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Wendy Lessig's well-traveled PA-12



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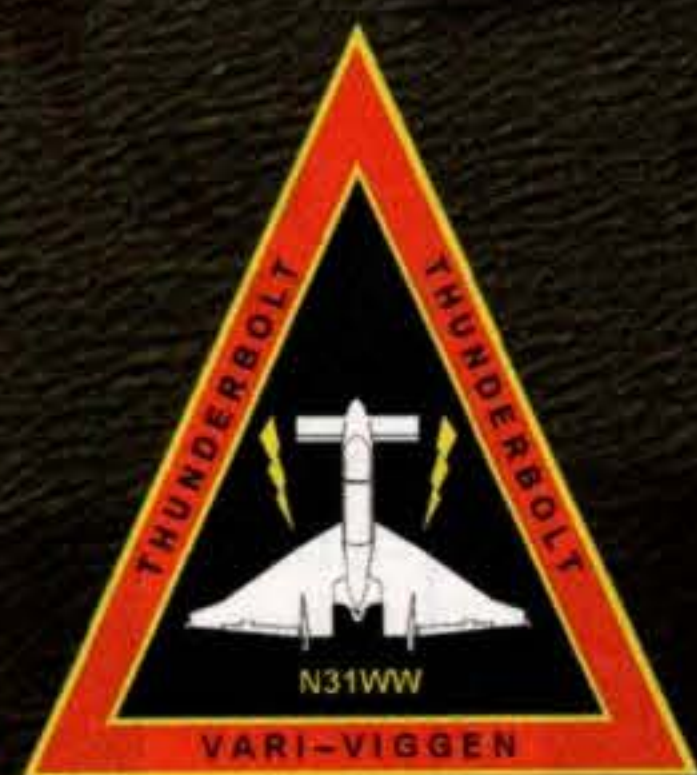
Charlie Spinelli's VariViggen

