SR-71 Blackbird: A Fast History

Code One

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Steps Toward The Blackbird

Two of the leading figures in the U-2 program, the CIA's Richard Bissell and Lockheed designer Kelly Johnson, had as early as 1955 decided to explore a follow-on reconnaissance aircraft that would seek to remedy the U-2's unexpected flaw—its easy tracking by Soviet radar. Multiple studies led to the conclusion that the best design to overfly the Soviet Union with impunity was a Mach 3, 90,000-foot-altitude aircraft with what would come to be called stealth characteristics.

Thus, the two most effective and longest-lived reconnaissance aircraft, both produced by Skunk Works, would be aerodynamically antithetical. The U-2 was a lightly built subsonic aircraft, essentially a jet-powered sailplane. The new aircraft, which after many transformations would become the A-12 (and in a more sophisticated version, the SR-71), was a large, heavy, immensely strong aircraft designed to cruise in afterburner at three times the speed of sound for hours on end.

Johnson led his team through a long series of possible configurations that ranged from a slender paper-airplane-like arrow shape to configurations that looked much like the Convair B-58 Hustler.

Johnson's small project team slowly elucidated the formula for success, working from one design to the next, sometimes going back to incorporate features from an older design into a new one. This was done in classic style, mostly with slide rules and with every drawing requiring an engineer's hand on the drafting board. Mercifully, at the time no one realized how painfully slow the process was.

On 24 July 1964, US President Lyndon B. Johnson publicly announced the existence of the classified Lockheed SR-71 program. The first flight of the SR-71 would come on 22 December 1964. Operational aircraft deliveries began in 1966. Throughout its career, the SR-71, unofficially, universally known as Blackbird, remained the world's fastest and highest-flying operational aircraft.

Internal Lockheed tests hinted at what would be fully exploited in the future—wedge shapes had the effect of deflecting radar waves and reducing the radar signature.

Ben Rich, who would later be in charge of the design team for the F-117 Nighthawk, led a small six-man engineering team that included no aircraft designers through the endless iterations to arrive at the final configuration. They worked on a door stretched between two desks, laying out the information that was derived from the intensive wind-tunnel tests.

From the data, the shape of the A-12 was derived. The long fuselage was given chines to obtain lift. To reduce the radar cross section, the engines were located in their mid-wing position, so that the shock wave at the design cruise speed of Mach 3.2 would just miss the inlets, and the outboard section of the wings were given a conical camber to relive pressure. When they showed the proposed shape to Johnson he said, “That’s it—you’ve got it.”

Johnson appointed Dick Boehme as program manager, although it was a task he himself relished and never really relinquished. Richard Bissell and John Parangosky represented the CIA while Brig. Gen. Leo Geary acted for the Air Force, Bissell established an evaluation team headed by Dr. E. M. Land (of Polaroid fame) to monitor the program, which had received the code name Gusto.

It soon became evident that radar technology had remained far in advance of radar countermeasure technology. It was deemed impossible to create an aircraft that would be invisible—or almost so—to radar, and the design requirements were changed to recognize this. On 28 August, Johnson was informed that Lockheed’s latest design, the A-12, had been accepted, with the proviso that work be intensified to reduce the radar signature.

The A-12 was a radical aircraft, with two large Pratt & Whitney J58 engines mid-mounted on the modified delta wing. Distinctive all-moving vertical tail surfaces were placed above the engine nacelles and canted inward. It was to be able to fly at Mach 3.2 at altitudes approaching 100,000 feet over a range of 3,800 miles. The most unusual element of the design was the elongated nose with its speedboat-like chines that gave it the appearance of a hooded cobra.

It was mutually agreed that the Skunk Works approach would prevail, and that the security measures that had worked so well for the U-2 were to be made even more stringent. Johnson set the first flight date just twenty months in the future. Project Gusto was terminated; the new project was code-named Oxcart. Lockheed was granted a contract to build five A-12s for $96.6 million over the next twenty-four months.

