new aircraft was a two-seater. The two-seat version made its first flight from the Groom Lake facility on 7 August 1963.

Crew of the SR-71 beside the airplane and wearing the space suits required for survival in the extreme conditions under which they fly.

As would be expected for the CIA's premier spy plane, no information on the program had been released publicly and remained very sensitive both politically and commercially. That changed, however, on February 29, 1964, when President Lyndon B. Johnson announced the existence of the program during a special news conference. The aircraft was unfortunately referred to as an A-11, and the pictures released were actually of the original prototype being used for testing at Groom Lake. The Air Force intended for the aircraft to be called the RS-71, following in the footsteps of the proposed RS-70 reconnaissance version of the B-70 bomber. However, four months later, on 24 July 1964, when President Johnson revealed that Lockheed was developing an even more advanced version of the "A-11", he misread his notes and announced the existence of the "SR-71". Well, when the President names it, that's the end of it and it has been the SR-71 ever since. However whatever the President called it, the name that has stuck is the Blackbird, based on the specialized heat absorbing and radar dissipating color scheme of the planes.

The Air Force and CIA continued to use the A-12's until June, 1968, but the first SR-71's entered the inventory on January 7, 1966, at Beale Air Force Base, California. The first unit to receive the SR-71 was the 4200th Strategic Reconnaissance Wing, which was later reorganized into the 9th Strategic Reconnaissance Wing. The redesigned plane was bigger, heavier, and had a larger interior that its predecessors. As a result, it offered more range and a greater payload and the space for a second crew member was adequate to accommodate a Reconnaissance Systems Officer (RSO) who had the mission of operating and maintaining the array of electronic and optical sensors and passive and active electronic warfare systems. This airplane became the ultimate tool for the CIA throughout the Cold War, providing reconnaissance of enemy facilities of the Western Bloc. The aircraft routinely achieved flight speeds in excess of Mach 3 and altitudes well over 70,000 feet. At the time of its inception, the SR-71 was the world's fastest conventionally-powered aircraft. From the time it achieved full operational status in 1966 to retirement, a total of 32 aircraft were produced and only 12 were lost, all from accidents, none from combat. The missions flown by these aircraft increased from approximately one per week in 1968 to one sortie per day in 1972. We may never know the number or extent of the missions nor the intelligence gathered by these incredible aircraft and their intrepid crews. The SR-71 was officially retired in 1989, but two SR-71's were activated out of retirement in the middle of the 1990's with the whole series once again seeing full retirement in April of 1998.

And the aircraft itself? Well, the Blackbird is truly one of the most technologically advanced aircraft ever built. Both its construction and systems were unique for its time. The primary construction material, Beta B-120, makes up 93 percent of the total weight. This titanium alloy developed in a joint effort by Lockheed and the Titanium Metals Corporation provides the aircraft with a tensile strength of up to 200,000 lb and an incredibly high structural integrity in high heat-sink situations. By the cubic inch, B-120 weighs half as much as stainless steel yet provides similar strength characteristics. The fuselage core consists of a tubular center with blended chines running the full length of the tube from nose to the wing's leading edge.

With the airplane boasting such remarkable ranges, one would expect fairly large fuel tanks and one would be correct. Approximately two-thirds of the fuselage and half of the wing space available is devoted to the 84,180 lb, 12,200 gallon, fuel tanks. The fuel, Shell Oil Company JP-7 serves as a heat sink for the entire aircraft, including providing the cooling for the crew members' space-man like suits. The fuel must be monitored constantly and redistributed automatically to account for CG and dynamic load requirements. Despite its sleek appearance, the Blackbird is not stressed for high-g maneuvers, having limits of -1 and +3.5 g's. Nitrogen is used to pressurize the fuel tanks and to prevent inadvertent vapor ignition. The in-flight refueling receptacle is mounted on top of the fuselage, behind the rear cockpit.

Close-up of the SR-71 from the refueling tanker.

The fuselage cants upward about 2 degrees from the center to reduce time drag at high Mach speeds. The tail cone is fairly long and has a fuel dump tube at the apex of the tail cone.

The wing is a cantilever design of basically delta planform, with a modified bi-convex section. Construction is of the multi-spar fail-safe type, with the spaces in between being used for fuel storage. The leading edge of the wing has an angle of over 52 degrees and the training edge forward sweep angle is approximately 10 degrees, with a conical camber developed over thousands of hours in wind tunnel testing. The Blackbird's are often subjected to large temperature fluctuations and extremes, so heat-generated expansion and contraction are a major concern. To combat this, the leading edges have a unique design and much of the surface of the wing is corrugated to assist in the displacement of such stresses. Conventional hydraulic elevons serve as the only pitch and roll control surfaces and allow 35 degrees of up travel and 20 degrees of down travel. (Note: Elevons are aircraft control surfaces that combine the functions of the elevator and the aileron, hence the name.)

The engine nacelles are integral to the wing and are supported by conventional ring-type carry-through structures. The outer wings and out half of each engine nacelle are hinged and fold upward for access to the engines. Mounted on top of each nacelle is a large vertical tail fin which can travel 20 degrees to left or right. These are canted inward about 15 degrees to take advantage of the chine vortex in such a way that the directional stability improves as the angle of attack increases.

The landing gear is tricycle type, but still unorthodox. There are two three-wheel main units and a conventional steerable two-wheel nose gear. Here again, heat is a main factor in the design of the aircraft. The main unit tires are inflated with nitrogen gas to minimize expansion and prevent fires and impregnated with powdered aluminum to improve their heat reflectivity. These tires retract inward toward the fuselage into specially cooled gear wells. These main wheels are also equipped with an anti-skid system and there is a mammoth drag chute which, when needed, deploys from a large compartment on the top side of the fuselage empennage.

Records:

The SR-71 record-setting trend actually began with the A-12. Once the existence of the A-12 was made public, the Air Force decided to use them to set a series of speed and altitude records. On May 1, 1965, records were set for sustained altitude of 80,258 feet; and speed records of 15/25 km closed circuit at 2,070 mph; 500 km closed circuit at 1,643 mph, and 1,000 km closed circuit at 1,688 mph. But these records were later eclipsed by the SR-71. On April 26, 1971, Major Thomas Estes and Major Dewain Vick flew a non-stop 15,000 mile mission in 10.5 hours for a new endurance record and were awarded the 1971 Harmon and Mackey Trophy (this airplane is the one on display in front of the Virginia Air Museum.) In 1974, a number of records were established by the SR-71. On July 27, 1974, the record for height in sustained horizontal flight was established at 85,069 ft; speed in a straight line at 2,193 mph, and speed over a closed 1,000 km closed circuit at 2,092 mph. On September 1, 1976, a non-stop flight from New York to London was flown in 1 hour 55 minutes 42 seconds and on September 13, 1976, a non-stop flight from London to Los Angeles (5,645 miles) was made in 3 hours 47 minutes 39 seconds at an average speed of 1,487 mph.

The SR-71 Blackbird is a remarkable aircraft. The Virginia Aviation Museum is deservedly proud to have one on display. Only 32 were produced and, at best, 20 of those survived use by the Air Force and CIA. One of those 20 is on display at VAM. Take the time to view and study this very significant piece of history – both aviation history and U.S. political and strategic history.

Sources:
Burbank's Blackbirds by Jay Miller, Air International Magazine, February 1985
http://www.militaryfactory.com/aircraft/
Wikipedia, Lockheed SR-71 Blackbird
photos courtesy of Wikimedia

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