 P.86



EXPERIMENTER
FEATURE





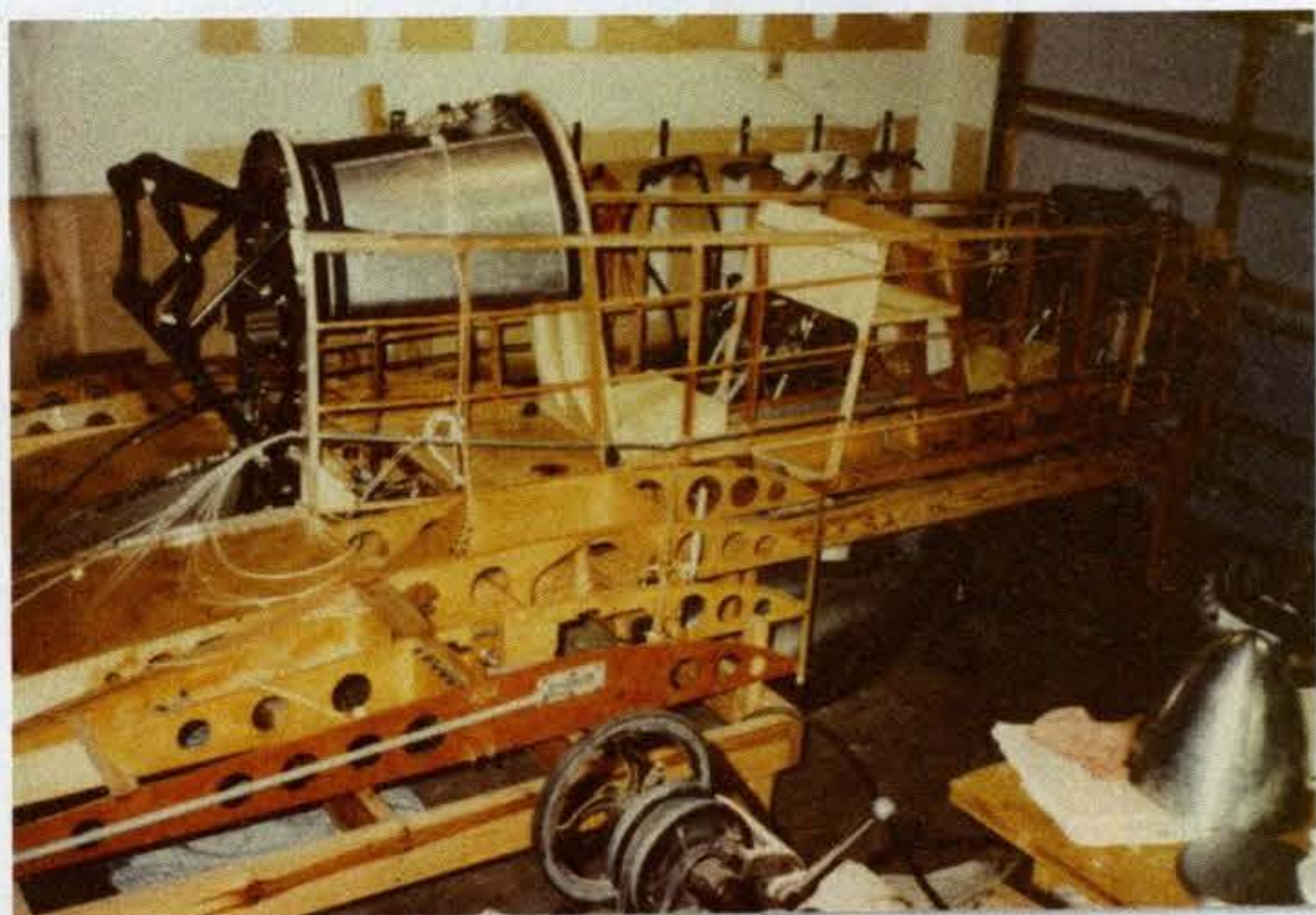
A VERY STORIED VARI-VIGGEN

40 YEARS OF FASCINATING FLYING

BY BETH E. STANTON

MOST PEOPLE BUILD AND fly experimental airplanes to have fun and go places. Then there is Charlie Spinelli. For decades, he has used his airplane as a test bed for brilliant scientific experiments. Charlie, EAA 491973, is a shockingly multitalented individual with expertise in mechanical, electrical, software and systems engineering, flight testing, ops analysis, and unmanned systems. He is also a pilot, A&P mechanic, and a retired Boeing associate technical fellow. His airplane is equally extraordinary — a rare VariViggen, the first full-scale aircraft developed by legendary aircraft designer Burt Rutan. The VariViggen has tandem seating, a wooden fuselage, composite delta wing, and retractable landing gear. It first flew in 1972, and the Rutan Aircraft Factory sold hundreds of plans, but fewer than 20 were built.

VARI VIGGEN



VARI BEST FRIENDS

IN THE EARLY 1980S, as a newly minted pilot and fresh out of college, Charlie got a job at Aeromet, a national defense research and development company. When aviation pioneer Ray Booker, a test pilot with a doctorate in atmospheric physics, hired Charlie, he became one of just a handful of employees at the new company.

It was here that Charlie met his soon-to-be best friend, aeromechanical engineer and test pilot Ken Winter. They worked together on a decadelong project modifying Rutan designs (VariEze, Long-EZ, and the Rutan-derived Cozy MK IV) into unmanned aircraft. A stepped approach pulled together systems for autonomous over-the-horizon flight, followed by remote takeoff and landing, and then payload integration using a modified S-TEC autopilot, remote control, and a single-board computer. These experiments served as the groundwork for the development of remotely piloted aircraft.

Ken was building a VariViggen, and as his new hangar mate, Charlie helped him out. A lot. The plansbuilt VariViggen was a challenging aircraft to fabricate. Every single part that wasn't scavenged from other airplanes had to be built from scratch. Making it a two-man job made it slightly easier. One of them would read off the numbers from the template while the other notated them on graph paper. Full-scale templates were drawn; pieces were fabricated from birch, mahogany, fiberglass, foam, aluminum, and steel, and then assembled. The airplane took 7.5 years to build.

VARI POIGNANT

KEN FLEW WITH Mike Melvill in Mike's VariViggen to learn the quirks of high centerline thrust characteristics before trying out his new airplane. Ken then flew his VariViggen to the EAA fly-in convention in Oshkosh a year later in 1982. Burt's original gear design could collapse if side loaded, and Ken's left main gear collapsed while taxiing to park in the grass. Burt, Mike, and Ken fixed it on-site. (Subsequently, Mike came out with plans for a new gear system with torque tubes and a transmission that ran off an electric window motor from a Ford. Ken later replaced his gear with Mike's improved design.) That year at Oshkosh, Mike and Ken flew the first-ever VariViggen formation.

