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EAA

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The Sport Performance Panther

A Corvair-powered delight

» **Frank Knapp's Lil' Cub**
A STOL wonder

» **A Turbo for the Rotax 912**

» **50 Years of FRED**

FAA Overreaching

BY JACK PELTON

OUR FOUNDER PAUL POBEREZNY understood from the beginning that aviation must be regulated, but he also knew that personal aviation can only thrive under regulation that makes sense. That's why Paul worked so hard to help the FAA develop rules that work for personal and sport aviation. I'm happy to say that EAA's efforts have largely been successful. But we must be ever vigilant.

A recent and worrisome example of the FAA overstepping its mission to ensure public safety is a new pilot medical certification policy that uses a pilot's weight to screen for a disqualifying medical condition. Starting soon aviation medical examiners (AMEs) will be required to calculate the body mass index (BMI) of a pilot and report it along with other medical data to the FAA.

The BMI is a ratio of a person's height to weight. If a pilot's BMI is greater than 40, and his or her neck measures more than 17 inches, that pilot must now be evaluated for obstructive sleep apnea (OSA). The testing for OSA must be done by a board certified physician expert in the field and will almost certainly mean a trip to a sleep laboratory where the pilot will be hooked up to sensors that monitor body functions during sleep. The cost of the testing will be several thousand dollars or more and won't be fully covered by many health insurance plans.

OSA has long been a disqualifying medical condition for pilots. It causes breathing passages to be blocked during sleep so the person briefly wakes many times during the night. This robs the OSA sufferer of quality sleep, which can lead to drowsiness and fatigue during the day. Obviously, fatigue of any source is an added risk for pilots.

But the new FAA policy has two big problems. One is that it employs a risk factor to require a pilot to prove he doesn't have a disqualifying condition. Being overweight can make it more likely that a person will suffer from OSA, but is merely a risk factor, not a conclusive screening test. There are many medical risk factors such as age, heredity, lifestyle, and so on, but they are vague and not conclusive. Demanding extensive medical testing based only on a risk category—weight in this case—is a new and very disturbing policy from the FAA.

The second issue with the new FAA policy is that it imposes a costly new requirement on all pilots while providing no safety benefit to the public. The private pilot flying a light piston single under daylight VFR will face the same OSA requirements as the captain flying a Boeing 747 for a passenger airline. And that makes no sense in terms of public safety.

When an operator offers any form of transportation to the public we can agree that operator must meet reasonable safety standards. The driver of a passenger bus, engineer of a passenger train, captain of a passenger ship, and the captain of an airliner all should meet minimum standards for competency and medical qualification. But that same standard doesn't apply to operators of private vehicles, boats, or aircraft. We are expected to make our own risk analysis before we get in a car with a driver we know, or launch with a friend in a boat, or take off in a private airplane.

Motorcycle riders have been largely successful in turning back similar overreach by state highway regulators. Some bikers want to ride without a helmet. It adds some risk to their safety, but doesn't increase risk to the public. If an adult biker wants to ride his motorcycle without a helmet, that should be his choice, and I'm happy to say, many state governments now agree.

The pilot flying a private airplane for his own reasons is fully capable of monitoring his own fatigue level. I don't want any pilot flying when tired, but if the pilot of a private airplane does, it's his own risk.

With its new OSA screening policy that targets overweight pilots the FAA has ventured out of the bounds of its mission and into the same territory as the motorcycle helmet regulators, or even those who want to ban huge sugary drinks. We can't allow broad, vague health risk categories to be used to ground pilots until they undergo expensive and invasive testing to prove they are fit to fly.

At EAA, AOPA, and the other associations we must remain vigilant to prevent this kind of overreach that burdens pilots without doing anything to enhance public safety. See Page 6 to read about the success EAA advocacy has had fighting this in Congress. EAA

On the cover: Dan Weseman shows off his Sport Performance Panther. (Photography by Michael Steineke)

Photography by Jason Toney

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Columns

Jerry Paveglio and Charlie Becker working on the EAA staff build Zenith CH-750.

Goals, Not Resolutions

Starting the new year off right

BY CHARLIE BECKER

EVERY JANUARY THERE IS always a big push toward New Year's resolutions. Unfortunately, New Year's resolutions are mostly forgotten by the end of January. Goals, on the other hand, are real targets to accomplish. So I'm going to encourage you to set some goals around your homebuilding. Here are some suggestions.

GOAL: START YOUR PROJECT

If you have been dreaming of building an aircraft, now would be the time to turn that dream into a reality. Make 2014 the year you start your project. Starting can be anything from working through the selection process, to taking an EAA SportAir Workshop, to learning the necessary skills, to taking delivery of a kit. You have 12 months to accomplish this goal. Define it however you want, but make a concrete step toward accomplishing your dream of building an aircraft. I can tell you that building is a fun, frustrating, challenging, and incredibly rewarding activity that I wish I had started much earlier in my life. Don't put it off; my guess is you'll wish you had started years earlier, too.

GOAL: RESTART YOUR PROJECT

Many of us already have a project going, but maybe it isn't in the active state right now. If you're stalled out, why not commit to restarting the project. If you simply got out of the habit, commit to specific dates and times that you will work on it. You'll be surprised how enjoyable it is to get back in the groove. Try making a commitment of at least 10 minutes every day on the project. It can be as little as reviewing the plans or organizing the shop. This will keep your mind engaged, and you'll be amazed at how 10 minutes turns into an hour of productive shop time.

Sometimes we hit a technical issue that saps our confidence and makes us back off the project. If you're stuck, call your local technical counselor to come over and help you develop a plan for overcoming that hurdle. All the problems that come up in a build can be overcome with some help. Technical counselors love visiting projects and take great joy in helping other builders overcome roadblocks. They want to see you succeed as much as you do.

GOAL: FINISH THAT PROJECT

My personal goal for our EAA staff build project, a Zenith CH 750, is that it will be flying by EAA AirVenture Oshkosh 2014. We are in that 90 percent done, 90 percent to go stage now. It looks like a finished airplane to the uninitiated, but we have a lot of important, detailed work to go. The panel needs to be installed, the controls rigged, engine hung, etc. Lots of little details to make it airworthy. We can see the finish line, but it still seems a long way off. Keep putting in the time, and little by little you'll be closing in on the finish line.

GOAL: BUILD AND FLY SAFELY

No matter where you are in your project, schedule a technical counselor visit to inspect your work. We all get so close to our project that we often miss issues that a tech counselor will catch immediately. The best way to preserve the incredible freedom we have to build aircraft is to have a solid safety record. Do your part by using the EAA Technical Counselor and Flight Advisor programs to demonstrate your commitment to safety.

Well, now that I've told all of you that your EAA staff is going to have the CH 750 flying by AirVenture, it is time to get back out to the shop! EAA

Photography by Jennifer Bowen

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EAA SportAir Workshops

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Young Pilot Uses EAA Youth Programs to Earn His Ticket

ERIC BEETS WAS determined to be a pilot, and the EAA Young Eagles program helped him achieve it. After Eric, EAA 1078480, took a Young Eagles flight on January 15, 2012, the 17-year-old high school student from Burlington, Wisconsin, made the decision that he would become a private pilot. Thanks to his determination and the EAA Young Eagles Flight Plan, Eric passed his checkride on April 5, 2013. Now he's organizing a Young Eagles rally at his home airport next spring.