Mountains To Climb

Few aircraft have so captured the imagination of the world as the Lockheed Blackbird, as the A-12/SR-71 series became known. The mystery surrounding its creation and employment, its starkly beautiful sculptural shape, and its absolute dominance in aircraft performance for more than thirty years give the Blackbird a place unique in history as both an instrument of technology and as a cultural icon.

The scope of the design problem was summarized in a July 1969 paper presented by Johnson to the American Institute of Aeronautics and Astronautics, detailing the problems and solutions of the YF-12A aircraft from his perspective. (The YF-12A was a proposed interceptor version of the A-12, which was first flown 7 August 1963. It was similar in most respects to the A-12.) His remarks give some dimension to the challenge he accepted, and to his remarkable optimism in promising to meet that challenge with the delivery of a flyable aircraft in twenty months.

The powerplants were initially left to Pratt & Whitney, for whom Johnson expressed the greatest admiration; later, his own team, led by Rich, would have to intervene. The engine would ultimately become one of the most sophisticated in the world, packaged in by far the most sophisticated nacelle.

In his paper, Johnson noted that the structural engineers were concerned about the anticipated high temperatures, ranging from 1,050 degrees Fahrenheit in the nacelle to 585 degrees at the nose and as low as 470 degrees at the tail. These had to be endured for a prolonged duration. This led to a decision to use unconventional titanium alloys in a structure that had to be open for equipment installation, inspection, and maintenance.

Heat-resistant titanium was as strong as stainless steel, at approximately fifty percent of its weight. About ninety-three percent of the structural weight of the aircraft was titanium alloy, which had an ultimate strength of up to 200,000 pounds per square inch in later models. (The remaining seven percent of structural weight was composed of radar absorbent material, or RAM, to reduce the radar cross section.) Ultimately, composite materials instead of titanium were used for the vertical fins, the first use of such materials for a major aircraft component.

Lockheed had experimented with titanium over the years. The goal was to obtain a high strength-to-weight ratio at very low cost—which proved impossible. In small applications, the difficulties inherent in using titanium were tractable; on a 100,000-pound airframe, there were almost insuperable difficulties in forging, welding, riveting, or even drilling the material. Titanium was scarce and costly, and eighty percent of the initial deliveries of Beta B-120 titanium alloy from the manufacturer were rejected for contamination. It was not until supplier officials were made aware of the intended use of the material that quality problems were solved.

Rich, reaching back to his university courses, recalled that black paint could be a heat emitter as well as a heat absorber. A few quick calculations showed that using a softer alloy of titanium and painting it black would greatly reduce internal temperatures. Even though it ran counter to Johnson's fanatical obsession for reducing weight, the sixty pounds of paint required could reduce internal temperatures by as much as 86 degrees Fahrenheit. The paint had an additional advantage, for it contained tiny iron microspheres that dissipated electromagnetic radiation.

Temperature was a vital consideration in many other aspects of the design. At ordinary ground temperatures, the surface of the wing had corrugated ridges running chord-wise (fore and aft); in flight, thermal expansion caused the aircraft to expand, the skin with it, stretching out the corrugated ridges into a relatively smooth surface.

Standard readily procurable equipment such as electronic gear (particularly wires, plugs, and transducers) was not designed for sustained high temperatures. There were no hydraulic fluids or pumps that could operate at 600 degrees Fahrenheit continuously. Grease that could sustain high temperatures had the characteristics of concrete at ordinary temperatures. Special heat exchangers had to be devised to reduce 1,300-degree-Fahrenheit bleed air from the engines down to a moderate 30 degrees Fahrenheit to cool the cockpit. No escape devices—parachute, drag chute, or ejector seat—had been designed that could take the range of temperatures that would be developed in the course of a flight.

To counteract the inevitable thermal expansion and contraction of control-cable runs, they were made out of the same material used in watch springs. The cockpit and the camera system had to be fitted with quartz glass panels that would provide clear vision in spite of the immense heat. Even parts such as radomes, antennae, and access plates had to be redesigned to use new material and new construction techniques. One curious result of the extreme cycle of temperatures during the course of every flight was the annealing of the titanium, which made the Blackbird's outer skin stronger and stronger.