Ken had flown his airplane for about 200 hours when he died in a research test flight accident in 1991. At the time, the VariViggen had been sitting in his garage awaiting some fixes. After the accident, the airplane sat for a year. Ken's mother decided that Charlie should take over the airplane since he had been so involved with building it. It took Charlie almost two years to get his best friend's airplane, now his, flying again.

Top: N31WW being constructed in Ken's garage.

Middle: Ken back on the ground after a successful first flight.

Bottom: Ken and Mike Melville fly the first ever VariViggen formation flight at EAA Oshkosh 1982.



SPECIFICATIONS

VARIVIGGEN SP N31WW

AIRCRAFT MAKE & MODEL: Rutan VariViggen SP N31WW
CERTIFICATION: Experimental amateur-built

LENGTH: 20 feet
WINGSPAN: 23 feet, 8 inches
HEIGHT: 6 feet, 1 inch

MAXIMUM GROSS WEIGHT: 1,860 pounds
EMPTY WEIGHT: 1,136 pounds
FUEL CAPACITY: 25 gallons (main), 13.7 gallons (aux)
USEFUL LOAD: 724 pounds
SEATS: 2

POWERPLANT MAKE & MODEL: Lycoming O-360-A1D
HORSEPOWER: 180
PROPELLER: Performance Propeller
MAXIMUM SPEED: 180 mph
MINIMUM SPEED: 65 mph
CLIMB RATE: 1,500 fpm
CEILING: 20,000 feet MSL
ENDURANCE: 4.5 hours



VARI UNCOMMON MOD

TO GET THE AIRPLANE airworthy, some garden-variety improvements — such as rebuilding the canopy, repairing the gear, and some engine work — were required. Then the real fun began. Charlie procured the \$25,000 S-TEC autopilot originally installed on the unmanned Long-EZ and contrived a semi-autonomous, mechanical fly-by-wire VariViggen.

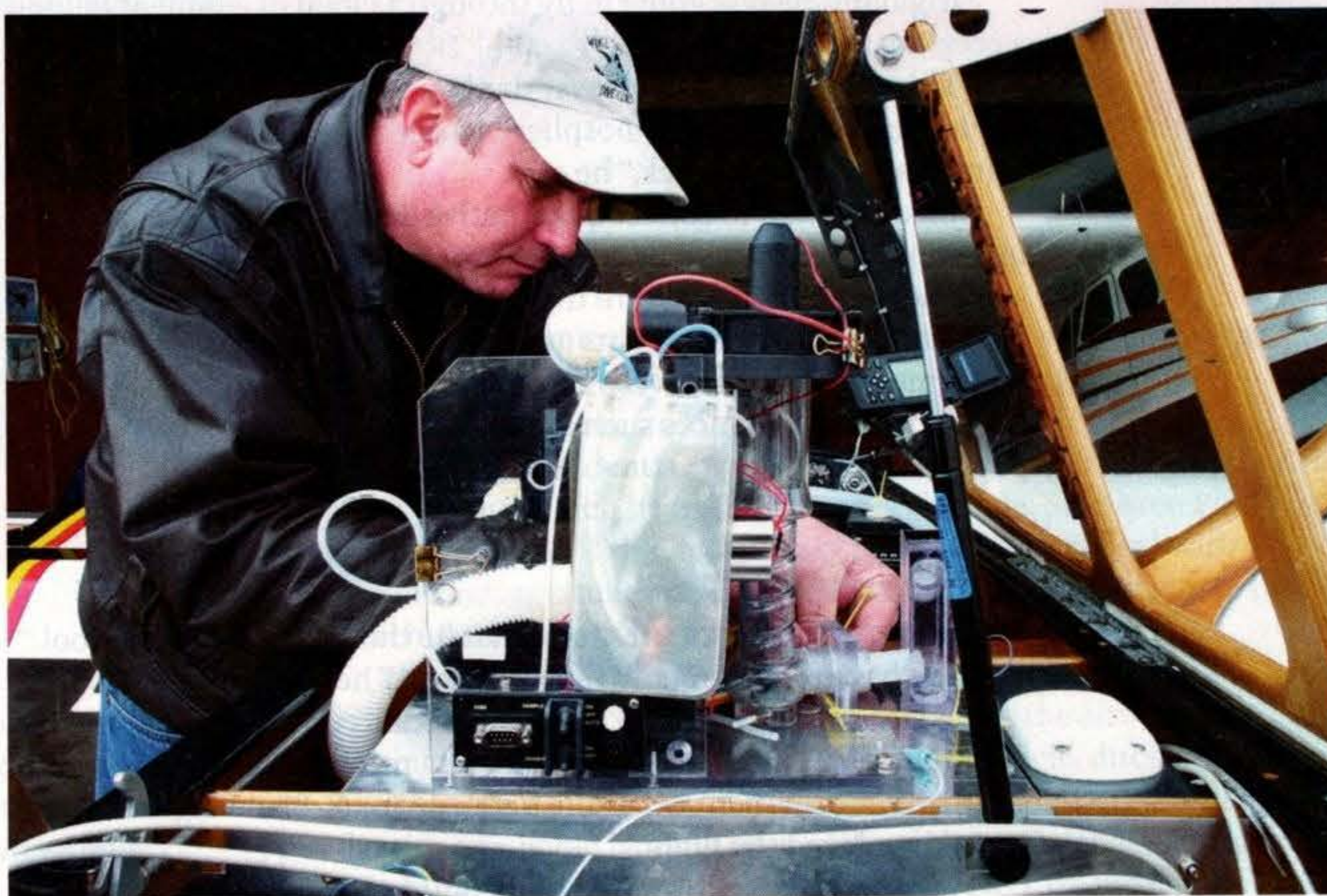
Using the schematics for the S-TEC autopilot and a Saitek X42 game controller casing stripped down and rewired with aircraft quality wiring, Charlie created a mechanical fly-by-wire system flown with a thumbstick that controls the airplane through the autopilot.

