SKUNK WORKS:

HOW BREAKING AWAY FUELS BREAKTHROUGHS

In the world's most innovative companies, 'Skunk Works' has become the standard for running top secret projects with elite special teams.

by **Matthew E. May**

IF YOU HEAD NORTH FROM LOS ANGELES ON INTERSTATE 5, hang a right on the Antelope Valley Freeway toward Palmdale and the Mojave Desert, and cut east past the **Antelope Valley Country Club**, you'll run into the Sierra Highway, off which you can see **Lockheed Martin**'s Skunk Works building, not far from Air Force Plant 42 and Edwards Air Force Base. You'll know you're in the right place because you'll see a white building with a cartoon skunk on it — the Skunk Works logo.

As you drive around, you'll see a good bit of barbed wire, a high concrete wall, and plenty of 'No Access' signs. You'll see an F-104 Starfighter on display near the main entrance off Lockheed Way and pass Kelly's Way, named for Lockheed's legendary chief engineer, **Clarence 'Kelly' Johnson**.

No matter how hard you try, or how many times you call the Lockheed Martin public relations office, you will not get inside.

Skunk Works is, and has been since its inception under Kelly during World II, Lockheed's top-secret Advanced Development Program.

Kelly Johnson ran Lockheed's innovative entity for nearly 45 years, from its inception in 1943 to 1975, when he turned the reins over to his longtime right-hand man, friend, and protégé, the late **Ben 'Stealth' Rich**, whose memoir *Skunk Works* remains the definitive thesis on the Lockheed program.

It was the appearance of Germany's first jet fighter planes in the skies over Europe that prompted the U.S. War Department in 1943 to knock on the door of Lockheed Aircraft Corporation, headquartered in Burbank, California, next to the Burbank airport. Lockheed actually owned the airport and had gone to great lengths to conceal the entire area from Japanese air reconnaissance. An enormous burlap tarp painted to depict a suburban

neighborhood camouflaged the factory, adorned with artificial trees, buildings, and cars (made of rubber) to give it a three-dimensional effect.

For the War Department, there was just one man for the job: 33-year-old Kelly Johnson, Lockheed's talented but eccentric chief engineer. In the eyes of Lockheed CEO **Robert Gross**, Johnson "walked on water," and had done so since he told Lockheed engineers ten years earlier that the design of their twin-engine commercial plane, called the Electra, was seriously flawed. At the time, Kelly was a 23-year old engineering student at the University of Michigan, where the Electra prototype was being tested in the school's wind tunnel.

Kelly contradicted his professors and informed Lockheed engineers in no uncertain terms that if one of the Electra's engines went out, the plane would go down. Not only did Kelly correct the design flaw, he did so with an unconventional twin-tail design that would become the Lockheed signature. The plane saved Lockheed and revolutionized aviation in the 1930s. Johnson's star rose, and he became the go-to guy on everything from aerodynamics to flight testing, including flying the planes he built; he declared that unless he scared himself nearly to death once a year in a cockpit, he wouldn't have the proper perspective to design good planes.

Johnson took all of three days in the late 1930s to transform the Electra into a bomber for the **British Royal Air Force**. Called the Hudson, it was so successful that England ordered 3,000 of them. Kelly's colleagues were so awestruck by his design skills that they swore he could actually see air.

In 1939, Johnson designed and built the only American fighter plane in production throughout U.S. involvement in World War II: the P-38 Lightning Interceptor. If you've seen World War II footage, you've seen the P-38: it's the twin-propeller plane with the funny-looking twin-boom tail design. It was the most maneuverable propeller plane of the war and played several roles. But the P-38 was no match for Germany's new jet fighters. The War Department needed a new plane, and fast.

Challenging constraints shaped the project: build a jet fighter prototype that would fly at 600 miles per hour — the edge of the speed of sound and 200 miles per hour faster than the current Lockheed P-38 propeller plane — in just 180 days. The only problem was that Lockheed was out of floor space, as the entire complex was devoted to 24/7 production of their current planes.

The jet fighter project was to be conducted with top secrecy, and so the space constraint was something Kelly decided to leverage. He rented a large circus tent, borrowed 23 of the best design engineers and 30 shop mechanics from Lockheed's main operation, and set up camp next to a foul-smelling plastics factory, figuring that the overwhelming odor would help keep 'nosy parkers' away.

The whole setup reminded people of **Al Capp**'s *L'il Abner* comic strip, and the 'Skonk Works', a dilapidated factory on the remote outskirts of Capp's fictional backwoods town. In the comic, scores of Dogpatch locals were done in every year by the toxic fumes of concentrated 'skonk oil', which was brewed and barreled daily by grinding dead skunks and worn shoes into a constantly smoldering still for a purpose that Capp never disclosed.