Eric gives EAA 100 percent of the credit for teaching him about aviation. After the Young Eagles flight, he completed the online Sporty's Learn to Fly Course (provided free to Young Eagles), applied for and was granted a scholarship to attend the EAA Air Academy, passed the FAA written exam on his first attempt (the cost of which was reimbursed by EAA), plus was chosen as a recipient of a Gathering of Eagles flight training scholarship.

Now he's spreading the word about flight to his friends and the public. "I've already given flights to some of my friends, and I feel it's my duty to help others discover flying like EAA helped me," he said. "I want to help get anyone and everyone interested in aviation, and I thought that telling my story to other parents, kids, pilots, and anyone willing to listen would be a great way to achieve my goal."

FAA to Delay Sleep Apnea Policy

THE FAA WILL DELAY implementation of its new sleep apnea policy in order to gather additional input from the aviation and medical community.

The new policy, which would mandate obstructive sleep apnea (OSA) testing and evaluation for pilots with a body mass index (BMI) of 40 and above, was scheduled to go into effect in January. EAA and its Aeromedical Advisory Council objected strenuously to the policy, saying such testing was not FAA's role, was of questionable medical use relating to pilot fitness, would cause additional financial burdens to pilots, and would overburden an already taxed special issuance system for medical certificates.

The FAA is now planning a meeting in early 2014 with aviation and medical stakeholders, including general aviation organizations and aviation medical examiners (AMEs).

"We are pleased to see that the FAA will organize a meeting mid- to late January, get all concerned together, and try to hash out a compromise that will address FAA's concerns about sleep apnea with all of our concerns about cost, intrusiveness, and adverse effect on the industry," said Sean Elliott, EAA vice president of Advocacy and Safety. "EAA stands ready to assist and represent the aviation community in any way possible."

EAA Hails Bill to Cut Third-Class Medical for Many GA Pilots

REPS. TODD ROKITA (R–IN) and Sam Graves (R-MO) introduced a bill in the U.S. House in mid-December that seeks to abolish the third-class medical certificate for many pilots who fly recreationally.

The General Aviation Pilot Protection Act of 2013 (HR 3708), co-sponsored by Reps. Bill Flores (R-TX), Mike Pompeo (R-KS), Collin Peterson (D-MN), and Richard Hanna (R-NY), would require pilots who fly recreationally to hold a valid driver's license in lieu of a third-class medical certificate and operate under specific limitations. EAA and other aviation associations worked with Rokita to develop and promote this legislation as part of a continuing commitment to lowering barriers to aviation participation.

"This legislation addresses two goals EAA has long advocated: eliminating excess red tape in the medical certification process while maintaining a safe way to keep pilots flying," said Jack Pelton, EAA chairman of the board. "Our members and the general aviation community have long supported a change in the medical certification process. This proposal will maintain safety, reduce costs for pilots and the federal government, and allow people to pursue the unique freedom of flight in the same way they can pursue other powered recreational activities." The proposed legislation would allow pilots to use a valid state driver's license in place of the traditional medical certificate if the flights are:

- not for compensation
- conducted in VFR operations only, at or below 14,000 feet MSL
- no faster than 250 knots
- in aircraft with no more than six seats and no more than 6,000 pounds gross takeoff weight.

In addition to allowing pilots to operate common GA aircraft for recreational flying without a third-class medical, the bill mandates that the FAA prepare and send a report to Congress detailing the impact of the bill's passage on GA safety within five years of the bill's enactment.

"The third-class medical certificate does little to evaluate the day-to-day fitness of pilots flying recreationally," said Sean Elliott, EAA vice president of Advocacy and Safety. "There are better ways to maintain high medical standards for aviation and allow individuals the freedom to enjoy the world of flight."

The bill continues EAA's effort to maintain aviation safety while growing participation in aviation. EAA and other aviation groups have regularly petitioned the FAA for medical certification updates and changes, most recently in the joint EAA/AOPA third-class medical certificate exemption request in March 2012. The FAA has yet to move on the request, despite more than 16,000 supportive comments to the docket during the public comment period—a fact not lost on members of Congress who have been monitoring the issue. EAA is grateful for the support of Congress on this issue, which is critical to pilots everywhere, and will work tirelessly toward passage of the bill.

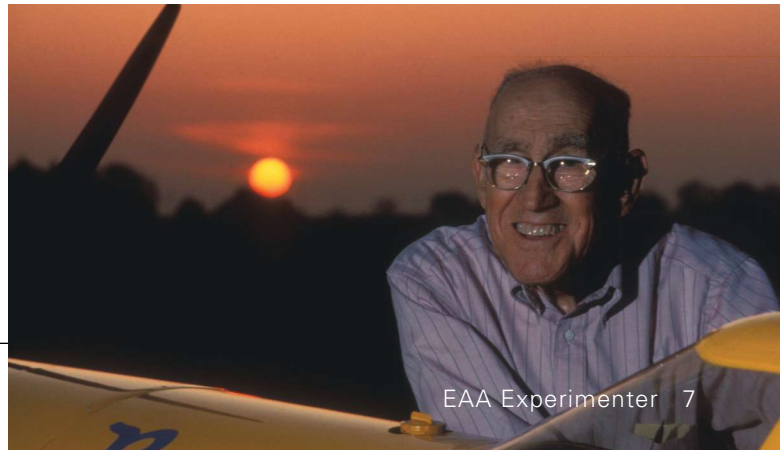
Steve Wittman Among 2014 National Aviation Hall of Fame Inductees

THE LATE SYLVESTER J. "Steve" Wittman, the pioneering aircraft designer, builder, and racer who was an early EAA member and the namesake of Oshkosh's Wittman Regional Airport, is one of six individuals who are among the class of 2014 inductees for the National Aviation Hall of Fame (NAHF).

The NAHF announced the upcoming year's inductees in mid-December on the anniversary of the Wright brothers' first successful powered flight on December 17, 1903.

Wittman built his first airplane in 1924 and competed in his first air race in 1926. He managed the Oshkosh airport and operated an FBO and flight school there while continuing to design, construct, and fly innovative aircraft, his homebuilt kit plans selling in the thousands. His final air race was in 1989, at age 85. Along with Wittman's name on the Oshkosh airport he managed until the late 1960s, EAA Chapter 252 in Oshkosh is known as the "Steve Wittman Chapter."

The six 2014 inductees will join 219 other aviation and space pioneers who have been welcomed into the NAHF since 1962. That roster includes EAA's late founder, Paul Poberezny, who was inducted in 1999. Also on the list of 2014 honorees is EAA board member Alan Klapmeier, who will be inducted along with his brother, Dale. The 2014 induction will take place in Dayton on October 4, 2014. Other inductees include: the late Bertrand "Bert" B. Acosta; Brigadier General James A. McDivitt, US. Air Force (ret.); and Emily Howell Warner. EAA



Belite SeaLite Flies

BELITE MADE THE successful first test flight of its new aircraft, the Belite SeaLite, in mid-December.