You don't see many S-TEC autopilots in experimental aircraft.

"Especially now, it's all changed," Charlie said. "I was doing this fly-by-wire stuff back in the '80s and '90s. Autopilot technology now has more capabilities. For the time, it was pretty darned advanced."



Right: Charlie preparing for a test flight in 1993.



Charlie preparing instrumentation for the first chemical and biological weapons detection system test flight in 2004.

VARI VIGGEN

VARI UNMANNED VEHICLE

AFTER BEING HIRED by Boeing, Charlie moved from Oklahoma to Seattle. The University of Washington had developed a sensor that detected chemical and biological terrorist attack weapons. An unmanned aerial vehicle flying with the sensor would be a perfect vehicle for this mission. In the event of an attack, it could be flown into a hot zone to detect and collect samples and then diverted to a safe place for decontamination. Samples collected from the sensor could be taken to a lab to determine who created the weapon.

Charlie was approached to instrument an airplane into an unmanned aerial vehicle (UAV) for the Army-funded flight test program. So, he turned his VariViggen into a surrogate unmanned vehicle.

He needed an attitude and heading reference system for the flight data recorder he was building, and Dynon just happened to be releasing the Dynon D10. He snagged the first one off the assembly line. The VariViggen was

instrumented with the sensor, autopilot,

flight data recorder, and telemetry link. It could fly autonomously once airborne with Charlie doing the takeoffs and landings.

Originally, he was going to fly through a cloud of simulant behind a crop duster.

"This was after 9/11, and everybody was really sensitive to deploying stuff into the atmosphere where people could see it and think it's a terrorist attack," he said.

Since they had to collect quantitative data, Charlie proposed an ingestion system where he would shoot a sample out in front of the airplane under high pressure that gets sucked back into the sensor.

Throughout six test flights at different altitudes, environments, and temperatures, they were successfully able to detect particles of simulants for substances such as Ebola and anthrax down to one part per trillion.

VARI AWESOME

CHARLIE BUILT SOMETHING else that he thought was "pretty cool."

"You have to understand this was 2004," he said.

He mounted a camera in the airplane and recorded cockpit video of him flying. He then took his flight data recorder that had recorded the flight information and wrote a plug-in for X-Plane flight simulator and replayed the flight.

"This had not been done by homebuilders before," Charlie said. "When I showed Austin Meyer [the creator of X-Plane], he just flipped out and said, 'Are you kidding me?' It was really cool because you could see the actual video from the airplane and then see a duplicate of that in synthetic view, which shows you what the simulators see. And they're running side by side. It's pretty awesome."

VARI YAW-Y

THE VARI VIGGEN HAS a pusher propeller configuration. The down-blowing blade is on the left side of the aircraft, creating more thrust on the left side.

"When you look at the boat tail, the air-flow goes straight back and ends up not attaching around the boat tail so there's about a quarter area of the prop where there's no air and it's almost a vacuum," Charlie said.

Turns and power changes cause the airplane to yaw.

