Skunk Works: A Personal Memoir of My Years at Lockheed Study Guide

Skunk Works: A Personal Memoir of My Years at Lockheed by Ben Rich

BOOKRAGS

Contents

Plot Summary

Skunk Works is a personal memoir written by the chief engineer of Lockheed's Skunk Works, Ben Rich. The book tells of his first experiences at Lockheed during the 1950s at the height of the Cold War. It ranges all the way past the First Gulf War, and describes the many, varied events that occurred and projects that were undertaken at Lockheed's aerospace development wing, The Skunk Works. The first four chapters recount the building of the first stealth bomber. These chapters are used to introduce us to the main cast of characters, which include various co-workers, pilots and government employees, particularly with the Air Force and CIA. We are also introduced to the second main character, Kelly Johnson, the chief of Skunk Works prior to Ben Rich and Ben's boss for decades. Chapter Five starts over, returning to Ben's first days with the company back in the early-1950s.

Throughout Chapters 5 through 8, he explains the odd inside joke that gave the Skunk Works its name, along with the entire story of the conception, construction and operation of the famed U-2 spy plane. It covers the political aspects of the plane, particularly the role it played in American foreign policy during the Cold War. Chapters 9 through 12 explain the conception, construction and operation of the Blackbird, the famous jet that could exceed Mach 2 and could spy and launch missiles from 80,000 feet. The next three chapters cover the stillborn project of a stealth submarine, the departure of Kelly Johnson from Skunk Works, and the two billion dollar boondoggle of a new line of stealth bombers. During this time, the authors have a variety of 'other voices' contribute to the story, including co-workers, pilots and even a few secretaries of defense.

Further, Rich covers many of the technical details and challenges that the Skunk Works team faced overcoming engineering problems, along with the more straightforward difficulties with funding and politics. He litters the story with personal details, sometimes discussing pilots who were injured, captured or killed. He also tells part of his own personal story, including the death of his wife and his second marriage. He even delves into the life of his boss, Kelly Johnson, with whom he eventually became very close, following years of being intimidated by him.

The book concludes with some frank thoughts from Rich about the nature of the aerospace industry, the challenges it currently faces and the challenges it will face in the future. He uses his experiences in the book to make certain recommendations about how to run the industry in the future. The Skunk Works was a very successful and innovative business model. Rich explains how the operation was such a success and how to copy and spread the model to continue to keep the United States at the forefront of military power.

Chapter 1, A Promising Start

Chapter 1, A Promising Start Summary and Analysis

The chapter opens with a dialogue in August 1979 in the Nevada desert. The Lockheed Skunk Words has built the world's first 'pure' stealth fighter; it is supposed to evade even the best radar. The main character - then chief Ben Rich - is hoping that the test flight will be a success. The plane was tested under very high security, so even many at the test grounds don't know how the plane works; they do not know that the very shape of the plane is supposed reflect the radar beams. The radar operator does not pick up the plane. The test is a success.

The chapter then transitions to the beginning of the project of acquiring the bid to build a stealth fighter and the process of constructing it. The project began in January, 1975. Rich works in Lockheed's "Skunk Works" which during the Cold War was a very secret, very high importance location for constructing weaponry (often thought to be targeted by the Soviets). The chief of the Skunk Works, Kelly Johnson, has just retired. He first joined Lockheed in 1933 and had a very powerful and charismatic personality along with great engineering skill. During most of the Skunk Works' history, few Americans knew it existed despite its producing some of the United States' most important offensive aircraft. Now that the Cold War is over (when the book is being written), many of these secrets can be revealed.

Rich is Johnson's vice-president and has been picked as his successor. Many people had only known Kelly Johnson as their boss for decades, so Rich has big shoes to fill. Rich develops a different, more collaborative, more hands-off style of management. His job is also difficult because Lockheed was at that time facing some scandals surrounding embezzlement and bankruptcy threats. Rich was under pressure to acquire new contracts from the military but he does not have the political clout of his predecessor. He knew that the Skunk Works had many political and business enemies; Rich travels to Washington to convince the Air Force Chief of Staff, General David Johns, to order a new line of U-2 spy planes. However, there were various cost considerations. Rich lands the order but it takes years before it goes to production.

During this time, one of the Skunk Works' mathematicians and radar specialists, Denys Overholser, discovers a paper by an old Soviet scientist, Pyotr Ufimtsev, which illustrated how to reflect radar beams with a certain combination of angles and materials. The engineer realizes that they can use the paper to construct a stealth fighter, which was at the time in great need due to the anti-missile systems the Soviets were constructing. Luckily, US intelligence was powerful enough at that time to give them good enough information about Soviet weaponry to help them adapt effectively. Some, like Johnson, oppose investing in new planes and believe it is better to focus on missile development, but Rich has a hunch about this project. Some in the government want to build a stealth fighter, but Lockheed would have to fight for the contract and is allowed into the competition.

Chapter 2, Engines by GE, Body by Houdini

Chapter 2, Engines by GE, Body by Houdini Summary and Analysis

Kelly Johnson is skeptical of the new project. In fact, many of Skunk Works' senior staff are skeptical. Rich feels questioned and undermined. They called the stealth plane "The Hopeless Diamond" or "a flying engagement ring." They also questioned the competence of the younger scientist who discovered the idea, Denys. But so far, the computer models worked well. Johnson and Rich had often bet over technical questions; Rich usually lost but he won over the success of the test materials at reflecting radar signals. In early-1976, the Skunk Works won the contract along with Northrop. The program would now be called Have Blue. They designed a craft and estimated its costs. There were rumors going around that the Skunk Works had falsified their experimental data. Eventually, however, most accepted the data and the project was classified top secret, which brought many restrictions and extra costs to the project.