The SeaLite is an amphibious, carbon-fiber, float-equipped aircraft, designed to fly legally under FAR 103 regulations off of water or land.

The base aircraft is a design variation of Belite's UltraCub aircraft and incorporates a number of technically advanced features that enable it to fly with an empty weight that is under the FAR 103–prescribed maximum airframe weight of 338 pounds allowed for a float-equipped ultralight.

James Wiebe, CEO of Belite Aircraft, was at the controls for the first flight: "I was pleased with this test flight; it demonstrated the performance and utility possible with a single-place amphibious aircraft. The ground roll was very short, the climb rate was impressive, and the landing manners were easy and benign."

The spars in the wing are constructed from carbon fiber, as are the floats and certain other key elements of the aircraft. The fuselage is constructed largely from aerospace aluminum. Each basic wing panel weighs only 20 pounds; each individual carbon-fiber float also weighs about 20 pounds.

The SeaLite also features a custom lightweight instrument panel with a full range of conventional instruments. The SeaLite was developed in direct response to a customer request and will be delivered to an individual in the upper Midwest early next year. In amphibious (land/water) configuration, this new aircraft is priced at $60,000. In straight (water only) configuration, it is priced at $50,000. Other nonaquatic versions of Belite UltraCubs have starting prices under $20,000.

For more information about the SeaLite, visit *www.BeliteAircraft.com*; watch a video of the first flight at *http://YouTube/8kQz49-0Dpw*.

Thatcher CX5 Makes First Flight

THE FIRST FLIGHT OF Dave Thatcher's latest creation, the two-place CX5, N14GB, took place on Tuesday, December 17, at Jack Edwards Airport in Gulf Shores, Alabama.

According to test pilot Dr. Glen Bradley, EAA 164271, it's quite an airplane. "Dave hit a home run with the CX4, and I told him today he has now hit two clean out of the park," he wrote in his pilot report to an online news group.

Thatcher, 81, EAA 654626, of Pensacola, Florida, gained wide acclaim for the single-place CX4, for which more than 500 plan sets have been sold. Bradley declared in the pilot report, "One can tell right away the two planes are brothers. Not only do they look alike, they fly very similarly."

The CX5 measures 18 feet in length with a 28-foot wingspan, has an empty weight of 721 pounds with a useful load of 579 pounds, and is powered by an 85-hp Volkswagen engine. Cruise speed

is 125 mph, and plans will be available following completion of the 40-hour flight-test period.

Read the full PIREP.

Zenith Flies With New Rotax 912iS

A STOL CH 750 has become the first Zenith kit aircraft in North America to fly with the new Rotax 912iS engine. The flight was the result of a collaborative effort involving Zenith Aircraft Company, which supplied the aircraft kit; Rotech Research Canada Ltd., which installed the engine; and Skytek Aircraft Services, which assembled the airframe. Skytek also developed the firewall-forward package for completing the engine installation.

"Both the aircraft and the engine performed flawlessly," said Sebastien Heintz, president of Zenith Aircraft. "We put 7.5 hours on the CH 750 on the first day and had no squawks. Rotax has done it right."

Heintz said the installation of the fuel-injected 912iS is considerably more complicated than the standard, carbureted 912ULS engine. However, the new model has considerably more redundancy, increased efficiency, and reduced pilot workload and is certifiable. It operates without primers, carb heat, or mixture controls. The engine and accessories are monitored constantly by a built-in computer that alerts pilots to any issues that arise on the ground or in the air. The end result is a higher level of reliability and enhanced safety.

The Rotax 912iS is a four-cylinder, four-stroke engine with opposed cylinders that is cooled by air and liquid. A dry sump features lubrication from a separate .8-gallon oil tank. Hydraulic valve tappets provide automatic adjustment. There are two redundant electronic fuel-injection systems, an engine management system, dual electronic ignition, electric starter, and integrated reduction gear. The 912iS has a 2,000-hour TBO.

Zenith Aircraft is now offering the 912iS as an engine choice from a list of powerplants that includes the 100-hp 912ULS, the turbo Rotax 914, the fuel-injected ULPower and Viking engines, as well as the Continental O-200 and the Lycoming O-235/233 engines. Each of these engines is suitable for the high-wing CH 750 series or low-wing CH 650 designs. For a video clip showing the first flight with the 912iS, visit *www.Zenith.aero/video/ch70-912*.

For more information on the CH 750 kit aircraft, visit *www.ZenithAir.com*.

First Quicksilver S-LSA Awaits FAA Approval

QUICKSILVER AERONAUTICS has completed the flight-test regimen required to comply with ASTM industry consensus standards for a special light-sport aircraft (S-LSA) with its strutted Sport 2S. With an FAA audit expected to occur in late 2013, Quicksilver hopes to gain FAA approval for the 2S as an S-LSA in early 2014. Quicksilver has produced more than 15,000 kit-built aircraft since the early 1970s; this will be the company's first S-LSA.

"We completed an entire ASTM design and performance standard test matrix that demands more than 100 hours of test flying," said Daniel Perez, chief operations officer for the California company. Those flight hours involved 236 takeoffs and landings. These results follow a long period of other detailed testing and significant document preparation and arranging the factory for repeatable, quality-controlled production of ready-to-fly aircraft.

The Sport 2S, a strutted, open-cockpit, side-by-side two-seater, is the first Quicksilver aircraft to complete the entire compliance package. The company is also progressing with S-LSA testing for its GT 500 aircraft, which was the first aircraft to win FAA Primary Category approval in 1993.

For more information about Quicksilver Aeronautics, visit *www.QuicksilverAircraft.com*. EAA

Landings...

There's short, very short, then there's ridiculously short

BY BUDD DAVISSON

Photography by Brady Lane

THE ANNUAL VALDEZ, ALASKA, short-field takeoff and landing (STOL) contest is famous for really silly takeoff and landing distances. The distances are so short that they could easily be measured with a yardstick. But how short is short? According to competitor Frank Knapp (EAA 1111767) flying his *Lil' Cub*, "We had no wind this year, so our landings were 54 and 56 feet. Even a little wind would have made them much shorter."

The landings may have been long to Frank, but they were short enough to win the overall contest at Valdez. And they were the result of the dozens of unique details Frank worked into his self-designed, ultra-utilitarian, Cub-ish-appearing aircraft. Starting with nothing more than some goals and vague ideas, Frank and his wife, Kris, built a championship machine.

Frank uses an 80-by-30 Catto propeller that really bites into the air.

Frank said, "I was pretty much brought up around these kinds of airplanes. My father had lots of airplanes and was a true bush pilot and creator with many innovative ideas. He had the ability to build things very light but with function, all the while using parts from the scrap box.

"He built a ton of interesting projects, including airplanes, swamp rigs, seagoing boats, air boats, lots of engine-driven tractors and kid vehicles, prop-driven snow machine, etc. If you thought something was junk, you had to be careful because it might become his next project.