"You have to ride the rudder to get the ball on top of the bowl," Charlie said. "You sit there in a slip the whole time until you physically take the rudder and push it on top."

A friend of Charlie's who worked on vortex generators for the 737 was intrigued by this characteristic. He got the VariViggen plans from Charlie and made a Catia model of the airplane and ran some computational fluid dynamics tests on it. He deduced that the airplane needed vortex generators, which Charlie promptly installed. Now, as the air-flow starts to separate, the vortex generators almost completely reattach the airflow.

"I still need another row to make it really attach," he said. "But it's gone from a full deflection of the ball to where it's now sitting at half a ball."



"IT'S HARD TO DESCRIBE HAVING SOMETHING LIKE THIS AND HAVE IT GO THIS WELL FOR THIS LONG".

—CHARLIE SPINELLI



VARI-VIGGEN EQUIPMENT:

ATTITUDE: Dynon electronic flight instrument system D10
POSITION: Bendix/King KLX 135A Lowrance AirMap 300
ENGINE PARAMETERS: Rocky Mountain Instrument Micro-Monitor
CONTROL: S-TEC System 60-2 autopilot
 Mobile devices running ForeFlight and other aviation apps



While flight-testing the vortex generators, Charlie built another flight data recorder. In addition to gathering yaw data, he mounted cameras on the wings and tufted the airplane.

“Eventually the plan was to have the flight data recorder control the cameras on the airplane along with all the flight data,” he said. “When you turn it on, you tell it what you want to record and for how long.”

VARI SAFE

THE ONLY INCIDENT Charlie ever had with the VariViggen was an oil pressure drop that led to an emergency landing.

“I had an oil leak from a certified part,” he said.

From this incident, Charlie developed a system that was granted a U.S. patent, which he installed on his airplane. Safe Area Flight Emergency (SAFE) is a technology that helps pilots deal with a forced landing situation. (See “SAFE Solution,” Innovation, in the March 2019 issue of *EAA Sport Aviation* magazine.)

The automated SAFE system monitors the energy state and configuration of an aircraft. The system can direct the aircraft to a landing site or, in the case of an unmanned vehicle, ditch it in an area that would do no harm. The system uses onboard sensors to identify attainable landing sites in the vicinity. Databases (airports, terrain, obstacles, vegetation, roads, parks, etc.) are incorporated into a trajectory generator, and tools are used to tap into the databases. SAFE technology may also be applied to help enable integration of UAV operations into the national airspace system.

VARI VIGGEN

GRASSROOT WINGLETS

In the autumn of 1974, Burt read about Richard Whitcomb's invention of the winglet in *Aviation Week & Space Technology*. Winglets are vertical extensions of wingtips that reduce wingtip vortex drag, thereby increasing aircraft efficiency, fuel economy, and range.

Right away, he incorporated this invention into his proof-of-concept VariEze by making changes to the airfoil shape and incidence of the vertical stabilizer, thus becoming the first homebuilt design to include winglets. Shortly afterward, he improved the original VariViggen Model 27 with the VariViggen SP Model 32 that included the addition of winglets.

Today, aircraft of all types from ultralights to jumbo jets fly with winglets. They may be incorporated into aircraft design, or custom add-on winglets may be made. Joe Clark, EAA Lifetime 413401 and founder and CEO of Aviation Partners Inc., has been developing winglet systems for corporate and commercial aircraft for decades. Aviation Partners introduced the blended winglet system for the Gulfstream II and the Boeing Business Jet and is the world's leading designer of advanced technology winglet systems.



Mike and Burt marveling Charlie's VariViggen at AirVenture 2019

VARI GOOD TIME TO FLY YOUR VARIVIGGEN TO OSHKOSH

CHARLIE ORIGINALLY PLANNED on flying Southwest Airlines, not his VariViggen, from Phoenix, Arizona, to EAA AirVenture Oshkosh 2019. However, momentum was starting to build. Burt was attending AirVenture for the first time in several years. A diverse gathering of Rutan aircraft would be on display during the week and fly in the air show. And Burt's considerable contributions to aviation would be celebrated with a number of presentations and forums.

The band was also getting back together from the 2016 Mojave, California, stealth photo shoot of Rutan airplanes flying in formation as a gift for Burt (see "Pretty in Planform" in the August 2019 issue of *EAA Sport Aviation* magazine). Burt had debuted the VariViggen at EAA Oshkosh in 1972, and Charlie's is the only one flying in the United States.

