

DESTINATION: MY WISCONSIN WRAP-UP

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The Reboot 182s

p.38



**Victor Aviation
Engines—Going
Above and Beyond**

p.30

**Maintaining and
Flying Your Cessna in
Winter, Part One**

p.22



“They don’t teach this stuff in schools.”

Victor Sloan

Once upon a time, near San Francisco, an airplane engine builder with years of experience and faith in his product, borne from decades of experience, got a phone call from a famous exhibition flyer.

The pilot had a contract with a large company to demonstrate its beautiful twin-engine airplane by flying an aerobatic routine at airshows around the country. The flyer told the builder that the engines installed in his twin weren’t dependable—he had canceled several



scheduled flight performances because of issues with them. He had heard about the airplane engine builder’s work and asked if his engines were as good as people said.

The builder told the flyer that he would never miss a performance again if the builder’s engines were installed. Skeptical of this claim, the flyer asked what he meant. The builder stated once again that if his engines were installed, the flyer would never again miss an airshow performance.

Based on this assurance, the flyer ordered two “Power-by-Victor” engines and never missed another airshow



Victor Sloan with a matched set of cylinders and pistons.



Victor Aviation Engines- Going Above and Beyond

STEVE ELLS interviews Victor Sloan of Victor Aviation, who provides a masterclass in high-end engine building.

performance! Today, his airplane, a North American Rockwell Shrike Commander 500S, is exhibited at the Steven F. Udvar-Hazy Center of the Smithsonian National Air and Space Museum in Chantilly, Virginia. Victor Sloan of Victor Aviation was the builder, and Bob Hoover, famed demonstration and aerobatic pilot, was the flyer.

Type “Bob Hoover’s Shrike Commander” into the Smithsonian’s website, and you’ll see the “Powered by Victor” decals on the engine cowlings. I had the opportunity to visit Sloan in May 2023 for a tour and interview. He told me that Hoover insisted that the Victor Aviation engine be displayed near his airplane in the museum—and it is.

Scott Crossfield: The Engineer

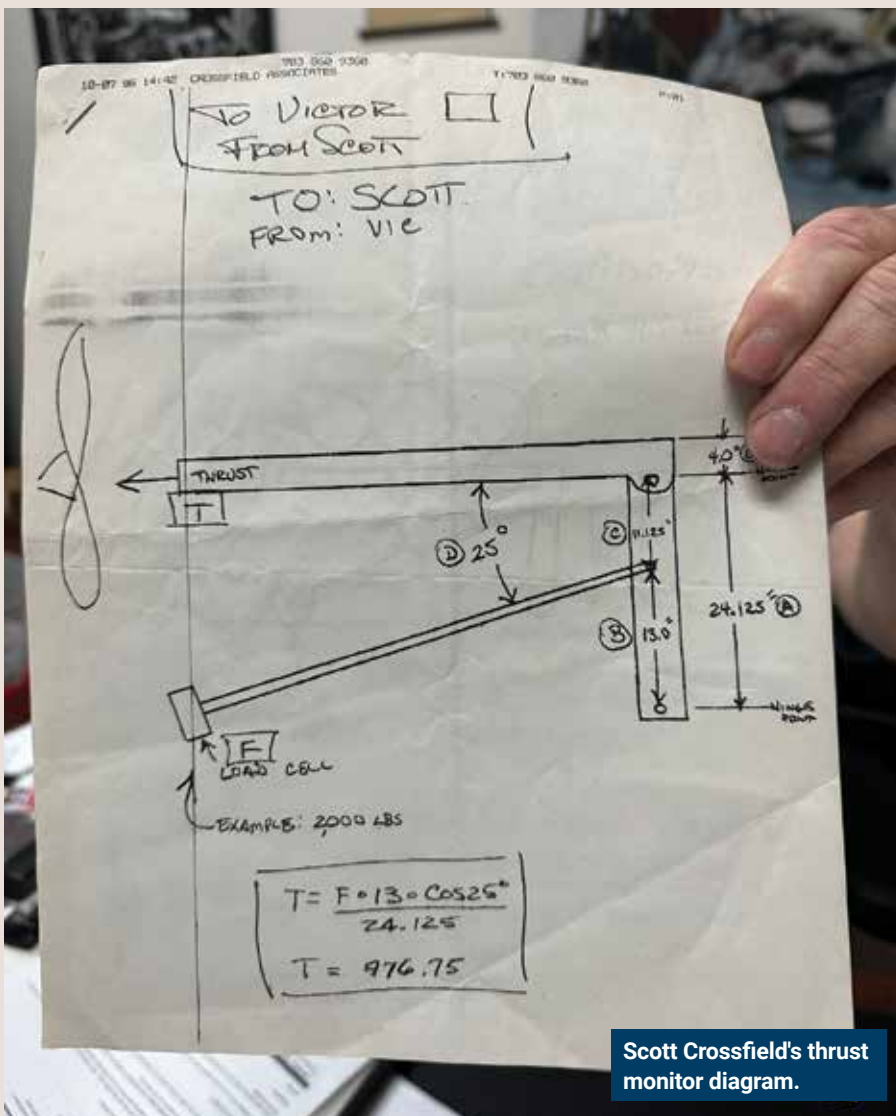
One day, a couple of decades ago, Sloan was sitting with aviation writer Bill Cox in the Victor Aviation booth at the SUN ‘n FUN airshow in Florida. A quiet soul filled out a contact form and walked away after dropping it in the box. Cox asked Sloan, “Do you know who that is?” “No,” replied Sloan. Cox answered, “That’s Scott Crossfield!”