"Dad also had a full-service automotive body shop doing everything from framework, paint, glass, radiators to some aircraft work. If that business was slow, he might smelt gold for jewelry or simply go fishing.

"Pretty much anything dad wanted, he built; there was nothing wasted. Ever. And that's how I was brought up. So, when my wife and I decided to build a super-short-field machine, although my background was as an electronics tech for the phone company, I had a pretty good hands-on building background to draw on."

Frank learned to fly in the J-3, and when a Cub is light, it is the most fun of any aircraft. Frank said the Cub is light on the controls and very responsive. "That's where we started, but we decided to integrate some of the ideas we felt might make the best airplane," he said. "Some of the goals were: light weight, good visibility, a dependable powerplant, and readily available

Frank Knapp and his Lil' Cub.

Photography by Brady Lane

parts. Basically, what we wanted was something that fit our style of flying better than the standard Cub."

Frank said a Super Cub fit his needs well, but most of his flying is alone; and he wanted something that was good on fuel so he could afford more time in the air. As he put it, "It's not so much about going cross-country as it is enjoying slow flight, so that's why the *Lil' Cub* has a removable rear seat with no rear controls and uses a smaller engine than most."

Not having an engineering background or anyone close who could do the analysis, Frank used the time-honored method of see-what-others-have-done-and-adapt-it. "We studied lots of small plane designs and the tests completed by Jerry Burr and others," said Frank. "Basically, we followed the general parameters of a Piper Cub J-3, PA-11, and Super Cub. To keep things organized, we used the "list method": One notebook kept the list of goals; another kept conceptual hand drawings, test results, and trim parameter changes."

Of course, as is almost always the case with a one-off experimental design, getting the airplane flying was just the first step. From that point on, refining the airplane was a nonstop series of changes where ideas were tried, found wanting, and so another was tried.

Frank said, "The build has been evolving based on the initial flying results. From there we modified the fuselage, tested and modified the flaps three times, modified the droopy aileron system a couple times, and we tried several sets of tires and installed a carbon tail tank.

"One of the best modifications to the Piper design was dropping the firewall and moving the small instrument panel out against the firewall. This allowed the Lexan windshield to extend much further than stock and allowed the windshield to be bent from flat-stock Lexan with no compound bends."

The flaps go all the way down to 70 degrees and the ailerons droop at the same time. At maximum deflection, the ailerons are down 22 degrees.

The engine for the *Lil' Cub* is the tried-and-true Continental C-85-12, with a few modifications aimed at squeezing a little more power out of it without reducing its legendary reliability. Frank explained those changes: "It has been stroked using an O-200 crank, and the jugs have been ported and polished, both of which generally yield only a little more power but increase efficiency. The same thing could be said of the balanced rotating assembly. It makes everything smoother, but the 10-to-1 pistons

To see the Lil' Cub in action, watch this video.

These slats are not fixed as you think at first glance. Instead, they are air-operated; they close with speed and open once the angle of attack is increased at slower speeds.

definitely produce a few more ponies. We're going to be installing a custom ground cam soon from Don's Dream Machines.

"We went to Kevin and Marshall Murray at Sky Dynamics Corporation, who helped design and build the exhaust system. It lets the engine breathe much better, which is essentially free horsepower and better fuel efficiency."

Pilots from the lower 48 states are bound to notice the plastic Log Cabin syrup bottle zip-tied to the motor mount. Frank explained, "Most Cub engines have some blow-by out the case breather, and the bottle catches any slobber, which keeps the belly cleaner."

Sharp-eyed observers will also notice what appears to be unused mounts for an engine cowling that isn't installed. Frank said, "We used a cowl for 200 hours, but we ran into difficulty when moving the thrust line very far. Also, with all the testing we were often running without the cowl, then, due to the weight, we just decided to leave it off. It contributed nothing but weighed something, which went directly against the concept of the airplane, which is 'Make it light and make it functional.' We do our best to stick to that."

For a prop, Frank is running an 80-by-30 Catto prop. (Yes, we said 30...hey, it's a short-field machine, not a boulevard cruiser.) He said they've tried several different props, but the Catto pulls better than the rest.

A casual glance at the front of the cockpit shows the unique forward location of the instrument panel, which exposes some unusual tubing trusses. Frank explained those: "We're running a few more horsepower so we forgo weight for strength in the motor support area. Additionally, although the fuselage follows a J-3 design, we eliminated braces on the floor, and the top of the fuselage is cross-braced with the spar attach fittings on the outside, like a Super Cub, rather than inboard, like a J-3. This gives more room and visibility."

Also unusual is the overhead flap handle on the left side. Frank said, "We debated whether to have flaps because of the weight; but we talked to a lot of other pilots who advised having them, so we made them part of the design. We used twine to decide the positions and leverages, but the flaps were relatively clean and simple with a stacked pair of pulleys in the rear to

Photography by Brady Lane

guide the cables down each wing. Once the flaps were designed, it became apparent that the same action could also be used to droop the ailerons. With a little trial and error, an overhead arm was used to get the proper leverage and travel for both flaps and ailerons. For the endless loop to function and allow the stick to still move the ailerons, a pair of pulleys were added on the bottom rear of the stick torque tube."

And speaking of the torque tube, it's just another example of how every single component was analyzed with the thought of how to make it work but weigh less. Everything that will structurally tolerate lightening holes was attacked with a step drill. The edges of each of the holes were carefully deburred and rounded to prevent stress risers, which must have been a tedious, time-consuming job, considering the hundreds of lightening holes everywhere you look.

One change Frank said he would make, if he had to do it over again, is the outline of the top of the rear fuselage. He said, "The Cub aft longerons are actually low, just about level with the bottom of the windows, and the upper fuselage has a system of standoffs and stringers that give the familiar upper fuselage outline. However, instead of using the top deck gingerbread, we opted to leave all of that out but keep the original layout otherwise. We would raise the upper longerons next time. Would be the same weight but more aerodynamic. Initially, the aircraft was flown with no fabric from the back of the cabin to the tail, like the well-known Super Cub *Got Rocks?*. We flew this way for more than 200 hours, then added the fabric.

"Incidentally, we were going to name our Cub *Got Pebbles?*, but there's a controversial mine in Alaska, the Pebble Mine. I told Kris we could name it *Got Stoned?*, but she overruled me; so the politically correct name *Lil' Cub* evolved."

The airplane is a tour de force of outstanding, utilitarian details with the tailskid being one of them. Rather than suffering the weight and expense of a tail wheel, Frank went with an Alaskan version of a tailskid. It features a shoe composed of multiple layers of conveyor belt material. Frank said they replace the outside layer about once a month if they do much flying on pavement.

The main gear is shod with 26-inch Alaska bush wheels with single-puck Grove brakes doing the stopping. However, check out the brake rotors; they are mostly holes. When asked why, Frank just grinned and said, "weight." He's pretty predictable.