"I told my wife I really ought to do this," he said. "This is a once-in-a-lifetime opportunity with Burt there. She said, 'Go for it,' and that's what I did."

A historic assembly of Rutan aircraft was parked in the Homebuilt Aircraft Display area. When EAA photographers showed up for a photo shoot, Zach Reeder, pilot and caretaker of Burt's Catbird, texted Burt to give him the heads-up. Burt and Mike showed up in a golf cart and crashed the photo shoot. As crowds flocked around Burt for his autograph, photographers struggled to get clear shots of the airplanes.

Finally, the crowds were herded back, and Charlie found himself alone with Burt and Mike.

"This was the first time I was really able to talk to Burt," Charlie said. "He was almost like a kid."

Curious if Charlie had done the mods to the gear, the first thing Burt did was drop to the grass under the airplane to check out the landing gear. For 45 amazing minutes, Charlie got to privately sit and talk with Burt and Mike. Burt commented that this was the most heavily instrumented VariViggen he'd ever seen.



VARI FORTUNATE

OVER THE COURSE of his career, Charlie has rubbed elbows with folks legendary in their fields and has worked with some of the best in the world. He believes that curiosity has led to some remarkable experiences in his life.

"I guess over time I was really fortunate," he said. "I was one of those people who generally hung around with people who are older than me. I tended to do that because I like to learn."

At the beginning of his career at Aeromet, he would fly with Ray on long overseas trips.

"One day pretty early on, I sat there and said, wait a minute, I'm sitting here in an airplane with one of the top atmospheric physicists in the world. Why in the hell am I not asking this guy questions? I'm flying through the classroom," Charlie said.

He began grilling Ray with questions. Ray then explained to young Charlie what was happening in the environment around them.

At Renton Municipal Airport southeast of Seattle, Charlie's airport neighbor was Clayton Scott, nicknamed Scotty. Scotty had flown more than a thousand B-17s from the factory during World War II and was Bill Boeing's personal pilot, the first Boeing test pilot, and one of the first pilots for United. The airport has since been named Clayton Scott Field. Charlie frequently helped Scotty with projects in his hangar, and he signed off Charlie's powerplant for his A&P certificate.

"The guy at the FAA freaked out and said, 'Do you realize who signed your logbook? Do you know who he is?'" Charlie said. "Yeah, I know who Scotty is."

VARI INSTRUMENTAL

CHARLIE'S VARI-VIGGEN has been his playground for a lifetime's worth of experimentation.

"The great part about it, it's like having your own instrument," he said. "You can go out and riff on it and try new things and improvise. What can I do with this thing next?"

A lot of his experiments stemmed from his unmanned vehicle days.

"That's what I got really intrigued with," he said. "I can make this thing do anything I wanted it to do. We had to build everything to do everything by itself and not screw up. And hopefully not crash."

Charlie retired from Boeing in 2018. He believes that it's getting time for his airplane to retire as well.

"I'm starting to see little things," he said. "As far as rot in the airplane or glue, it's not coming apart; that's all been in pretty good shape."

His nits with the airplane are cosmetic and avionics-related. He calls the 40-year-old paint job a "10-foot paint job."

"From 10 feet, it looks really good," he said.

He'd also like to gut the airplane and replace the instruments with lighter, modern avionics. However, he's concerned about the practicality of doing all this work, only to develop issues on the aging wooden airframe.

VARI FAREWELL

SEVERAL YEARS AGO, Charlie was walking around the Steven F. Udvar-Hazy Center in Chantilly, Virginia, and noted its Rutan collection consisting of the original VariEze and a Quickie. When he mentioned to the docent that he was flying one of Burt's original airplanes, the docent took him to see the curator.

"The curator thought it was a significant airplane because of it being the first Burt Rutan design," Charlie said.

He has decided to donate his VariViggen to the Smithsonian's National Air and Space Museum.

"It has gotten recognition now, and it's the time to do it," he said.



It's bittersweet for Charlie to say goodbye to the airplane that has been such an integral part of his life, an airplane that carries not only his spirit, but that of his best friend.

"It's been just a fun ride to have something like this," he said. "It's hard to describe having something like this and have it go this well for this long."

He likened saying goodbye to his airplane to a daughter leaving home.

"You've got to let them go at some point. I really love flying this thing," he said. "It's been an absolute blast." *EAA*

Beth E. Stanton majored in English because it involved the least amount of math. She finds it hilarious that now she is a pilot and writes stories about airplanes and technical stuff.