They were assigned high-level security. They faced a deadline to produce two test planes in fourteen months, which the security restrictions slowed down. They scrambled to find parts and began building. There were details of the new plane that were hard to work out, such as building the flat planes that would reflect radar properly. They were also delayed by contract negotiations with the machinists union. They continued to pursue their traditional operating procedures, but many of these procedures had been broken. Yet they finished assembling Have Blue. It moved to the test flight stage.

The chapter transitions into a description of the test flight event. Previous test flights had been running smoothly. Bill Park, the test pilot, seems to have things under control. Have Blue takes off, but there are some problems. Bill has to bail out, and suffers some minor injuries but the test flight is a success; it passes the radar tests.

Chapter 3, The Silver Bullet

Chapter 3, The Silver Bullet Summary and Analysis

Rich has an energetic and upbeat style of management and is learning the ropes. The Air Force awards them the stealth contract without a successful test flight; this was unusual, since funds were often tight. Carter's chief of the National Security Council, Zbigniew Brzezinski, came to visit the Skunk Works. Rich impresses him and tells him to explain to President Carter that the stealth project can render the USSR's investments in radar a complete waste. They are commissioned to build a small stealth fighter, known as the Silver Bullet. It was top secret and aimed to make quick-hits against heavily defended targets, late at night. Building the planes was an ideal project for Skunk Works. The Carter administration expanded spending, and while they had some trouble with project development, things pushed forward. Bureaucratic red tape increased, as did the regulatory authorities that would inspect the Skunk Works regularly. They signed the contract in November 1978 and had until July 1980 to build the first airplane and "get it right."

Economic conditions were driving inflation through the roof and oil prices were skyrocketing. This significantly increased prices for their materials. The election of 1980 is raging and Reagan is bashing Carter for not having an extensive defense budget. While Skunk Works did fine under Carter, they were flooded with funds and employees under Reagan. They often had trouble finding reliable additional workers, and many of these workers were lazy, poorly-skilled and prone to complaints, some of which would sometimes threatened the Skunk Works with trouble. Despite all of these troubles, the plane is still being built.

At this time, Ben Rich's wife Faye comes down with lung cancer and has a lung removed. She begins to recover but dies in August. Her death destroys Rich emotionally; all he can do is throw himself into his work. The stealth fighter helps him cope but also impresses the Air Force staff. They bought fifty-nine silver bullets, and the Skunk Works could deliver because they had perfected their manufacturing techniques.

Chapter 4, Swatting at Mosquitoes

Chapter 4, Swatting at Mosquitoes Summary and Analysis

Chapter 4 introduces us to Major Al Whitley, a top fighter pilot who supervised the building of the F-117A, the famous stealth fighter. Al and his crew watched the F-117A in assembly and learned all of its parts. Assemblage went well and Rich was surprised that they didn't have more trouble. They continued to have trouble with inexperienced workers, but the stealth fighter came on line a year later. Later, a suggestion is made to automate the F-117A's flight path to maneuver and test without a human pilot.

The Defense Department reveals the stealth fighter in 1988. Numerous fighters are built and their first real-world test is during the First Gulf War. Stealth fighters were to make first strike in Baghdad in early-1991. Shockingly, no stealth fighters were lost during the bombardment. The stealth fighters were shown on television and impressed the public due to their accuracy, speed and ability to precision-bomb in a way that avoided taking prisoners and hurt civilizations. Public morale stayed high. They did run into problems eventually, however. The stealth fighters were being flown long hours, something for which they were not equipped. The fighters also ran out of bombs. Luckily, the war drew to a close before this became too much of an issue.

Chapter 5, How We Skunks Got Our Name

Chapter 5, How We Skunks Got Our Name Summary and Analysis

The book turns back the clock to Ben Rich's first day at Skunk Works, in 1954. Rich was twenty-nine, a thermodynamicist who specialized in solving heat problems and designing inlet and exhaust ducts in airplane engines. He began his work building the F-104 Starfighter, the US's first supersonic jet. All Lockheed projects were of this great magnitude. Working with Kelly Johnson was intimidating, due to his personality and skill but Rich was happy to work under Johnson rather than at the main Lockheed facility, where he was before. Initially, he only expected to work with Skunk Works for a few weeks.

Ben Rich was raised in the '30s and '40s by his father, Isidore, and mother, Annie. Isidore ran a hardware lumber mill and Annie was a talented linguist. Isidore was a stern man, more so than Johnson (this was how Rich handled Johnson). Rich grew up in the Philippines, a member of one of the first Jewish families to settle on the islands. During World War II, Isidore and Ben worked in a machine shop in LA. At this time Ben became fascinated with engineering. Ben went to UCLA and a professor of his told him about a Lockheed job. Ben was hired and eventually Kelly needed to borrow a thermodynamicist for a secret project. Ben was recommended.

The Skunk Works got its name from a L'il Abner comic, where "Injun Joe" tossed his old shoes and a dead skunk into a vat. The cartoonist, Al Capp, named this still, "the skonk works." One day, a Skunk Works employee picked up the phone and answered, "Skonk Works." Kelly fired the man (although he came back the next day) but everyone already referred to this part of the Lockheed production facilities the Skonk Works but Capp's publisher complained when he heard that they were using the term, so they called the place the Skunk Works.

Skunk Works had very high standards from its inception. Kelly would have no less. They built a variety of important jets. Kelly was chief engineer at this time under CEO Robert Gross, who had purchased Lockheed out of bankruptcy in 1932. Throughout Kelly's tenure, he solved a wide range of important engineering problems. He ran the Skunk Works according to strict rules, which Ben followed.

Ben is asked to stay on and he is then introduced to the U-2 spy plane.