The basic fuel system is as simple as the rest of the airplane with an 11-gallon tank in the left wing that gravity feeds directly to the engine with no header tank between. However, there's a unique, carbon-fiber, 5-gallon tank from Randy Apling at Carbon Concepts LLC nestled in the rear fuselage under the elevator screw jack. Besides giving a solid hour of extra fuel, it functions as a variable weight that can be used to put the center of gravity (CG) exactly where Frank wants it with various loads. The entire aft part of the cabin behind the seat is a cargo area, so his CG constantly varies, depending on the mission at hand.

When it came to building the wings, Frank again opted for traditional structure but with his own twist. "We used aluminum angle ribs, and all support braces have lightening holes,"

ORATEX COVERING:

THE NEW KID ON THE FABRIC-COVERING BLOCK

Frank Knapp used a new, nontraditional covering method on his *Lil' Cub* that has been developed by Lanitz-Prena Folien Factory Oratex (Leipzig, Germany). Bridging the gap between iron-on model aircraft covering and traditional aircraft fabrics, Oratex polyester fabric is already sealed and painted, and once glued in place, is shrunk to taut by heat. It is certified in some countries for some certified airplanes, and Frank and Kris can't say enough good things about it.

We asked Frank to lead us through the process, and he quickly told us that the advantages to it are that it is light, is super easy to apply, and has no smell or toxic properties. Because the heat-activated adhesive is water-based, there is no painting involved unless you want to.

Frank said, "Oratex saved at least 25 pounds on the *Lil' Cub*. Our experience with the airplane shows that it takes between $500 and $1,000 to lose one pound when replacing something with titanium or carbon, assuming you can find something to replace it with. Even at the light end of that assumption, Oratex saved $12,500 in weight! I think it paid for itself several times right there.

"My wife, Kris, took ownership of the fabric work. She had zero experience working with aircraft or fabric. Although I have hacked and cut doing changes and different tests, I think her work still looks great. I helped Kris with riveting the fabric to the ribs, but with two grandparents working on the fabric, we were completely done in four long days! Most processes would take longer just to do a single wing! Here's the process we used:

1. First, we cleaned and lightly primed all metal to be covered, then scuffed again lightly.
2. We brushed on a light coating of glue to the frame parts, wrapping the last tubes to be covered and let dry.
3. Next, we hung the fabric over the area, then marked the back side of the fabric (with pencil) where it would attach to the framework.
4. We applied a light coat of glue to the back of the fabric and let it dry.
5. We hung each fabric section in place and tacked it in place using a small electric iron. No clips were required because the glue attaches with heat.
6. Once the fabric was attached, we started with the perimeter, then shrunk the overall panel using a heat gun.
7. After the previous section was properly attached, we moved to the next, applying glue to any overlapping areas that we would then bond with heat.
8. The fabric was attached to the ribs either with rivets or by sewing. The seams were covered using colored tape that already has glue applied to the back surface. These easily attach using heat.

"Anyone taking basic care and having no previous experience can produce a good, safe covering job while not requiring the investment in breathing or painting equipment. My past projects included a lot of painting, and as a result, my body has built up a toxicity level, which requires a lot of caution around any paint products. My wife and I covered the entire aircraft (after preparation) in four (long) days using no special care or protection. We enjoyed the process and look forward to the next.

"We found the fabric to be much stronger, I believe, because the paint/UV protection is already applied at the optimum thickness. This makes fabric much tougher to normal flying abuse. While in Arizona, we regularly used a pressure washer to clean the fabric. The 2,500-psi water at 2 to 3 inches from the fabric did not affect the fabric, paint, or even the tapes! When flying the rivers in Alaska, the fabric does not chip or damage like other (thicker) processes. It costs about $75 per square yard.

"The fabric doesn't gloss like a new Chrysler, but it also doesn't weigh as much as high-gloss processes either. The shine is a soft gloss and very pleasing to the eye. We enjoyed that the product is nontoxic (doesn't smell) and is so easy to apply. With more than 470 hours in Arizona sun and Alaskan grime, the fabric is holding up wonderfully. I will use Oratex on my next project. We don't sell the stuff; we're just sold on the product!"

Oratex is distributed in the United States by Lars Gleitsmann, USA Oratex/Lanitz-Prena-Aviation Products, 4621 Caravelle Drive, Anchorage, AK 99502. Learn more about Oratex at *www.BetterAircraftFabric.com*. Contact Lars by calling 907-229-6792 or e-mailing *Lars@betteraircraftfabric.com*.

he said. "The spars are aluminum with 3-inch holes in the front one and 2-inch holes in the rear spar. Currently there are 13 full ribs with no short leading edge ribs, which are usually used to support a leading edge. We can get by without the nose ribs because our leading edge is carbon fiber and is so stiff that it doesn't need the support. The fabric is pop-riveted to each rib with no rib stitching. The tip is currently a short wood bow, and normal drag, anti-drag wires are used throughout."

It should be mentioned that the carbon-fiber leading edge has two rows of 3-inch lightening holes on the lower side that are covered by the fabric. A good indication that someone is a hardcore weight freak is when he cuts lightening holes in carbon fiber, which is already feather light! We wouldn't be surprised to find that Frank's fat tires are filled with helium.

What appear to be fixed slats on the leading edges of the wings, and which certainly complicated the wing structure, are actually air pressure–activated slats. Frank said, "The slats close with speed and open once the angle of attack is increased at slower speeds. We tested several opening gaps and found that a 3-inch rear gap allowed good transfer of air through the opening without frontal bunching of air."

And speaking of details, note that Frank has vortex generators (VGs) on the inside of the slot that is formed, when the slats are out. He explained, "The VGs were very effective at preventing an early stall before the slats were installed. Because of the boundary layer improvement without slats, we left the VGs in place to help stabilize the compressed slat air. While testing with slats extended, if one side had no VGs, it would stall; however, the side with VGs would not."

It's also worth noting that carbon fiber is used in a lot of unexpected applications. For instance, the brackets that hold the slats in place are constructed from seven layers of carbon, rather than being formed or milled aluminum. They also used carbon fiber for the window and doorframes as well as miscellaneous small covers. Obviously, Frank thinks every ounce counts, which has paid off.

The flaps that he is flying now are fairly "normal" hinged units, but he said they may evolve into being double-slotted Fowler types. However, he added, "They must be light first,

As this issue going to "press," we learned that the Lil' Cub was destroyed in a hangar fire in late December. However, we felt the uniqueness of this aircraft deserved that its story still be told. In better news, one of the world's most unique aviation competitions, Valdez Fly-In & Air Show, will be re-created at EAA AirVenture Oshkosh 2014. The airplanes that compete at that event in May each year will visit Oshkosh. Along with flying demonstrations during AirVenture's daily afternoon air show July 28-30, the Valdez STOL aircraft will stage a "fun flying" demonstration from the grass ultralight runway on Friday evening, August 1. The aircraft also will be on display in special parking areas and on the main showcase ramp at Oshkosh, with pilots and builders part of forums and evening programs throughout the week.

