

# SR 71/72

Nakul Joshi

## Abstract

Beautiful and fast, the Lockheed SR-71 “Blackbird” aircraft was amongst the most successful reconnaissance aircraft ever built. A marvel of engineering, it fulfilled its military role perfectly: it flew too high to be detected by radar and could not be shot down simply because it was faster than any missile in the sky. Retired for political reasons in 1998, it continues to hold the record for fastest manned air-breathing craft. Recently, Lockheed announced the development of the Blackbird’s successor, the unmanned SR-72 “Aurora”. This paper examines the various innovations that made possible the unique capabilities of the Blackbird, and takes a glimpse at the possibilities offered by the Mach 6+ Aurora.

## Index Terms

lockheed, skunk works, sr, blackbird, aurora

## I. INTRODUCTION

**T**HE need for a high-speed stealth recon aircraft was recognised by the CIA in 1960, after the downing of a U2 aircraft over Soviet airspace. The U2 was thought to be safe from enemy radar at its 20km altitude, but the relatively slow craft was intercepted by Soviet planes near the Ural mountains [3], causing an escalation of tensions during the Cold War. The CIA then commissioned the design and construction of a plane that could fly faster and higher than the U2, while still being able to take high-quality photographs over enemy terrain.

### A. Description

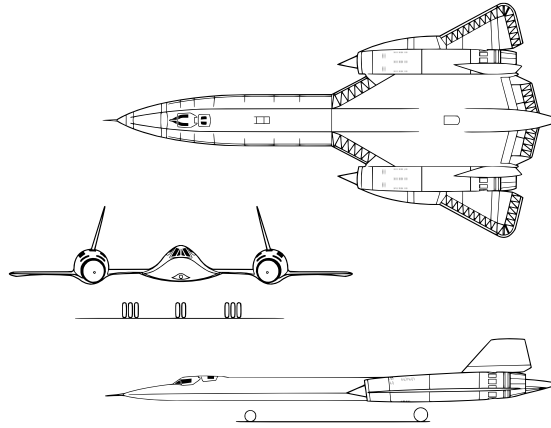


Fig. 1: Views of the SR-71A

Three versions of the craft were built: the main production variant was designated as SR-71A while the trainer variant was named the SR-71B. A third variant, built from the remains of a YF-12A craft, was designated SR-71C. The unique shape of the craft was specifically designed to minimize radar cross-section. It had a length of 32.74 m and a wingspan of 16.94 m. It was capable of flying 5,400 km at up to Mach 3.3 (3,540 km/h), at a cruising altitude of 24,000 m.

## B. Operational History

The contract for the Blackbird was awarded to Skunk Works, a division of Lockheed that had already completed advanced and top secret projects such as the A-12. Test flights commenced in 1964, while the first SR-71 entered service in 1966. A total of 32 SR-71s were built: 29 SR-71As, 2 SR-71Bs, and the one SR-71C. The craft were used for surveillance over such hostile territories as Vietnam, China and North Korea. Flights over the Soviet Union had technically been banned since the 1960 U2 incident, but the Blackbird's high cruising altitude allowed it to gather data without entering Soviet airspace. It was extremely successful; none were shot down or otherwise lost to the enemy. By 1990, the Blackbirds had clocked more than 11,000 mission flight hours over some 3,500 missions, spending about 2,750 mission flight hours at Mach 3 speeds [1].

However, the perceived expenses of operating the craft, along with the lack of support for the project from Air Force officials, led to the halting of the SR-71 program in 1989, with six units left in storage and ready to be enabled within sixty days if necessary. This allowed the program to be reactivated by Congress in 1993, when political tensions had begun growing in the Middle East as well as North Korea. The reactivation was met by resistance from the Air Force, however, and the project was stopped for good in 1998, with two units being given to NASA for a year and the rest being sent to museums around the United States.

## II. ENGINEERING

The SR-71 was far ahead of its time. To put this into perspective, one only has to observe that its first flight was three years before the introduction of the world's first pocket calculator in 1967. Consequently, it had to be designed by hand, with a slide rule and graph paper. Its cutting-edge performance characteristics stand as a testament to the genius and meticulousness of the engineers at Lockheed. In this section, we discuss some of the innovations that went into the SR-71.