Chapter 6, Picture Postcards for Ike

Chapter 6, Picture Postcards for Ike Summary and Analysis

This chapter takes place during the 50s, and tells the story of Ben Rich's work on the U-2 Spy Plane. Rich was shocked by how secretive the plane was; he couldn't even talk to his wife about it. He found that the entire project revolved around Kelly Johnson. The goal of the U-2 project is to take photos of Russia from undetectably high altitudes and give valuable reconnaissance information to the CIA. Rich works more hours and his wife worries about what project he is working on. At this time, East-West relations are at record low. Both the US and the USSR had tested hydrogen bombs and subtle provocations were exchanged between the two countries. This motivated Rich to work hard.

The US had tried to use weather balloons to spy on the USSR. They had some successful missions but most of the balloons were shot down. The U-2 had to fly higher, move faster and take better pictures. In fact, the most important part of the U-2 spy plane was the hatches which contained the cameras. Kelly is stressed out by the pressure and took it out on some of the engineers. He also seemed to be threatened by his most competent assistants. The stress was heightened by the presence of government officials, like the assistant to the secretary of state.

Eventually, Rich gets to see the plans, along with Kelly's assistant Tony LeVier. LeVier is in charge of finding terrain to test the plane. LeVier selects the desert between Nevada and California. The test site and airplane are ready by early July in 1955. At this time, Kelly was in a terrible car accident, but found his way back to the office in two weeks. The U-2 was still ready on time. On August 2nd, 1955, Tony LeVier test flew the U-2. While there were some complications, the test was a success. At this time, President Eisenhower was informed that they had an excellent new spy craft.

Chapter 7, Overflying Russia

Chapter 7, Overflying Russia Summary and Analysis

The U-2s are ready to fly over Russia. The planes can ascend to seventy-thousand feet in an hour. The Skunk Works engineers have some technical difficulties, such as U-2 flights burning the rubber in the plane, to give one case. However, they quickly solve them. The U-2 could fly for long periods, but it tolerated few mistakes or a distracted pilot. There is pressure on Skunk Works from the CIA to get the plane's structure right and keep production moving.

The first 'overflight' occurred on July 4th, 1956. It was a success, but the plane was tracked by unexpectedly up-to-date Soviet radar systems. Some of the first-person accounts of the U-2 pilots are printed in the chapter. The general effect of these testimonies gives one the sense that these flights were both dangerous and exhilarating.

The Soviets have developed a new missile that the US feared. The CIA wanted to lower the radar signature of the U-2 significantly through a project known as 'Rainbow.' Kelly and his staff debate over the best method; the CIA was desperate, so they did not have much time to figure out what to do. One of the U-2s finds a new nuclear reactor in Russia, a great success. The Soviets continue to successfully track the U-2s, despite Skunk Works' improvements. Kelly is frustrated and the U-2 flights may have to end. The CIA was pushing for one more flight, however. The last flight was tragic; the Soviets shot down a U-2 and captured (alive) the pilot, Francis Gary Powers. Khrushchev, then Soviet Premier, used this to humiliate Eisenhower. The U-2 spy flights had to be canceled. Sadly, many in the intelligence community and military were furious with Powers for not killing himself to avoid an international embarrassment. Despite this tragedy, the U-2 flights provided the United States with crucial intelligence.

Chapter 8, Blowing Up Burbank

Chapter 8, Blowing Up Burbank Summary and Analysis

In 1956, Kelly wants to build a hydrogen-fueled jet that can travel long distances. This project is initiated alongside the operation and production of the U-2s. He asks Ben Rich to research how to handle hydrogen fuel, and Ben obliges by taking on a fake identity and meeting with various scientists. Kelly wants a jet engine that can fly for hours at speeds that exceed Mach 2. They first run a feasibility study with Dave Robertson, another engineer. The experiments with volatile hydrogen gas were dangerous, but no one was hurt. Within three months, they are creating more hydrogen fuel than anywhere on the planet. The Air Force gives them $96 million for the project, in part because they know that the Soviets are working on a similar project.

Various engineering problems and accidents create problems, but like so many others, they are taken care of. The Pentagon continues to push Skunk Works to finish, but the Soviets pulled the rug out from under them by using hydrogen fuel to launch Sputnik I. TSkunk Works' project, however, was not a total waste as they knew now that they could produce a large supersonic airplane and engine.

During this time, Skunk Works is producing U-2s. It turns out that they continued to be used after Eisenhower officially shut them down. They were used not only for reconnaissance on the edge of the Russian border but were sometimes even used by NASA and the DEA. The Powers shoot-down made other nations uneasy about hosting the U-2s, but others were interesting in purchasing them. Since the U-2s are still in production, Skunk Works continues to improve upon their designs. However, the U-2 continued to prove dangerous to fly, as evidenced by a brief story from a (then) young U-2 pilot, Buddy Brown. The U-2s produced crucial intelligence discoveries decades after production began, even into the first Gulf War.

Chapter 9, Faster Than A Speeding Bullet

Chapter 9, Faster Than A Speeding Bullet Summary and Analysis

Chapter 9 tells the story of the Blackbird, the greatest high-performance airplane of the 20th century. The story begins with Kelly Johnson being disappointed that the hydrogen-powered airplane hadn't come to much. Kelly then came up with a bigger idea, as a way to overcome the deficiencies of the U-2. Skunk Works would build a Mach 3 airplane that could fly at this speed for long distances. Rich is made program manager for the propulsion system, a daunting task for an engineer as young as Rich. Kelly promises to deliver to the CIA within twenty months. However, it took him some time to convince Washington that the plan was feasible, and that the height of the new plane would be a great advantage.

The production of the Blackbird began with great focus, as they had few other projects. Ben had a small team to work on the new propulsion system; Washington gives Skunk Works the go-ahead with Project Oxcart. Then the privacy restrictions went up. The Blackbird's design faced enormous technical problems, the worst of which was making the plane both light enough to fly at high speeds, heat resistant enough to avoid burning up and able to carry enough fuel to fly long distances. Much of the chapter covers these technical struggles in detail. The promise of the propulsion system is that it would be the most powerful ever built. The heat must be dealt with through the use of a new alloy - Titanium. They must also find a way to reflect radar beams without adding excessively to the plane's weight. After about six months of wind tunnel testing, the airplane design appears feasible, with enough flight efficiency to make the airplane appear buildable.