One day, a designer picked up a ringing phone and answered it with, "Skonk Works." The name stuck, and it wasn't long before even those working at the main Lockheed plant were calling it that, too. Over the next 15 years, Skonk Works became part of the Lockheed lexicon. In 1960, when Al Capp's publisher objected to Lockheed's use of the name, rather than abandon it, they changed it to Skunk Works and registered both the name and the cartoon skunk logo as trademarks, thus becoming the official alias of the Lockheed Advanced Development Program.

In the years since, the term 'skunk works' has come to refer to any effort that involves an elite special team that breaks away from the larger organization to work autonomously on an advanced or secret project, usually tasked with breakthrough innovation on a limited budget and under aggressive timelines. The term has even become official, and is defined in the fourth edition of the *American Heritage Dictionary* of the *English Language* as "an often secret experimental laboratory or facility for producing innovative products, as in the computer or aerospace field."

Perhaps it was the stink that drove Johnson's secret team to design and build the prototype for the P-80 Shooting Star—nicknamed Lulu Belle—in a mere 143 days, 37 days ahead of schedule. Although World War II ended before the jet fighter could prove itself, Lockheed produced nearly 9,000 during the lead-up to the Korean War. The P-80, later called the F-80, won the first all-jet dogfight over the skies above North Korea.

Given the success of the P-80 project, Lockheed management agreed to let Johnson keep his elite design and development team running, as long as it did not interfere in any way with his primary duties as Lockheed's chief engineer and was kept on a shoestring budget. Kelly hand-selected a few of the brightest designers and moved into a building known only as 'Building 82'. Skunk Works would remain there until it moved operations out to California's Mojave desert in 1994. Johnson split his time between the main Lockheed plant and Building 82, usually turning his attention to Skunk Works in the latter part of each day.

"Those guys brainstormed *what-if?* questions about the future needs of commercial and military aircraft," writes Ben Rich.

"And if one of their ideas resulted in a contract to build an experimental prototype, Kelly would borrow the best people he could find in the main plant to get the job done. That way the overhead was kept low and the financial risks to the company stayed small."

There was nothing fancy about the Skunk Works space. In fact, Johnson preferred to keep things as spare as possible. When Ben Rich was lent out temporarily to Johnson in 1954, little did he know that he would never leave. He describes his first impression of the space as being nearly as eccentric as Kelly himself:

> The office space allocated to the Skunk Works operation was a narrow hallway off the main production floor crowded with drilling machines and presses, small parts assemblies, and the large assembly area which served as the production line. There were two floors of surprisingly primitive and overcrowded offices where about 50 designers and engineers were jammed together behind as many desks as a moderate-size room could unreasonably hold. Space was at a premium, so much so that Kelly's ten-person procurement department operated from a small balcony looking down on the production floor. The place was airless and gloomy and had the look of a temporary campaign headquarters where all the chairs and desks were rented and disappeared the day after the vote.
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> But there was no sense of imminent eviction apparent inside Kelly's Skunk Works. His small group was all young and high-spirited, and thought nothing of working out of a phone booth, if necessary, as long as they were designing and building airplanes. Added to the eccentric flavour of the place was the fact that when the hangar doors were opened, birds would fly up the stairwell and swoop around drawing boards and dive-bomb our heads, after knocking themselves silly against the permanently sealed and blacked-out windows, which Kelly insisted upon for security. Our little feathered friends were a real nuisance, but Kelly couldn't care less. All that mattered to him was our proximity to the production floor. A stone's throw was too far away; he wanted us only steps away from the shop workers, to make quick structural or parts changes or answer any of their questions.

That first secret project set the standard for every Skunk Works project to follow, including the U-2 bomber, the SR-71 Blackbird, and the F-117 Nighthawk stealth fighter. High-quality designs in a short time frame with limited resources became the hallmark of a Skunk Works project.

Johnson had three simple management principles supporting a single fundamental belief: don't build an airplane you don't believe in. His principles: first, it's more important to listen than to talk; second, even a timely wrong decision is better than no decision; and third, don't halfheartedly wound problems—kill them dead.