One of the most daunting aspects of the high-temperature flight regime was that there was no fuel available that could take the continuous high temperatures without clogging the engine fuel system. The A-12 carried 85,000 pounds of fuel in five non-insulated wing and fuselage tanks, where in-flight temperatures would reach about 350 degrees, in part because fuel was used as a heat stink.

The fuel, which was sometimes to be off-loaded from a KC-135 tanker at an ambient temperature of 60 degrees below 0 Fahrenheit and then injected into the engines at high pressure and a temperature of 350 degrees Fahrenheit, was developed jointly by Ashland, Shell, Monsanto, and Pratt & Whitney. Called JP-7, it was a safe, high-flashpoint fuel that would not vaporize or blow up under the tremendous heat and pressure to which it would be subjected. It also contained chemicals that enhanced stealth characteristics by reducing the shock diamonds that formed in the exhaust at speed. Tankers had to be dedicated to carrying JP-7 fuel, which ultimately had to be stocked in special fuel farms around the world.

The low volatility of the JP7 was such that a lighted match would be extinguished if dropped into it. This was fortunate, as the Blackbird leaked fuel on the ground through the structural gaps necessary to accommodate the thermal expansion of the metal at high speeds. When the metal expanded, the leaks stopped.

One side effect of a fuel tailored to the A-12/SR-71 requirements was that it was difficult to ignite at low temperatures and high altitudes by means of conventional ignition systems. Instead, a chemical ignition system using flash-sensitive triethylborane, commonly referred to as TEB, was installed in case a restart was required either on the ground or in the air.

Rich's team created what he called a "smart fuel" system in which sensors placed in the tanks and fuel lines continuously sensed the fuel temperature, always routing the warmest fuel to the engine intakes while routing the coolest back into the tanks for warming. Fuel was also used to maintain the center of gravity, being pumped fore or aft as required to trim for changes in speed. The high temperatures had equally grave implications for the fuel pumps, the fuel lines, and the fuel-purging system.

Johnson summarized the situation by remarking that "everything on the aircraft, from rivets and fluids up through materials and power plants, had to be invented from scratch." By the time the last Blackbird had rolled out (at a cost of about $17 million each), the Advanced Development Projects team manufactured 13,000,000 separate titanium parts. Although the Skunk works detested paperwork, the use of titanium on such a scale required that everything be recorded about each batch of material, from the mill pour right down to the direction of the grain of the metal in the sheet from which the part was made.

In a brilliant confirmation of the adage "Less is more," the number of design engineers in the Advanced Development Projects was considerably less than two hundred at the peak of the design effort.

Engine Issues

Similar small teams were used at Pratt & Whitney, whose chief designer, William Brown, worked well with Rich and his people. The original J58 produced 26,000 pounds of thrust using an afterburner, and was theoretically capable of propelling an attack plane at Mach 3 for a few seconds on a bomb run. By the time it had gone through the almost total revision required for incorporation in the Blackbird, the J58 was putting out 32,500 pounds of thrust. The analogy most preferred by Lockheed engineers was that the engines produced as much thrust as the four huge turbines of the Queen Mary ocean liner.

The Blackbird required afterburners that were required to operate for extended periods, gulping 8,000 gallons of fuel per hour at speeds over Mach 3 on a continuous basis at altitudes up to 100,000 feet.

The extraordinary performance required of the J58 necessitated so many extensive changes to the basic engine that it was not ready on schedule. The revision of the J58 involved the creation of what became known as a bleed bypass engine. The bleed bypass design, while complicated in both mechanical and electronic terms, avoided a number of major problems encountered at high Mach cruising speeds, including induced compressor stall, stress to the compressor blades as a result of the stall, unacceptably high temperatures, reduced thrust, and increased fuel consumption.

The overall security requirements for the A-12 were so great that it was considered impossible to conduct flight operations out of Edwards AFB, California, where most Air Force experimental flight tests were conducted. Ten bases that had been slated for closing were considered as alternates, but none proved to be acceptable. Some of the basing requirements were almost contradictory. The base had to be secure and well away from civil and military airways. Yet it had to be easily accessible by air. Good weather year round was an imperative, as was an 8,000-foot runway. The base had to accommodate large numbers of personnel and have fuel facilities both for the Blackbird and for the conventional aircraft to support it.