Finally, Skunk Works completes a test model. They try a test flight, and as usual face initial technical difficulties; but the plane flew and it was a marvel.

Chapter 10, Getting Off the Ground

Chapter 10, Getting Off the Ground Summary and Analysis

The Blackbird was hard to control, hard to build, hard to fly and hard to sell. It was shockingly beautiful but extremely expensive. And it would break from time to time. When the Blackbird was announced to the public in the fall of 1964, many communities started to complain that the Blackbird had shattered windows across their communities; some of these complaints were genuine. Nonetheless, Kelly was an excellent salesmen in Washington. The Blackbird had changed the balance of power. Skunk Works produced a variety of 'add-ons' to increase the sales-pitch, such as ICBM launches that required little propulsion, since they were launched from high speeds. The contract for the Blackbird was solid, but the original budget had doubled.

Their main contact in Washington, Bissel and his boss, Allen Dulles, had to resign over the botched Cuban Missile Crisis, so Skunk Works found themselves in a bit of a bind to finance building the Black Bird. President Kennedy was surrounded by a variety of policy makers that wanted to cut costs in the military budget, and the Blackbird faced the ax. The Air Force Chief of Staff, General LeMay, partly blamed Kelly for the failure in Cuba, for encouraging the government to cut back its production of standard bombers. However, Kelly was eventually able to convince LeMay to buy ten Blackbirds. Secretary of State, Robert McNamara was apparently gearing up for a major showdown with the Russians. However, much to the disappointment of Skunk Works, Kennedy's advisers convinced him to cut back on their purchase order because they refused to believe that the Russians were building a similar aircraft.

Kelly fires up two tests flights to impress the government, which they used not only to demonstrate the Blackbird's speed but to show its high degree of accuracy in shooting down drones. The test flights were a great success, but the Air Force was not as moved as Kelly had hoped because McNamara decided that he wanted tactical fighter-bombers to be used in Vietnam. The Blackbird was simply too expensive, though it had acquired legendary status in communist countries.

Chapter 11, Remembering Habu

Chapter 11, Remembering Habu Summary and Analysis

The Blackbird's records were not surpassed thirty years after it was built. For building the Blackbird, Kelly received the Medal of Freedom from President Johnson. Ben also won the American Institute of Aeronautics and Astronautics Award in 1972 for designing the propulsion system.

In 1968, LBJ ordered the CIA out of the spy plane business, but the planes were still used for reconnaissance operations. The American public is still largely unaware of how many dangerous missions Blackbirds were used to complete. From North Vietnam to Cuba and northern Russia, the Blackbird could do reconnaissance and outrun any missile that followed them, by several miles at least. The chapter then transitions to tell some of the stories of those pilots who used the Blackbird during military conflicts ranging from Cold War reconnaissance, to the Korean War and the Vietnam War down into the minor international conflicts in Lebanon, etc. in the 1980s. We hear from Colonel Jim Wadkins, a pilot, Walt Rostow, LBJ's national security adviser from '66 to '68, Captain Norbert Budzinske, an Air Force RSO, Lt. Colonel Buz Carpenter, an Air Force pilot, Major Butch Sheffield, another Air Force RSO, and four others, three pilots and a Skunk Works employee. The Blackbird reconnaissance throughout the '60s, '70s, and '80s was crucial to effective operations in these areas. Many of these missions were so risky, that the president himself had to approve them. Nixon had to approve such a mission against the Russians during the Yom Kippur War in 1973 and Reagan used the Blackbirds to patrol the Polish-Soviet border in the beginning of 1982 when the Polish government cracked down on the Solidarity movement.

In 1970, the US government ordered Skunk Works to destroy all of the tooling equipment for the Blackbird, depressing the Skunk Works staff. The administration didn't want to spend the money and thought that keeping twenty blackbirds on hand would be enough to last into the 21st century. Dick Cheney, who was then defense secretary, made the call. One of the last Blackbirds was turned over to the Smithsonian Institute for display. Ed Yeilding, an Air Force pilot, flew it there and broke several world records just for fun.

Chapter 12, The China Syndrome

Chapter 12, The China Syndrome Summary and Analysis

The most dangerous and secretive project that the Blackbird was involved in started in 1962, when China broke with Moscow. The project was known as Tagboard and was intended to use the Blackbird to launch drones, unmanned spy craft, to spy over China in order to gain intelligence on any potential military plans. Working out the details of how to build the drone was difficult and selling the drone to the CIA was difficult too. The Air Force, however, was interested. Their third test-flight was a disaster. Piloted by Bill Park and Ray Torick, the drone attached to the Blackbird crashed into the Blackbird and sent it crashing down. Park had to be picked up in a life raft 150 miles at sea. Torick was not so lucky. When he crashed in the water, he opened up his helmet visor and water flooded his pressure suit. He sank and drowned. The Chinese did not discover the crash.

The project was canceled in 1971. Again, the tooling was ordered destroyed.

Chapter 13, The Ship That Never Was

Chapter 13, The Ship That Never Was Summary and Analysis

Ben comes up with an idea to build a stealth submarine. He and his staff create a design, but Kelly had a rule against working with the Navy, since they were fickle and difficult. A submarine captain complained about the submarine's shape, which angered Ben. DARPA was interested and so Ben and a colleague designed some official building plans. Skunk Works argued that investing in a stealth submarine would be ultimately cheaper than the other strategies that the armed forces were pursuing against the Soviets at sea. In 1978, Ben took his test results for the sub to Bill Perry at the pentagon. He was impressed and commissions a prototype called the Sea Shadow. Ben was pressured by economic conditions to give the project up to Ocean Division, a shipbuilding company in Northern California. Nonetheless, Sea Shadow was built, but it worked too well. The ship was so invisible to radar that it created a 'blank spot' on radar screens, devoid of reflected radio waves. It was for this reason easily tracked. By the time they solve this problem, the admirals have become uninterested. Ben now accepts the Kelly's lesson about the Navy.