If you’re unfamiliar with the name, Mr. Crossfield was a pioneering test pilot for NASA and, in 1953, was the first man to fly Mach 2—twice the speed of sound.

Cox urged Sloan to talk to him. Sloan caught up with Crossfield, and after a few minutes of conversation, Crossfield asked Sloan if it were true that he could

troubleshoot the internal condition of the Continental IO-470 engine in his Cessna 210A without taking the engine apart. Sloan said he had engineers that could do that. Crossfield flew to the Victor Aviation engine facility in Palo Alto, California, to see this for himself.

At Victor Aviation, an engineer from Bruel and Kjaer, a test and measurement company, fed signals from a piezoelectric accelerometer attached to Crossfield’s engine into a full domain spectrum analyzer, and within a few minutes, reported that there were three detected problems: there was an anomaly in an accessory drive gear; there was a problem with a camshaft lobe or lifter, and there was a problem with the rear main bearing.



Scott Crossfield's thrust monitor diagram.

... Crossfield asked Sloan if it were true that he could troubleshoot the internal condition of the Continental IO-470 engine in his Cessna 210A without taking the engine apart.

Crossfield, who held an MS in Aeronautical Engineering from the University of Washington, watched closely as his engine was torn down. All the noted discrepancies were there. Thus developed a respect and rapport between the two men that lasted throughout the remainder of Crossfield's life.

Sloan described Crossfield as "the most intense, no B.S. engineer I've ever met."

Partially to be close to Edwards Air Force base for the yearly get-together of test pilots, and because of their friendship, Crossfield spent around a month every year with Sloan in Palo Alto. During these times, he urged his host to further develop his practices by utilizing processes that were in use in modern aerospace engineering.

Sloan showed me his engine test stand truck and pointed out the thrust velocity load cell that was prompted

by a one-page freehand sketch from Crossfield. Crossfield also urged Sloan to learn about and use cryogenics.

Sloan's studies and understanding yielded the issuance of three patents for advanced non-destructive testing (NDT) procedures; Cryogenic Non-Destructive Testing and Material Treatment, Cryogenic Transition Detection, and Method and System for Victor Noise Reduction.

In addition to building reciprocating aircraft engines, the company does a great deal of NDT for government agencies, such as NASA's Ames Research Center.

Victor says...