The solution was to return to the secret Nevada base built for testing the U-2 and upgrade it to accommodate the new aircraft.

Almost simultaneously, a program began for selecting personnel required to support and operate the A-12s. Pilot selection was rigorous. Candidates had to be between twenty-five and forty years of age, less than six feet tall, and less than 175 pounds. They had to be married, emotionally stable, and extremely well motivated. They had to have recent experience in high-performance aircraft and be experts in aerial refueling. Equally high standards were set for all other personnel, from the commanding officer to the ground crewmen.

First Flight

While all the multitudinous related tasks were being dealt with, production difficulties continued to frustrate Johnson, his Skunk Works team, and more importantly, the Air Force and the CIA. The planned production schedule began to slip, and Johnson told the CIA that Lockheed’s difficulties with wing assembly and Pratt & Whitney’s problems with the engines would result in a delay of three or four months in the schedule. He promptly received a rocket back from Bissell: "This news is extremely shocking on top of our previous slippage from May to August and my understanding as of our meeting 19 December that the titanium extrusion problems were essentially overcome. I trust this is the last of such disappointments short of a severe earthquake in Burbank."

Such caustic comments from the usually unflappable Bissell indicated how important the A-12 was in CIA planning. The contemporary Soviet policy of expansion by encouraging revolutions in countries around the world had to be monitored and contained, and the A-12 was essential to that process.

The difficulties continued, particularly at Pratt & Whitney, where delays became so extreme that Johnson decided to adapt the A-12 to the J75 engine for preliminary test purposes. This was time-consuming and expensive in a program in which costs were already soaring, but it was a sensible fallback position.

The prototype A-12 was disassembled and moved by road to its test site in a caravan of trucks and a special trailer, arriving on 28 February 1962. There it was assembled, only to give immediate disappointment; the fuel-tank sealant had failed to adhere to the titanium, and the aircraft poured fuel on the ground. Repairs took more than a month.

It was not until 25 April that test pilot Lou Schalk was to undertake high-speed taxi rests, with a planned momentary liftoff followed by an immediate landing on the runway. The taxi tests went off well. But as soon as Schalk lifted off, the aircraft wallowed erratically, oscillating laterally, longitudinally, and directionally.

With total disaster only milliseconds away, it took all of Schalk's skills to establish control, chop the throttles, and land in a huge cloud of dust on the lakebed, well off the runway. The low hop had reached no more than twenty feet in the air and touched down in little over a mile. The trouble turned out to be an improper fuel loading, which put the center of gravity too far aft. On subsequent flight tests, the airplane flew very well. This incredible lapse in oversight was the sort of inexplicable error that drives engineers and pilots crazy, but nevertheless lurks like a great white shark around every program.

The "official" first flight for CIA and USAF representatives took place on 30 April 1962, and went off smoothly. Eight days later, Schalk took the A-12 supersonic for the first time.

The next five A-12s arrived by December 1962, and the tests were accelerated. These aircraft were all equipped with the J75 engines, including the fourth aircraft, a two-seater intended for training and nicknamed Titanium Goose. While other aircraft were subsequently retrofitted with J58 engines, the Goose retained the J75s throughout its service.

Experience Builds

The A-12's potential for growth was obvious, and both fighter-interceptor and bomber versions were studied. The fighter version featured an advanced Hughes radar system, a full complement of missiles, and a fire-control system. Three YF-12s would be built. The bomber remained a paper design—it was a budgetary threat to the Air Force's ill-fated B-70.

It is not surprising that with such a radically advanced aircraft, the testing process was fraught with incidents. Of the fifteen A-12s and three YF-12s that were built, five A-12s and two YF-12s were lost in accidents, a daunting thirty-nine percent loss rate. Two test pilots were killed.