Chapter 14, The Long Goodbye

Chapter 14, The Long Goodbye Summary and Analysis

The chapter opens with an executive at Northrop Aircraft Company offering Ben a job. The job would give Ben a significant raise. He felt bad about bringing it up to Kelly, who he felt loyal to due to their long association.

Kelly had taken Ben under his wing over the last six years and trained him as his successor. Ben realized, though, that Kelly's stubbornness often cost the Skunk Works good jobs, such as building fighters. Nonetheless, Kelly and Ben were close, particularly after Kelly's wife Althea died. He remarried his secretary, MaryEllen, a few months after her death on her recommendation, but she died within a few years of diabetes. Oddly, MaryEllen advised Kelly to marry her friend Nancy, which he did.

Ben finally gets up the courage to mention the offer to Kelly. Kelly thinks the offer is B.S. but offers to match Northrop's offer with a counteroffer. Ben eagerly accepts. He is now a VP along with Rus Daniell. Ben now accompanied him on trips to the Pentagon and helped him plan projects. Kelly received great respect in Washington but younger Air Force engineers, while respecting his past accomplishments, rarely listened to his suggestions for new airplane designs. Further, Kelly had many enemies in Washington. Kelly eventually retired and selects Ben as his successor, due to his younger age and energy for the job. They remain close but Kelly does not second-guess Ben's decisions. Ben decides to remarry, this time to a woman named Hilda. In 1986, Kelly broke his hip and died in the hospital four years later due to various health complications. Hilda and Ben visited him often. They brought him to the last Blackbird flight in 1990 but he only vaguely recognized what we happening. Kelly died on December 22nd, 1990 at age 80. He was "an authentic American Genius." In Ben's words, "there will never be another like him."

Chapter 15, The Two-Billion-Dollar Bomber

Chapter 15, The Two-Billion-Dollar Bomber Summary and Analysis

Kelly's memory continues to regulate Ben's actions. He keeps Kelly's rules going forward. Ben also followed Kelly's rule of only taking projects that he believed in, and Ben often gave up projects - even during hard economic times - for this reason. Early in the chapter, Ben Rich becomes outraged at a Reagan speech where he promises to build a 'hypersonic' jet, or one that can fly five times the speed of sound. Someone on Reagan's technical team messed up - it would not be possible to build such a jet for at least fifty years. The government made odd errors of this sort all the time. For instance, dealing with the Pentagon on a regular basis seemed to have no connection to merit.

This observation leads into a recounting of Skunk Works' competition with Northrop for a new stealth bomber contract. There was a great deal of political maneuvering. Skunk Works could do the job more cheaply, but Northrop needed the work to stay afloat. For either group, however, the stealth bomber project would be expensive. Skunk Works was already busy as well. The sad fact of the aerospace business is that the government runs it as a form of 'paternalistic socialism' and often takes responsibility for staffing and maintaining the aerospace workforce. And it was for this reason that Northrop was able to compete for the contract.

The project was simply too big for any one company. So Skunk Works teams up with Rockwell and Northrop with Boeing. And team-ups were tricky because one's partner could be a competitor in the future. Eventually, Skunk Works priced their stealth bomber for $200 million; Northrop's bid was much higher but they somehow still won the contract. Ben was furious. And the government made the wrong decision. Northrop dramatically increased costs, which caused Congress to reduce the number of bombers they wanted to buy. But buying fewer bombers means they cost more per unit, approximately $800 million in fact. To lose one plane, therefore, was a fiscal disaster.

To construct the planes, an incredibly complicated network of companies and sub-contractors formed, a system Ben regards as deeply inefficient. But he accepts that the 'piecemeal' manufacturing approach is probably the wave of the future.

Chapter 16, Drawing the Right Conclusions

Chapter 16, Drawing the Right Conclusions Summary and Analysis

This final chapter contains some reflections from Ben Rich on the current state of the military aircraft industry and its future. He outlines many challenges and suggests many solutions. We will cover some of them.

During Rich's forty years working at Lockheed, he worked on twenty-seven distinct aircraft. Today, most engineers would be lucky to build one. The Cold War is over and the need to constantly build new and better aircraft is no more. However, the post-Cold War era still needs the Skunk Works and Rich believes the concept of Skunk Works should be widely adopted. Heretofore, the model has not been adopted because many do not understand its structure and government managers will not grant most defense companies the necessary independence to operate as Skunk Works has. It takes a great deal of skill and courage to fight bureaucratic control.

The post-Cold War era brings some good developments - better technology and more focus on avoiding casualties; but Rich worries about the loss of the United States' skilled work force and industrial base. Further, new technology needs to be used. The aerospace industry must remain inventive and learn how to complete projects for lower costs. Costs can be reduced through smarter logistics management and maintenance, and keeping better track of the obscene waste of funds within the industry. Regulations and controls threaten to destroy the entire industry. New defense spending is needed as well and aerospace companies must commit themselves to building prototypes. Companies must avoid surrendering authority and responsibility to the government, as this usually brings disaster.

The aerospace industry must also develop new methods of protecting the country, such as dealing with nuclear proliferation, while the United States must avoid becoming militarily overextended and intervening in world affairs. New technologies should focus on unmanned fighting machines and self-propelled vehicles.

Epilogue: The View from the Top

Epilogue: The View from the Top Summary and Analysis

The epilogue is brief and contains testimonies from three secretaries of defense on the incredible contributions made by the Skunk Works during their tenures. Harold Brown (SoD from 77 - 81), Caspar Weinberger (81 - 86) and William Perry (93 - 97) all testify to the efficiency and innovativeness of the Skunk Works and the Skunk Works model. They argue that the Skunk Works has kept the United States military on the forefront of military power, and that it has done so through its integrity, commitment, teamwork and autonomy.