During my visit with Sloan, he often spoke about bringing techniques and practices from other disciplines into his engine-building shop. This includes practices from drag-racing engine

builders, his experience building engines for his friend Kenny Roberts of motorcycle racing fame, and from other experts outside the aircraft-engine overhauling world, such as Crossfield.

Sloan developed many Victor Aviation exclusive practices. These practices are FAA-approved and included in his FAA Repair Station operating specifications. There's no Supplemental Type Certificate (STC) approving the use of these methods by other engine shops.

These include machining cylinders to equalize internal volume, flow matching the airflow on each cylinder in an engine to equalize power output with improved volumetric efficiency, and matching the induction tube outlet with the cylinder head's intake valve inlet.

Other steps include coating internal parts with an iron manganese phosphate coating for three reasons: to reduce friction, to provide lubrication in the gear train during the first start of every new engine, and to prevent rust on steel parts.

The list goes on: balancing both ends of the crankshaft, as well as the pistons, pins, rings, and connecting rods (con rods). This realtime crankshaft balancing process has three steps: balancing the bare crankshaft at each end, balancing the crankshaft assembly after installing the correct gears, and a final balance after installing the vibration-dampening counterweights.

"Factory balancing is to within 8 to 10 grams; we balance to a ½-gram imbalance at each end of the crankshaft," said Sloan. "To me, balancing means the accumulation of internal gear friction reduction, reciprocating and rotational mass, and air-flow balancing."



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Cryogenic chamber.

Connecting rods receive the iron manganese coating and are then balanced on the big end for rotational balance, on the small end for reciprocating balance, and overall for equalized balance.

Cylinders

During my tour, Sloan said, “We re-machine every new cylinder we buy; to us, a new cylinder is working stock.” According to Sloan, “New cylinders can distort and go oblong when hot. This causes ring friction, power loss, and too much movement of the rings.”

After Victor Aviation has processed the new cylinders, he grinds a new internal barrel profile and choke that tests have shown to work better. The valves and valve seats are ground to present a venturi-type profile, which is tuned during intake valve adjustments. “A finished set of our cylinders are perfectly matched in combustion chamber volume and airflow balanced to $\pm 1\%$.”

Years ago, at the Northrop Institute of Technology, where I got my initial Airframe and Powerplant training, I was taught that a perfect valve seat took three grinds, the upper, the lower, and the final. According to Sloan, Continental no longer cuts this type of seat, nor does it lap the valves to the seats.

Sloan told me, “All I’m doing is correcting for production line losses and improving the complete engine with the processes in our operational specifications. That’s why my engines fly faster, climb better, vibrate less, and last longer.

“All this takes a lot of time to do. There are no computer numerical control (CNC) machines in my shop. I have a Swiss watchmaker mentality toward engine building.”

The staff at Victor Aviation are all technicians, according to Sloan. “My right-hand man, John Pava, has been with me for 45 years, one of my assemblers has been here 35 years, another one for 32 years, and another for 28 years. Since none have ever worked in another engine shop, they haven’t seen how other shops build engines.”

When asked how long it takes to build an XR Black Edition VII, his most “massaged” engine, he answered, “250 hours.” When asked how that compares to other engines, he said it takes about 30 hours to build a factory engine and about 80 hours for a field overhaul.



Iron manganese phosphate coating.

Cryogenics

At Crossfield's urging Sloan learned about cryogenics. During my tour, Sloan showed me a large round silver barrel that was shaped like a 55-gallon drum on steroids.

"This is like a large Thermos bottle. We pump liquid nitrogen in to cool the parts. I can also heat the parts; it's all computer-controlled," said Sloan.

The cryogenic phase-change inspection and treating process can vary from as little as 30 minute to about two days for the ferrous parts of one engine.

I asked which parts get "the treatment."

"The parts that my Director of Operations and I know have a frequent history of incomplete metallurgical phase transformations, occurring from an improper heat-treating process of a manufactured part," answers Sloan.