That Johnson was able to prevail was a tribute not only to him, but also to his superiors, Hall Hibbard, Dan Haughton, and Robert and Courtlandt Gross. They recognized the great financial risk involved, but they allowed him to proceed, confident in his ability to ultimately deliver the aircraft that the country needed, and willing to risk huge sums to back that confidence.

On 27 October 1962, Maj. Rudolph Anderson's U-2 was shot down by an SA-2 missile over Cuba. The tragic incident added urgency to the A-12's flight test program, and the Blackbird's performance envelope was pushed closer to the design requirements. Mach 3 had been reached by July 1963, and the design speed of Mach 3.2 was reached in November.

The existence of the aircraft was publically revealed for the first time on 29 February 1964. President Lyndon Johnson had been the target of claims by Republicans that he was neglecting defense issues, and he responded by announcing the existence of the "A-11, which has been tested in sustained flights at more than 2,000 miles per hour and at altitudes in excess of 70,000 feet." Johnson went on to describe what was actually the YF-12; his use of "A-11" has variously been described as an astute security measure or a simple misunderstanding of Kelly Johnson's inputs.

First Notice Of The RS/SR-71

Less than five months later, President Johnson would make an announcement concerning the next version of the Blackbird, which was at the time designated RS (reconnaissance-strike)-71 by the Air Force. In his talk, he referred to it as the SR-71. The designation was quickly adopted and SR came to stand for "strategic reconnaissance." (Rich recalled that the president's slip of the tongue required Lockheed to make changes on 33,000 drawings.)

The Air Force had chaffed at having to relinquish its traditional strategic reconnaissance role to the CIA in the A-12 program. It had not stinted on its assistance to the CIA, and had supported the Oxcart program fully. But the fact remained that the Air Force wished to have strategic reconnaissance within the province of the Strategic Air Command.

Lockheed was eager to respond. On 18 February, the Air Force authorized Lockheed to proceed to build six aircraft, with a contract for twenty-five more to follow. The program received the code name Senior Crown.

Other major related programs, such as Senior Bowl, involved the design, construction, and test of thirty-eight D-21 drone vehicles for unmanned strategic reconnaissance. The drone was intended to overfly territory that was too dangerous or too sensitive for overflight by the piloted A-12s.

Tests proved the air-launch process to be too hazardous. On 20 July 1966, off Point Mugu, California, a D-21 hit its launching aircraft immediately after its release at Mach 3.25. As might be expected, the modified A-12 (called an M-21) broke up. Both M-21 crew members ejected, the launch control officer, Ray Torick, drowned when his pressure suit filled with water.

Johnson immediately decided that the launch technique was too hazardous to continue and recommended that it be stopped. The D-21 was subsequently modified for launch by two specially equipped B-52H bombers. At least four operational missions were flown; none was successful.

In the midst of these myriad efforts, Johnson was solving problems ranging from selecting engineers to getting SR-71 ready for flight. In all of these programs, Johnson had to be able to maintain secrecy, yet share key information.

Senior Crown made perfect sense to the Air Force, but created a red flag to those analyzing defense budgets. They could not understand why the CIA operated an A-12 fleet and the Air Force operated an SR-71 fleet, each fleet with virtually identical missions.

The principal difference in the two aircraft was a pressurized cockpit for a second crewman in the SR-71. The SR-71 fuselage was stretched and equipment was rearranged to optimize the use of space and to accommodate the second crew member and 2,434 gallons of additional fuel.

All the hard lessons learned in the A-12 program paid dividends as the SR-71 construction progressed smoothly, with Bob Gilliland making the first flight of the aircraft on 22 December 1964. The aircraft performed well, presaging a bright future in the Strategic Air Command.

Blackbirds Into Action

The performance of the YF-12s improved rapidly. By 1 May 1965, the Air Force was willing to attempt to set a number of international records. Two YF-12As were employed in the attempts, and the results amazed the world. In short order, the YF-12As established an absolute altitude record of 80,258 feet, and three speed records including the 15/25-kilometer closed-course record of 2,070.102 mph.

Despite the records, serious concerns remained about the performance of the J58 engine.