Characters

Ben Rich

Benjamin Robert Rich (1925 - 1995) is the main character of Skunk Works and its primary author. He follows Kelly Johnson as chief of Lockheed's Skunk Works operation; he is only the second chief. He joined the Skunk Works in 1954 and ran the operation from 1975 to 1991. Rich developed a large number of important airplanes, including the F-117, the original stealth aircraft. He was involved with the production of the U-2, F-104, SR-71 (The Blackbird), A-12 and F-22.

Rich was the son of Jewish parents who settled in the Philippines. They moved to the US in 1942 and Ben worked with his father in a machine shop, where he came to love engineering. He studied mechanical engineering at Berkeley and received an MA in thermodynamics from UCLA. He was hired to Lockheed immediately and was pivotal in designing the propulsion system for the Blackbird, for which he would later when an award. He also produced the 'inlet ducts' for the U-2. Rich's role in the story of Skunk Works is pivotal. While Kelly Johnson was its first chief operator, Rich assisted Johnson in the production of many of the Skunk Works most important operations. Further, when Rich took over he produced some of the most important aircraft of the 20th century. He possessed a non-confrontational style of management and did not run the Skunk Works as hierarchically as Johnson did. He was widely regarded as energetic, innovation, and a constant joker.

Clarence

Kelly Johnson (1910 - 1990) was the first team leader of Lockheed's Skunk Works. He was an early aircraft engineer and an incredibly famous innovator. He was pivotal in the development of over forty aircraft. He received numerous honors as a result of his work and is considered to be among the most important figures in the history of aerospace. Kelly's parents were Swedish immigrants. He was an early genius and was only thirteen when he won his first prize for designing a plane. He married his wife in 1937, Althea, who died in 1971 and had two others wives before he died (the second of which also died while he was alive).

Kelly was the father of the Lockheed L-10 Electra Airliner, and joined Lockheed in 1933. By 1938 he was the chief engineer in charge of research. He was chief of Lockheed's Burbank plant by 1956. He was the lead figure in the production of the F-104 Starfighter, the U-2 Spy Plane and the SR-71 Blackbird. Kelly retired from Lockheed in 1975 but continued to aid Ben Rich in a consulting capacity. Kelly was often known for his strict, Scandanavian style of management and followed the motto, "Be quick, be quiet and be on time." He was a private man, but far from shy. He was known as stern and stubborn. Defense officials often found him difficult to work with. He had a strong, domineering personality and a fine attention to detail along with a blunt sense of integrity. Ben Rich

finds him a constant inspiration despite finding him intimidating for decades. The two men become close towards the end of their lives.

Presidents of the United States

Presidents often had to sign off both on Skunk Works defense contracts but also the missions run by Skunk Works planes. These presidents include every major president from Eisenhower to Clinton - Eisenhower, Kennedy, Johnson, Nixon, Ford, Carter, Reagan, H. W. Bush, and Clinton.

Secretaries of Defense

Kelly and Ben often worked directly with the secretaries of defense from each president's administrations. Some of them even testify in the book to the importance of Skunk Works' contributions, including Harold Brown (SoD, 77 - 81), Caspar Weinberger (SoD, 81 - 86), and William J. Perry (SoD, 93 - 97).

Denys Overholser

Skunk Works mathematician and radar specialist who discovered the scientific work necessary to create stealth technology and created practical uses for the science he discovered.

Pyotr Ufimtsev

The Russian physicist and chief scientist at the Moscow Institute of Radio Engineering who discovered the scientific principles behind stealth technology.

Ed

Skunk Works structural engineer who designed the configuration of the U-2 spy plane.

Bill Park

Test pilot for the first stealth aircraft, Have Blue.

CIA officials

Various CIA officials were responsible not only for Skunk Works' projects but for convincing the White House of the need for these projects. They also ran various spy missions with Skunk Works' aircraft.

Air Force officials

The wing of the military that Skunk Works worked with most frequently was the Air Force. Various Air Force officials fill the book.

Air Force Pilots

The Air Force often supplied its top pilots not only to test Skunk Works' craft but to use them in reconnaissance missions.

Dick Boehme

One of Kelly's early assistants.

Faye

Ben Rich's first wife who died of lung cancer.

Francis Gary Powers

A U-2 pilot who was shot down and captured by the Russians, causing international embarrassment for President Eisenhower.

Althea

Kelly's first wife, who died of cancer after a long struggle.

Mary Ellen

Kelly's second wife and his former secretary, who Althea encouraged him to marry since she thought he needed someone to take care of him. She dies a few years after their marriage.

Nancy Horrigan

Kelly's third wife and Mary Ellen's best friend. Mary Ellen encouraged Kelly to marry Nancy on her death bed.

Rus Daniell

Kelly's vice-president, around Kelly's age, who was thought to be his successor. Kelly selected Rich instead.

Hilda

Ben's second wife, an antique store owner.

Objects/Places

Burbank

Burbank, California was the location of the Skunk Works.

The Skunk Works

The massive research and construction facility where most of the book's major events take place.

Lockheed

The aerospace company which operates the Skunk Works.

P-80

The United States' first jet fighter, constructed by the Skunk Works.

F-104 Starfighter

The United States' first supersonic jet, created by the Skunkworks.

U-2 Spyplane

The famous spy plane that could take photographs from extremely high altitudes. They were famous for their use by the Eisenhower administration during the Cold War for overflights of the USSR. It was designed by the Skunk Works.

SR-71 Blackbird

The fastest airplane in history, the SR-71 could travel at Mach 3 for extended periods of time. It was invaluable for Cold War reconnaissance and could not be touched by any of the United States' enemies defenses. It was designed by the Skunk Works.