Photography by Brady Lane

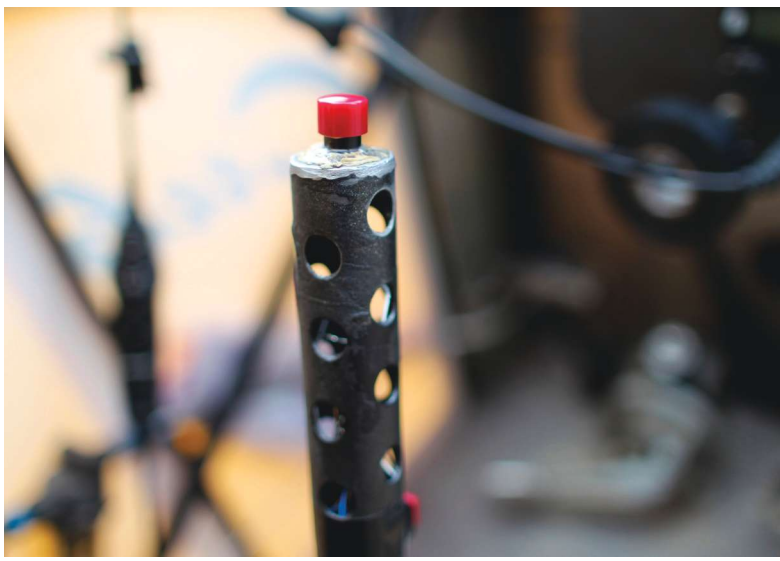
then provide performance gains second." The flaps go all the way down to 70 degrees (!) and the ailerons droop at the same time. At maximum deflection, the ailerons are down 22 degrees.

All of Frank's weight-saving efforts have resulted in a sophisticated airplane that weighs 685 pounds with the fat tires and 85-hp-plus engine, as compared to the factory weight of a 65-hp J-3 Cub of around 765 pounds. The airplane's gross weight is 1,300 pounds, so the useful load nearly matches the empty weight. That's an efficient airplane! Of course, it is optimized for short-field performance, so it pays a penalty, as in a 62-mph cruise, "...70 mph, if going downhill a little," Frank added. I'm betting a different prop that isn't so short-field oriented would up the cruise considerably. But then it might take him as much as 100 feet to take off and land. Gee!

Speed isn't what it's all about. Frank said, "The most fun is flying the rivers with a 10- to 15-mph breeze. I'm just sightseeing, going nowhere while riding the next puff of air to a near stop all afternoon long. At the same time, should I want to visit a sandbar or small valley, I know it will more or less hover to a landing."

Frank has two basic methods for making his spectacularly short landings:

1. a low-and-slow approach using up all possible inertia; once crossing the line, pull back and mush to a one-bounce landing, converting some of the remaining inertia into the ground. Immediately remove any flap/droop and use brakes to help stop.
2. a higher stabilized approach slowing to behind the power curve and controlling the touchdown point with pitch and throttle. Once on the ground, immediately remove any flap/droop and use brakes to help stop. This provides the shortest landing; however, it's more difficult to pinpoint the spot.



Frank even drilled lightening holes into his control stick to reduce weight.

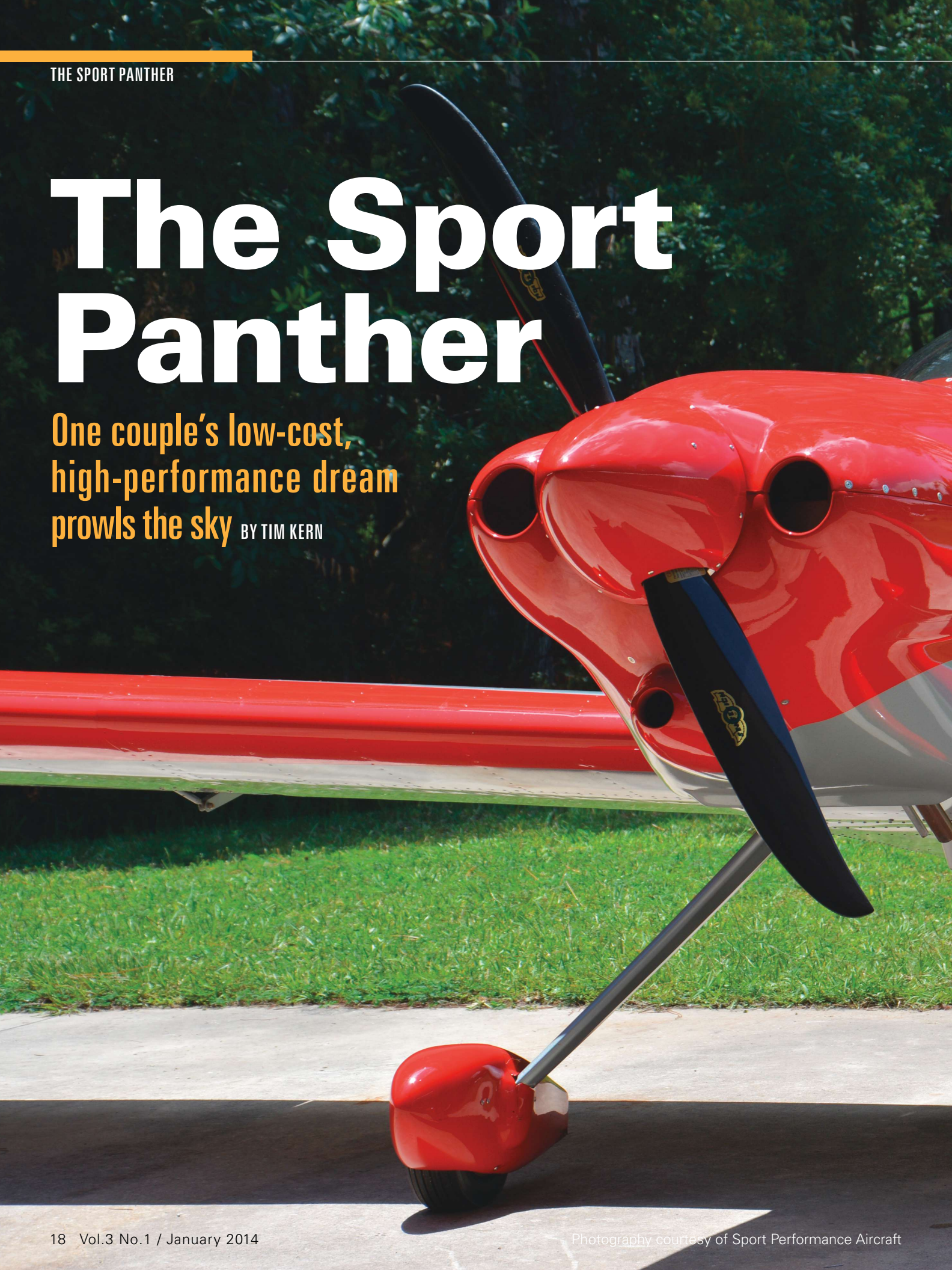
Don't try this at home, children. Frank and his ilk are professionals and do the impossible on a daily basis. Still, when you see the hardware he has developed for the task, doesn't it make you want to start modifying a Cub and go visit places where airplanes aren't supposed to go? EAA

Budd Davisson is an aeronautical engineer, has flown more than 300 different aircraft types, and published four books and more than 4,000 articles. He is editor-in-chief of *Flight Journal* magazine and a flight instructor primarily in Pitts/tailwheel aircraft. Visit him at *www.Airbum.com*.