With the A-12, airflow into the engine was modulated by a Hamilton Standard hydromechanical spike. The spike was programmed to move a total distance of twenty-six inches fore or aft as required. It operated in concert with a series of bypass doors, bleed ports, suck-in doors, tertiary doors, and ejector flaps to customize the flow of air through the engine and keep its volume constant as speed progressed from engine start to Mach 3.2.

Once through the engine, the air had to be accelerated again to the same speed at which the aircraft was traveling, by means of the ejector system and the afterburners. The process of adjustment took an immense amount of test time before the proper synchronization of inlet-spike movement and engine-door opening and closing sequences was effected.

In the meantime, the pilots had to contend with the hazard of a mismatch between the inlet spike and the engine's requirement for airflow. A mismatch would cause an "unstart," a violent disruption of the normal inlet shock wave. The aircraft tended to swing its nose sharply to the disturbed engine; this phenomenon was later countered by the Digital Automatic Flight and Inlet Control System. During early tests, the pilot would have to manually open the bypass doors and reset the spike to get the air flowing smoothly again. These troubles were most often encountered in the Mach 2.4 to 2.8 speed range (not where you wish to induce violent movement of the aircraft).

Rich, who was responsible for intake design, decided that the fault lay with the Hamilton Standard spike, the movable cone used to match the shock wave with the inlet. He obtained an electrically powered actuator for the spike from the Garrett Corporation, and the problems were solved overnight. When all the airflow devices were finally fine-tuned, the aircraft gained in thrust and reduced drag, so that speed went up and fuel consumption went down.

Rich's innovations and other improvements in the aircraft's performance made it possible to declare it operational in November 1965. (Ironically, that same month, the Bureau of the Budget fired its first shots. Accountants could tell precisely how much the two programs cost, but had no idea of the value of the information generated by Blackbird overflights.)

Urgent requirements soon appeared. The CIA called for the employment of the A-12 over China. Shortly thereafter the Department of Defense sought it for reconnaissance over North Vietnam. Plans were drawn up for an operation called Black Shield that called for A-12s to operate out of Kadena AB on Okinawa on a temporary basis at first, followed by a permanent deployment. The Oxcart detachment would be named the 1129th Special Activities Squadron, and given the nickname "Road Runners."

By 1966, the A-12 had reached relative maturity and was meeting most of its specified requirements. Its sister ship, the YF-12, was demonstrating its ability to fire missiles at the speed of Mach 3.2 and bring down QB-47 drone aircraft.

Yet no steps were taken to deploy the aircraft, because Secretary of Defense Robert McNamara denied permission. He was increasingly committed to fighting a ground war in Southeast Asia, and refused to make use of air power to its fullest extent because he did not wish to antagonize China. In his judgment, the use of A-12 was somehow more risky than the continued use of the U-2. In consequence, the funding for the A-12 was reduced. As the perceived threat of Soviet bombers had diminished, the YF-12 program was canceled.

Yet even McNamara could not ignore the continuing buildup of North Vietnamese capability. By May 1967, the surface-to air defenses around Hanoi had reached a point at which a U-2 would almost certainly be shot down, and an agreement was reached to use the A-12 over North Vietnam. The first mission was flown out of Kadena on 31 May. In a three-hour and thirty-nine-minute flight, photos were obtained of more than one-third of North Vietnam's 190 surface-to-air missile sites. Six more missions were flown by 15 August.

The Blackbird performed well over Vietnam and North Korea. Communist opposition increased, and missiles were launched on several occasions. Only one A-12 sustained damage, picking up one piece of shrapnel on a 30 October 1967 sortie over North Vietnam. The aircraft was used over North Korea in the aftermath of the seizure of the USS Pueblo (AGER-2) on 2 January 1968.

The last operational flight of the A-12 came on 8 May 1968, a mission over North Korea. The Black Shield unit was brought back to the US and remaining Oxcart aircraft were stored in a hangar for more than two decades before seven of them were finally given to museums and an Air National Guard unit for display. One YF-12 was converted to the lone SR-71C trainer, one was given to the Air Force Museum, and one crashed.