"When materials have been manufactured, it's possible that they receive improper heat treating; which typically means they were quenched improperly—either too slow or too fast or in the wrong or a contaminated atmosphere. The parts can change when they are heated and cycled during normal operation on the engine, and can cause an infant mortality failure," said Sloan.

To better understand why Victor Aviation insists that parts have completed the phase-change process and/or been tested to detect the change, it helps to understand that when a cylinder that has not undergone the complete phase change and is installed on an engine, it will eventually undergo the phase change over time, but as it does, the part changes size.

"It's as much as two-thousandths (0.002") in a cylinder, and while it doesn't sound like much, it's huge in a cylinder," said Sloan.

Sloan told me that he devised a patented method to detect the phase transfer change without cutting the part or requiring looking at it with an electron scanning microscope.

"We detect phase transformation using cryogenics and vibration," said Sloan. "We put parts in here [the cryogenic chamber] and are able to monitor the phase change with an electromagnetic acoustic ultrasound transducer.

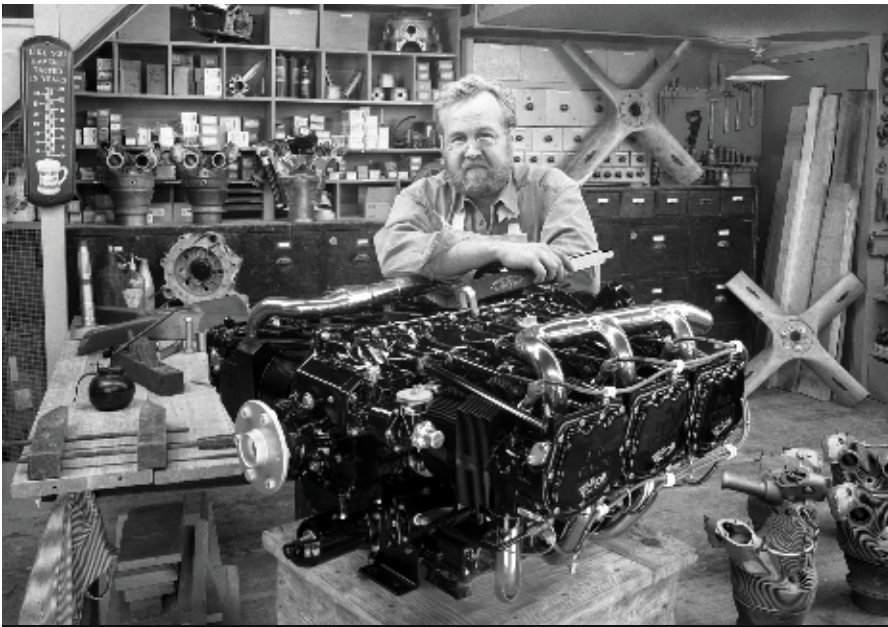
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Sound and vibration test stand setup.

“Factory balancing is to within 8 to 10 grams; we balance to a ½-gram imbalance at each end of the crankshaft.”

Reciprocating and Rotational Balancing” (\$2,495), “Cylinder Volumetric Efficiency Balancing and Flow Testing” (\$4,200), and “Thermally Emissive Electrostatic Powder Coating” (\$4,395-4,895).

There are another 14 options. They include “Hydraulic Lifters and Camshaft Precision Matching” (\$3,200), “Engine Thrust Velocity Load Cell Extended Double Test Run Cycle” (\$2,995), and “Multiple Angle Valve and Seat Machining” (\$3,850).

The XR Black Edition VII includes all of these options, including the “Power-By-Victor Precision Flow Balanced Cylinders” and Iridium fine wire spark plugs. The XR Black Edition VII engine has a 10-year/TBO Express Limited Warranty for Workmanship. Other editions also have warranties.

In addition to building complete engines, Victor Aviation will occasionally build a set of new cylinders that are “Victorized” using the processes described in this article.