The Sport Panther

One couple's low-cost, high-performance dream prowls the sky

BY TIM KERN



Photography courtesy of Sport Performance Aircraft


N515XP

FOLLOWING A PROJECT TO completion takes dedication, brains, and a bit of luck. The more brains and dedication, the less luck is needed. Such is the case with the Sport Performance Panther, shown in complete and flying form at EAA AirVenture Oshkosh 2013.

"I've been involved in aviation my whole life," said Dan Weseman, co-founder with wife Rachel of Sport Performance Aviation LLC, as we sat under his awning at Oshkosh.

Twenty feet away, covered by showgoers, was their baby—a single-place, Corvair-powered, low-wing monoplane that features monocoque and steel tube construction, with aluminum skin and a fiberglass cowl that sits behind a Sensenich composite prop and spinner. It's called the Panther, and its engineering is stealthy; it looks simple and is simple to build, but it wasn't simple to design.

The Panther in flight. It can be built as either a tail dragger or tri-gear.

The single-place Panther has a sturdy roll-over structure.

Dan and Rachel Weseman have spent several years on this plane, which they first showed to the public at the 2012 Sun 'n Fun International Fly-In & Expo. It is the result of a lot of thinking and firsthand experience. In Dan's aviation life, he's been a draftsman (both pencil and CAD); he has run and programmed CNC machinery; and he's a self-educated engineer who tempers his own experience and ideas with those of an aerospace engineer friend. Dan said, "I taught myself CAD some five years ago; and I've read and reread Chris Heintz's book [*Flying on your Own Wings*], John Roncz, and others." In addition to having built a Corvair-powered Sonex (irreverently called a "Cleanex"), he has also built an RV-4 and parts for a Harmon Rocket; he currently owns a Glasair.

It's called the Panther, and its engineering is stealthy; it looks simple and is simple to build, but it wasn't simple to design.

Dan is perhaps best known as a supplier to top-line Corvair engine builders, with his bolt-on "fifth bearing" setup, billet crankshafts, and alternator options now powering hundreds of homebuilts. Dan won the Cherry Grove trophy in 2009, which is given annually to the pilot who makes the greatest contribution to the Corvair movement. As pointed out in *EAA Sport Aviation* (January 2011), "A solid, safe, well-built Corvair can fit your firewall for well under $5,000. So can a crummy one, so it's important to learn a few things first." Dan is one of the people who makes the parts and has the know-how to help build the good ones. And so his Panther was designed to use the smooth six-cylinder Corvair as its primary engine.

Still, Dan wanted to build, using an engineer's explanation: "my own set of compromises. I wanted to do *my own*."

FROM CONCEPT TO COMPLETION

Looking at his dream not only as a fulfillment of his own ideas but also as a commercial kit from the start, he notes similarities between his Panther and other well-known kits. "We [designers] all started at about the same place," he said. "You might think of this as a cleaned-up and rounded Sonex, using only about 60 percent of the parts count of an RV-4."

Continuing the comparisons, Dan said, "You could also think of it as an inexpensive, uncomplicated RV-3."

"Uncomplication" takes a lot of thought. The folding wings emulate those of many sailplanes, with overlapping spars at the center section; four pins (two forward, two aft) are safetied. Folding or unfolding the wings is a 5-minute, one-person job. The dry-break fittings between the wings keep assembly and disassembly dry. And the tanks incorporate "flop tubes" in case the builder wants to do some aerobatics and has the powerplant to do it.

Photography courtesy of Sport Performance Aircraft

For everyday storage, the Panther's wings fold. Using a combination of Navy and sailplane technology, Dan has a setup that can go from folded to flyable in about 2 minutes. An additional plus is that the tanks can be filled when the wings are folded.

Although folding the wings is the usual footprint-reducer of choice, the wings are also easily removed for hauling. The Panther can be trailered in a 7-foot by 7-foot by 19-foot-long trailer "with half an inch left side-to-side," Dan said. "From wings-off in the trailer to flyable takes two guys 15 minutes."

Dan also noted that this is one of the only modern kit planes where you can get great performance by building your own engine. For about $7,000, you can have an AeroVee (80 hp) or Corvair (100 hp) engine ready to make your day.

Other details show a lot of thought: The cable covers and map pockets are also stiffeners. The 2-cubic-foot forward luggage compartment provides enclosed storage usually provided by the second seat. (There is also a luggage compartment, aft.)

Inset, the isolator used for the automatic connection of the fuel sender unit in the wing. It's created by the 3D "printer."

WHY A SINGLE-SEATER?

There is just one seat, with a five-point harness. Why, when the vast majority of light-sport aircraft (LSA) are two-place? First, a solo machine can accommodate nearly any size pilot without compromising aerodynamics. The Panther fits a wide range of pilots, courtesy of 6 inches of rudder pedal adjustment and 8 inches of seat adjustment. A single (or tandem) configuration's frontal area is constrained more by the engine than the cockpit, and the ballistics of the fuselage can be superior to that of a wider airplane, as well. This allows higher speed on lower power, which is another way of saying "economy." Center of gravity is more easily controlled (and therefore optimized). Additionally, a single-seat design in a weight-constrained class allows a lot of fuel capacity and a strong structure. Rollover protection and ballistic parachute mounts (the ballistic chute option is being developed) are built into the welded 4130 chromoly structure.

Light weight also gives a light wing loading. Dan said, "We've tested a 45-knot stall at 1,115 pounds."

Rachel and Dan Weseman.

SOME SPECIFICATIONS

The Panther, available as an amateur-built "Sport" model or as an LSA, can be built as either a taildragger or as a tricycle gear on an aluminum 6061-T6 monocoque fuselage forward of the seatback, with aluminum-skinned 4130 chromoly steel tube, aft.

Both models are rated for +6*g* and -4.4*g*; both incorporate four-position flaps, with up to 40 degrees of travel. The 1,115-pound LSA can carry engines of 80 to 120 hp; the Sport can handle up to 160-hp engines.

The LSA wingspan is 23 feet, 6 inches, yielding just under a 12 pounds/square foot wing loading. The 1,150-pound Sport has a 21-foot, 6-inch span and consequent 13-½-pound loading.

The LSA's claimed top speed of 140 to 180 mph can far exceed that of the LSA rule. Dan said, "Our intention was to install a large engine to provide excellent takeoff and climb performance, coupled with the prop to not exceed the continuous power at sea level LSA requirement of 138 miles per hour." The LSA's VNE is listed as 200, and the Sport's cruise is pegged at 160 to 200, with a VNE of 220 mph, at which the prototype has been tested.