Under the cooperative hands of the CIA, the Air Force, and Lockheed, the A-12 became an incredibly capable weapon system. Politics inhibited its use and grounded it prematurely.

The Air Force And The SR-71

The question immediately rises as to why the Air Force simply did not take the A-12 into service, instead of opting for the SR-71. The answer is the Air Force requirement, which called for an aircraft with greater range, larger payload, and the need for a Reconnaissance Systems Officer, or RSO, to obtain the maximum yield from the aircraft's equipment.

The first operational SR-71 was a trainer version known as the SR-71B, which was delivered to Beale AFB, California, on 7 January 1966. The SR-71B had an elevated second cockpit for an instructor pilot.

The production of the SR-71 was difficult because of the high turnover of the workforce. The learning curve did not drop as forecasted. Yet by December 1967, all thirty-one of the SR-71s had been delivered to the 9th Strategic Reconnaissance Wing at Beale. Two squadrons, the 1st and the 99th, whose histories go back to operations with General Pershing's 1913 efforts against Mexico, operated the Blackbirds. The first operational mission came on 21 March 1968.

Unlike the CIA's somewhat tentative use of the A-12, SAC began employing the Sled (as the SR-71 was called by its pilots) extensively. By the end of 1969, the newest Blackbird had flown more than one hundred operational missions.

The Vietnam War made exceptional demands upon the SR-71. It was also used intensively from its base at RAF Mildenhall in the United Kingdom. Missions included surveillance of the Middle East, including Libya, Lebanon, and Yemen. Special assistance was rendered to Israel during the Yom Kippur War. In Southeast Asia, many flights from Kadena were made over North Vietnam, where the cameras could return photos of cargo on the decks and in the holds of ships in the harbor. While a typical flight over North Korea lasted only seven minutes, hundreds of much longer surveillance flights were conducted over China.

The usefulness of the SR-71 went beyond the military to the diplomatic tables. During the Yom Kippur War, Henry Kissinger asked that the SR-71 make reconnaissance flights over the battle area. Under US pressure, Israeli premier Gold Meir had said that her troops had halted. To her embarrassment, Kissinger was able to lay two Blackbird photos in front of her, taken on successive days, which showed the advance was continuing.

Everything thus conspired to make the SR-71 legendary almost instantly. It was top secret; it flew higher, faster, and farther than any aircraft in history; and it covered enemy territory with impunity, apparently invulnerable to surface-to-air missile attacks, and certainly unapproachable even by interceptors as advanced as the Soviet MiG-25. As sophisticated as it was, it flew from relatively primitive forward operating locations, bases without the usual infrastructure, without difficulty.

Yet the SR-71 was expensive to operate. By 1989, budget concerns and a shift in Air Force leadership spelled the end of the program. The aircraft was officially retired on 26 January 1990, to much official and unofficial disapproval. It had served well.

The SR-71s logged a combined total of 53,490 hours of flight time, of which 11,675 had been spent at Mach 3 plus. They had flown 3,551 operational sorties for a total of 17,294 hours, during which more than a thousand surface-to-air missiles had been fired at them. All missed. Twelve SR-71s were lost, but only one crewman was killed, a tribute to the ejection seats and life support systems.

When the Air Force retired the SR-71 in 1990, a decision was made to give one example to the National Air and Space Museum. The aircraft set a new transcontinental speed record, traversing 2,404 statute miles in just sixty-seven minutes, fifty-four seconds.

Besides its combat capability, the Blackbird was also an excellent research aircraft. NASA operated both YF-12 and SR-71 aircraft for experimental work, having obtained two SR-71As and an SR-71B trainer as supersonic test platforms. NASA's use of the SR-71 sustained it operationally until the Congress provided the Air Force $100 million in the fiscal year 1995 defense budget to bring three SR-71s back to operational use.

The first of three reactivated SR-71s returned to the Air Force after extensive refurbishment on 28 June 1995 as Detachment 2 at Edwards AFB, California. The aircraft were being modified with datalinks when the Air Force program was defunded in October 1997. The last flight of an SR-71 (NASA Serial Number 844) occurred on 9 October 1999 at the Edwards AFB Airshow.