Victor Aviation engines add value, says VREF

According to VREF, a well-known airplane valuation website, installation of a Black Edition V, a Black Edition VI, or an XR Black Edition VII adds quite a bit of value to an airplane.

Sloan showed me a letter from VREF to Victor Aviation stating that installing one of these engines increases the airplane's value by the engine's out-the-door cost.

This is stunning, since the rule of thumb I have heard for the last three decades is that the installation of a new factory or remanufactured engine will increase the value of the airplane by half the cost of that engine. For example, if you install the top-of-the-line Victor XR Black Edition VII engine, VREF suggests that the value of the airplane would increase by the price of that



Crank balancer display.

by measuring the magnetic ratio in a part, the phase change can be detected; it's expressed as a percentage.

Sloan told me that the parts he is most concerned about are brand new parts.

“The goal of the Victor Aviation process is to make sure that all the ferrous parts—those that experience

has shown need verification that proper heat-treating procedures were performed—have been inspected and treated using our patented cryogenic NDT process prior to installation of the parts in an engine.”

“Our practices ‘season’ the parts,” he said, and all aluminum parts, even new cranks or used cases that have been repaired by an outside agency, are stress-relieved for longer life.

Engine options

When a customer seeks a price quote, they are sent a menu of options. Any of the options—there are 18—can be added to the Victor “Aviator Series Base Overhaul” engine. For instance, option “I” is “Cryogenic Liquid Nitrogen Stress Relieving” upgrade that costs an additional \$4,995 for the Aviator and the Black Edition V engines. It's included in the Black Edition VI and the XR Black Edition VII engines.

Other options include “Real Time

We don't use gel, like doctors; we use a magnet to hold the transducer in place,” said Sloan.

“We send ultrasonic sound waves through the material as it's being cooled and heated as the material transforms from one type of metallurgy to another,” said Sloan. He told me that if the heat treatment is properly done, ferrous metals change from an austenite structure to a martensite structure,” he said.

This was way over my head, so this definition helped: “Martensite is a hard, brittle phase of steel with a tetragonal (atoms dispersed evenly in a square shape) crystal lattice. It is formed by rapid cooling of austenite, a process known as quenching.”

Prove it!

Sloan showed me how Victor Aviation determines if the phase change to martensite is complete. He said that austenite is non-magnetic, while martensite is, so

engine—\$86,915, in today's dollars. If realized, that could be a massive financial benefit for the aircraft owner.

Ever curious, and always seeking better methods and tools to build the best engines in the industry, Sloan told me that many of the steps taken, such as the use of cryogenics to ensure the phase change in ferrous metals, are done to relieve stresses in engine parts prior to build-up. It strikes me that Sloan will go to any length to build reliable engines.

Experience and information gleaned from other specialists, from unlimited fuel dragster engine builders to NASA space vehicle engineers, shows there's a measurable advantage in using stress-free and closely matched parts to deliver an exceptionally dependable airplane engine. Sloan and Victor Aviation can deliver that engine.

Editor's note: Intellectual properties/procedures and tests are registered trademarks and patents of Victor Aviation Services Inc., Victor Technology Inc., and Victor Intellectual Property Inc. (collectively).

STEVE ELLS is contributing editor and tech rep for Cessna Flyer Association. He has been an A&P/IA for 45-plus years. He is a commercial pilot with instrument and multi-engine ratings and loves utility and bush-style airplanes and operations. He's a former associate editor for *AOPA Pilot*. He owns Ells Aviation and lives in Templeton, California. Send questions and comments to editor@cessnaflyer.org.

RESOURCES

CFA SUPPORTER

VICTOR AVIATION

victor-aviation.com
youtube.com/@victoraviation9592/videos

ADDITIONAL READING

"NORTH AMERICAN ROCKWELL SHRIKE COMMANDER 500S, ROBERT A. 'BOB' HOOVER"
tinyurl.com/hover-commander-500s

"FLYING THE FEATHERED EDGE—THE BOB HOOVER STORY"
youtube.com/watch?v=QcdJ-jTtw4



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