F117-A

The stealth tactical fighter used in Desert storm, designed by the Skunk Works.

The SR-71's Propulsion System

Ben Rich designed the famous propulsion system of the SR-71, for which he won a prestigious award.

The U-2 Spy Plane's Inlets

The parts of the U-2 spy plane that contained the cameras it used to take photographs, which Ben Rich designed.

Washington D.C.

The location of the Pentagon and the United States' defense establishment generally. Kelly and Ben made many trips their to sell their aircraft.

The USSR

The communist enemy of the United States during the Cold War. The Skunk Works designed many of the aircraft used to fight against the USSR in other countries and the aircraft used to do reconnaissance over the Russian territory.

Vietnam

The small Southeast Asian country where the United States fought a war in the 1960s and 1970s against the North Vietnamese communists and their Soviet and Chinese allies. Skunk Works' aircraft were used in the the Vietnam War.

Korea

The east Asian country where the United States fought a war in the 1950s against the North Korean communists and their Soviet and Chinese allies. Skunk Works' aircraft were used in the Korean War.

Themes

The Skunk Works Model is a Success

Throughout Skunk Works, Ben Rich is concerned to explain the structure of the Skunk Works' operation. The Skunk Works had relative autonomy from the Lockheed management and from the various arms of the defense establishment. The team could develop their own ideas and market them with little supervision from the state. The leadership built trust with the leaders of the defense establishment in order to preserve their autonomy. They maintained a level of integrity by taking pride in their work and refusing to bend to pressure. Further, Kelly ran the group according to a clear set of principles that were explicitly delineated, along with promoting teamwork. He often assigned different aspects of an aircraft design to particular small teams of individuals. These teams formed a deep cohesion, which allowed them to be extraordinarily productive.

The Skunk Works also sought out top-notch talent consistently throughout its operation and fought to retain them. A key feature of the Skunk Works' success was its ability to innovate, which was in turn made possible by its teamwork, excellent talent and sense of personal pride. This is illustrated throughout the first fifteen chapters in part to lead up to the final chapter, Chapter 16, where Ben Rich makes an effort to promote the Skunk Works model of aerospace production. He defends its merits mentioned above throughout the chapter and argues that the Skunk Works model should be the central model for the aerospace industry.

Keeping One Step Ahead of the Competition

One of the major driving forces of the plot is competition. The Skunk Works had to compete against the other major aerospace firms, particularly - at one point - with Northrop. In Chapter 15, Lockheed competes with Northrop for a defense contract to build a new stealth bomber. Typically, Lockheed's Skunk Works stayed competitive through building innovative craft for reasonable costs and maintained a high degree of business integrity. In this case, however, Northrop appears to have secured the contract despite their higher costs due to the fact that they were in business trouble and the government took responsibility for the operation of many of the major aerospace firms.

Perhaps the major form of competition throughout most of the book, however, is the race between the Skunk Works and their Russian/Communist equivalents. For instance, when the Skunk Works designed the first stealth craft, they did so because they knew that the Soviets had radar technology that the United States had given them after World War II. They were surprised to learn that the Soviets had updated their radar systems, which made their job more difficult. The U-2 spy plane faced similar difficulties, because the Soviets had the technology to track them and shoot them down. The Skunk Works greatest triumph over the Soviets was the Blackbird, which the Soviets simply could not

stop. The job of the Skunk Works was to stay one step ahead of the competition, and the Skunk Works was consistently able to help the United States stay ahead of the Soviet Union.

The Unique Challenges of the Aerospace Industry

The Skunk Works story is full of challenges, not only internal technical and financial problems with Skunk Works' projects but with dealing with the federal military-industrial bureaucracy. The aerospace industry faces several unique challenges: first, the projects it takes on are extraordinary expensive. They involve huge feats of innovations, completely new designs and enormous amounts of capital costs. Further, acquiring the necessary funding is not accomplished through the market but instead is drawn from a single source - the federal government. As a result, landing defense contracts is not only a matter of making a good case financially for giving Skunk Works' the contract but arguing that the project is in the interests of the United States' people. Furthermore, Skunk Works must develop relationships with particular defense officials in order to convince Congress and the President of the United States to fund their projects.

For instance, during the operation of the U-2 Spy Plane, Skunk Works not only had to constantly solve new technical challenges but had to work with the CIA to convince President Eisenhower that the U-2 reconnaissance missions were extremely valuable and worth the risk of international embarrassment. When the Soviets shot down Francis Powers and captured him, Eisenhower was humiliated in front of the international community, which led to the end of U-2 missions over the Soviet Union. In this way, the aerospace industry faces challenges the many other industries do not.

Style

Perspective

The perspective of Skunk Works is multi-faceted. First, the book is written entirely in the first-person, no matter who is speaking. The main narrator is Ben Rich, assistant to Kelly Johnson and ultimately the chief of operations of Lockheed's Skunk Works. Nearly the entirety of the story is told from his perspective. We read his story of how he came to work at the Skunk Works, his perspective on the major projects they worked on, and his impression of all the major characters. Further, we are more or less only introduced to his thought processes. We rarely get a peak into the 'inner lives' of the other characters. Rich's perspective is energetic, upbeat and eager to tell his story. However, he is also rather opinionated. He seems to be politically indifferent between Democrats and Republicans so long as they support Skunk Works' projects and do not interfere. He prefers to work with reasonable government officials and in Chapter 16 we are treated to his complicated views about how to keep the United States at the forefront of military power.

However, the book is littered with other perspectives. We are often treated to small excerpts of perspectives from other figures in the story. For instance, the pilots who first fly the major aircraft built in the book are usually given a page or two to give their perspective on the plane, the flight, the Skunk Works and the major characters. We also often hear from individuals of quite high rank, such as generals and secretaries of defense. Each has his own story to tell, but overall they give quite high praise to the Skunk Works.