Over time, Kelly developed 14 'rules' for all Skunk Works projects as a way to put his core belief and basic principles into practice. Half of these rules (with a few word substitutions) can be applied to virtually any Skunk Works project, and they prescribe a robust framework within which to operate in an innovative environment:

1. The Skunk Works manager must be delegated practically complete control of his program in all aspects. He should report to a division president or higher.
2. Strong but small project offices must be provided.
3. The number of people having any connection with the project must be restricted in an almost vicious manner. Use a small number of good people (10 to 25 per cent compared to the so-called normal systems).
4. A very simple drawing and drawing-release system, with great flexibility for making changes, must be provided.
5. There must be a minimum number of reports required, but important work must be recorded thoroughly.
6. The contractor must be delegated the authority to test his final product in flight. He can and must test it in the initial stages. If he doesn't, he rapidly loses his competence to design other vehicles.
7. Access by outsiders to the project and its personnel must be strictly controlled by appropriate security measures.

The remaining seven rules are all specifically focused on military defense contract work. You can see all 14 at lockheedmartin.com/us/aeronautics/skunkworks/14rules.html.

Ben Rich neatly tied together the elements that have allowed the Skunk Works program to enjoy an ongoing record of break-through innovation for nearly 70 years:

> We created a practical and open work environment for engineers and shop workers, forcing the guys behind the drawing boards onto the shop floor to see how their ideas were being translated into actual parts and to make any necessary changes on the spot.
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> We made every shop worker who designed or handled a part responsible for quality control. Any worker—not just a supervisor or a manager—could send back a part that didn't

meet his or her standards. That way, we reduced rework and scrap waste.

We encouraged our people to work imaginatively, to improvise and try unconventional approaches to problem solving, and then got out of their way. By applying the most common-sense methods to develop new technologies, we saved tremendous amounts of time and money while operating in an atmosphere of trust and cooperation both with our government customers and between our white-collar and blue-collar employees.

In the end, Lockheed's Skunk Works demonstrated the awesome capabilities of inventiveness when free to operate under near ideal working conditions. That may be our most enduring legacy, as well as our source of lasting pride.

A successful Skunk Works [project] will always demand a strong leader and a work environment dominated by highly motivated employees. The Skunk Works' strength is the autonomy they have enjoyed from management and their close teamwork and partnership with their customers.

In the years since Kelly Johnson retired, Skunk Works has become the *de facto* standard for running top secret projects with elite special teams among the world's most innovative companies. Not surprisingly, it was the model **Steve Jobs** used in launching the Macintosh division of Apple (see sidebar below.)

In closing

If you are contemplating your own Skunk Works project, take a page from Kelly Johnson and Lockheed's book: set a stretch goal, frame it with intelligent constraints, select a special team, secede from the main operation — and get to work. **R**

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SKUNK WORKS @ APPLE

Macintosh began as a small Skunk Works project for a low-cost computer that was being developed by Apple employee **Jeff Raskin**. It was Raskin who introduced **Steve Jobs** to **Xerox Palo Alto Research Center** (PARC) engineers, who had developed the graphical user interface technology that would one day become the hallmark of Apple Computer's operating system.

In his book *Steve Jobs*, biographer **Walter Isaacson** tells how in 1979, Raskin wrote a manifesto titled "Computers by the Millions," whose opening lines read: "If personal computers are to be truly personal, it will have to be as likely as not that a family, picked at random, will own one." It was thus Raskin's vision to create a "computer for the masses," built to be essentially an inexpensive, self-contained appliance using a graphical interface. Raskin got permission to begin a small development project, which he named after his favourite kind of apple, the McIntosh, changing the spelling to avoid confusion with the name of the high-fidelity sound system company **McIntosh Laboratory**.

Raskin and Jobs didn't see eye to eye, and Raskin eventually left Apple. By that time, Jobs had been stripped of his research and development role and made the non-executive chairman of the Board, without operational control. Since it was a minor

project, Jobs was allowed to take over the Raskin Macintosh project, which suited Apple management fine: it kept Jobs occupied in a distant building away from the main operation. It suited Jobs as well: "It was like going back to the garage for me," he told Isaacson. "I had my own ragtag team, and I was in control."

Jobs cherry-picked a team of about 20 'pirates', as he referred to them, and seceded from the Apple main campus. He relocated the team to a small building three blocks away, next to a Texaco station. The two-story brown-shingled building became known as Texaco Towers.

As the success of Macintosh grew, so did the team, which became a division and moved back to the main Apple campus in 1983. Jobs kept the renegade spirit alive with his maxim, "It's better to be a pirate than to join the Navy." Jobs actively recruited rebels and 'swashbucklers'—talented but audacious individuals who could move fast and get things done—to his A Team.

On his 28th birthday, programmer **Steve Capps** hoisted a Jolly Roger with the Apple logo for an eye patch, and the team erected a billboard outside Apple headquarters that read: "Happy 28th, Steve. The Journey Is the Reward—The Pirates."