### A. Engines

The Blackbird's engines are perhaps the single most impressive feature of the craft. Its twin Pratt & Whitney J58-P4 powerplants delivered a total thrust of 300 kilonewtons [2] to the craft, sufficient to power a small cruise ship. The engines had to be specially configured to counter several issues that were unique to the Blackbird: they had to generate enormous power in the low-oxygen environment of 80,000 feet, all the while contending with the extreme heat generated both by the engines themselves as well as atmospheric resistance.

In a more conventional engine operation, moving air has to be slowed down and compressed to high pressures before it can be used to ignite fuel. This is typically done with a turbojet, whose spinning blades compress the air and forward it to a turbine where it is combusted. To fly faster, more air must be compressed into the turbine, which burns the fuel hotter, thus limiting the speed of the plane to the temperature that the engine can withstand. However, the numerous moving parts of a conventional turbojet cannot withstand the temperatures needed to achieve Mach 3 speeds.

Addressing the limiting factor of temperature called for an ingenious hybrid design: the J58 had a turbojet *inside* a non-moving ramjet engine. The turbojet engine operated at subsonic speeds (see Figure 2a), actively sucking in air to ignite fuel.

As the craft accelerated, the turbojets ceased to operate: at high speeds, air began entering the engines so fast that air had to be kept out rather than sucked in. The spikes began retracting, routing air around the turbojet and into the ramjet engine (see Figure 2b). Ramjets need no moving parts, since the speed of the aircraft is itself sufficient to compress the air. This allows them to withstand the high temperatures more easily. One unexpected upshot of this design was that the plane became more fuel-efficient the faster it went, achieving peak efficiency at Mach 3.2. Pilots were limited to this speed for fear of damaging the plane, but former pilot Shul fondly recalls that "the jet would always give you a little more speed if you wanted it to" [4].

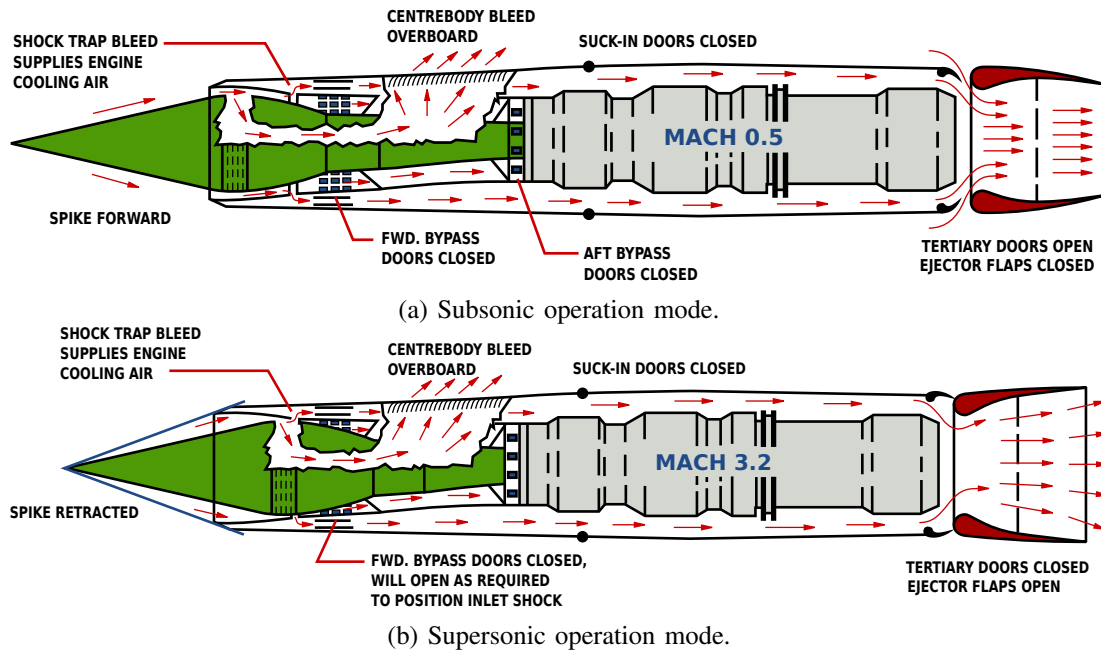


Fig. 2: Engine airflow diagrams.

### B. Stealth

As a reconnaissance vehicle, the Blackbird had to evade sight and radar. The plane was coated in radar

### C. Hull

### D. Navigation

### E. Life Support

## III. CONCLUSION

### REFERENCES

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