Tone

The tone of the book is largely set by Ben Rich. He is a naturally optimistic person in an extremely dangerous time (the Cold War). So the tone is a mixture between the excitement Ben feels solving technical problems and producing beautiful war craft on the one hand and the urgency of staying one step ahead of the Soviets and their allies on the other. For instance, one of Ben's first projects is to work on the U-2 Spy Plane. Solving the technical problems involved in designing and producing the craft were challenging but Ben was excited by being able to work on such a secret project and being able to put his skills to the test. However, when the U-2 was used, it created deep political tensions. When the Soviets discovered the U-2s they attempted to shoot them down. At one point, they shoot down a U-2 and capture one of its pilots, bringing great embarrassment to the Eisenhower Administration. This was met with disappointment among the Skunk Works staff and spelled the end of producing new U-2s (for the most part). However, just when Rich seems down, he moves quickly to the next project and the next set of fascinating technical problems that must be solved. Even the death of Ben's own wife gets relatively little attention; he does not describe his grief, and only mentions her death casually; the same goes for his second marriage. The saddest point

in the book seems to be the slow, agonizing death of Kelly. Still, all in all the tone is one of wonder, excitement and the drama of being on the inside of the Cold War.

Structure

The structure of the book is not chronological, strictly speaking. The first four chapters introduce the reader to Ben, Kelly and the other characters by telling the story of building the first stealth bomber. However, these events occur in the mid-1970s, while the book covers the four decades Ben Rich worked for the Skunk Works, from the early 50s to the early 90s. At Chapter 5 we are returned to Rich's early days at Lockheed and then as a member of the Skunk Works team. The fifth chapter explains how the Skunk Works got its name. The next several chapters cover the conception, construction and operation of the U-2 spy plane, and the next few that follow that cover the conception, construction and operation of the Blackbird. We are given the story of these two craft from beginning to end, along with the F-117 Stealth Bomber. The technical details of conception and desire are discussed, as are all the political and financial issues associated with construction. Further, the structure of the team is outlined, the operation of the craft, the test flights, the pilots, the performance of the craft, its weak points and the eventual decommissioning of both crafts. The last few chapters pick up the pieces, covering a failed project, a lost bid to built stealth fights, the departure and death of Kelly and finally with the final chapter containing not a story but Ben Rich's recommendations about how to keep the Skunk Works moving forward along with causing the Skunk Works model to proliferate throughout the aerospace industry.

Another important feature of the book's structure is that it does not contain only Ben's comments. We are treated to testimony from numerous other voices in the stories, from the pilots of the relevant craft, to the air force staff the Skunk Works worked with, to the generals who were impressed by the operation and design of the Skunk Works. The epilogue contains three testimonies, each from a different secretary of defense that worked directly with the Skunk Works. These voices add an element of corroboration to Ben Rich's story, showing that his memoirs are in fact based in reality.

Quotes

"Captain," he began, "you won't believe this ..." (6)

"If this airplane lived up to its billing, we were making history." (58)

"But the Air Staff was so pleased with the airplane that they decided to go for twenty-nine, then fifty-nine. I almost had them convinced to go for eighty-nine." (85)

"No shoot-downs; no prisoners; no hostages." (105)

"The U-2," Boehme whispered and put a finger to his lips. "You've just had a look at the most secret project in the free world." (116)

"Tony, this is top secret. What you just saw you must never ever mention to another living soul. Not your wife, your mother, nobody. You understand?" (131)

"The U-2 overflights of the Soviet Union provided us with the greatest intelligence breakthrough of the twentieth century." (163)

"Tell the president-elect that our bird flies at seventy thousand feet." And I said it with pride. (191)

"It was the epitome of grace and power, the most beautiful flying machine I've ever seen." (219)

"... the airplane and its operations were kept so secret that few inside or outside our government knew it was flying. But the Russians knew. So did the North Koreans, North Vietnamese and Chinese. And there was nothing they could do to stop it." (237)

"At 85,000 feet and Mach 3, it was almost a religious experience." (242)

"Believe it or not, I got it as a Christmas gift from a Soviet KGB agent. He told me this piece was found by a shepherd in Soviet Siberia." (270)

"Starve before doing business with the damned Navy. They don't know what in hell they want and will drive you up a wall before they break either your heart or a more exposed part of your anatomy." (272)

"Like all the rest of us at Skunk Works, I ran my heart out just to keep up with him (Kelly). Kelly, I thank you. All of us do." (209)

"The open secret in our business was that the government practiced a very obvious form of paternalistic socialism to make sure that its principal weapons suppliers stayed solvent and maintained a skilled workforce." (306)

"The Skunk Works has always been perched at the cutting edge. More than half a dozen times over the past fifty years of cold war we have managed to create breakthroughs in military aircraft or weapons systems that tipped the strategic balance of power for a decade or longer, because our adversaries could not duplicate or counter what we had created. That must continue to be our role into the next century, if we are to preserve what we have accomplished and be prepared for the hazards as well as the opportunities for the uncharted, risky future." (341)

Topics for Discussion

Please analyze the relationship between Ben Rich and Kelly Johnson. Be sure to mention its various stages and describe its culmination in detail.

Why was the U-2 Spy Plane eventually shut down by the Eisenhower Administration?

Why was the SR-71 Blackbird decommissioned?

What are some of Ben Rich's recommendations concerning how the aerospace industry should be run?

What features of the Skunk Works does Rich think made it successful?

Please name three of Kelly Johnson's rules of operation and explain them in detail.

How did the Skunk Works lose the contract to build the new line of stealth bomber to Northrop?

What are some of the challenges in the aerospace industry of working with the federal government?

Why wasn't the stealth submarine taken beyond its prototype stage? How does this confirm or deny Kelly's rule about working with the Navy?