The Panther holds 27-½ gallons of fuel in two tanks; fuselage and wing fuel lines mate through quick-connect fittings. The fuel tanks are removable via nut plates, or they can be riveted—it's the builder's option. The seat sits low; there is room for a parachute, and the canopy has a quick-jettison design. A taller canopy is offered, suitable for extra tall pilots, and open-cockpit testing is underway.

BUILDERS HAVE REAL OPTIONS

Another advantage that light weight brings is the ability to use other engines and stay within design limits. "The airplane is

Photography by Jim Koepnick

ADDITIVE MANUFACTURING

MAKING PARTS WITH 3D PRINTING, BY PAUL SALTER

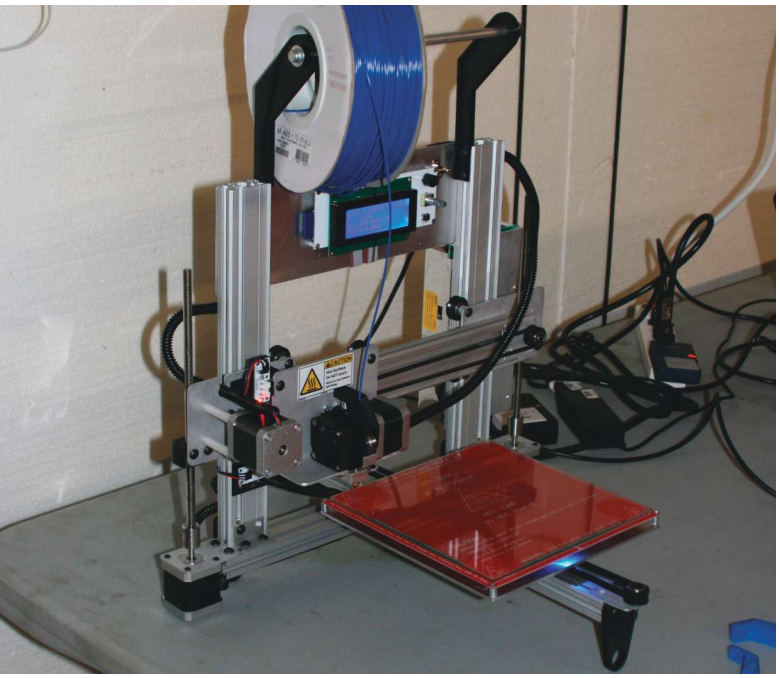
Additive manufacturing is a relatively new type of manufacturing that has been evolving over the last 15 years, and it promises to revolutionize manufacturing techniques. Current machining processes require the purchase of large pieces of material, and then everything that is not needed for the part you are making is cut away. This generates an enormous amount of scrap material.

Additive manufacturing reverses this process and starts with material in either a powder or filament form and only places material where it is needed to form the part. This saves a great deal of material costs and allows complex items to be made almost as easily as hitting the print button on your computer, with little or no scrap. Large aerospace companies are starting to use additive manufacturing techniques using metal powders that are heated with a laser to form jet engine blades, rocket engine injectors, and other difficult-to-manufacture items. Unfortunately the equipment for additive manufacturing with metal is very expensive and currently starts at prices of $100,000 or more.

Fortunately, another type of printer has emerged using plastic filament on spools. The filament is heated nearly to its melting point and deposited in layers using the same technology as CNC milling machines. As the material cools, it bonds to the surrounding material, forming the part. These printers are now available in kits that can be purchased and assembled for as little as $600 by a hobbyist. They are also available in pre-assembled versions starting around $1,000.

Sport Performance Aviation has started to use one of these low-cost printers to manufacture some of the plastic parts for its folding-wing Panther aerobatic aircraft. These include an isolator used for the automatic connection of the fuel sender unit in the wing and for a fixture to make the assembly of the rudder easier. These parts have a honeycomb internal structure and are essentially hollow. This allows the rudder fixture to be manufactured using approximately half of the material used by conventional manufacturing techniques.

The isolators and rudder fixture are only the beginning; there are plans to use this technology for other parts. Sport Performance Aviation is always looking for innovative engineering solutions along with inexpensive and practical manufacturing techniques.



The 3D "printer" that Sport Performance Aircraft uses to manufacture parts for the Panther.

Looking at his dream not only as a fulfillment of his own ideas but also as a commercial kit from the start, he notes similarities between his Panther and other well-known kits.

designed for 80 to 160 hp," Dan said. In addition to his favorite Corvair, the engine options include the Jabiru four- or six-cylinder engines, the AeroVee, O-200; and Lycoming O-233/235, O-320 for the Sport version, plus ULPower four- and six-cylinder engine.

Other Panthers are currently under construction, including a tricycle LSA with a Continental O-200, a Jabiru 3300 LSA taildragger, and an O-320 taildragger Sport.

Building the Panther should be on the easy side. In addition to a conscious effort to reduce parts count and include a jig-welded frame, all the machined parts are precisely made with CNC equipment; the 7075-T6 main gear is grooved for the brake lines; the sheet metal has matched holes. Builders can buy precut, prepunched, preformed, powder-coated forward fuselage kits.

Though most of the sheet metal parts on the tail cone and fuselage are match-hole, some skin holes are necessary in final fitting.

WHAT ABOUT FLYING?

One airplane, the LSA taildragger version with a Corvair engine seen at Oshkosh 2013, and most recently seen flying at U.S. Sport Aviation Expo in Sebring, Florida, has completed flight testing. As tests were concluded, test parameters were widened until the design limits were all confirmed. "As of today (early December 2013), we have 80 hours on it and full positive-*g* aerobatic testing from 0 to 222 mph, with *g*-loads from -1.5 to +6, including deep stalls, spins, and aerobatic maneuvers," Dan said. "We have not been surprised."

Dan said, "It spins, but you have to make it spin. Hands-off recovery takes about one turn; assisted, half that."

So far, Dan's flying impressions tend to describe the Panther's flight characteristics "like a really light RV-4. The stick travel is long but crisp, and it's not twitchy. Long rudder travel gives a light feel there; it's easy to do full control-stop slips, with or without flaps."

PRICING

The firewall-aft kit sells for $11,500. A kit for the cowling, pre-welded engine mount, and baffling for the Corvair goes for $1,500, with prop and exhaust builder options.

For more information, visit *www.FlyWithSPA.com*. EAA

Tim Kern is a private pilot and has written for more than 40 different aviation magazines. He was a key builder on two aircraft projects and has earned the title of Certified Aviation Manager from the NBAA.

Photography courtesy of Sport Performance Aircraft

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Framing in the hut.

Heat Hut

A hangar within a hangar

BY CY GALLEY

HAVE YOU EVER HAD a project in your hangar that you wanted to work on but you couldn't because your hangar was too cold due to outside temperatures? As you may know, there is nothing colder than an airport in winter up north. Going into a metal hangar doesn't make it any warmer.

This fall, Keith Williams of EAA Chapter 75 sold his instrument panel of steam gauges from his RV-6 to replace it with a couple of glass panels similar to what he has in his RV-12. Planning ahead, he knew that he needed to have a warm spot to do the work, as winter was coming. He built a lightweight "heat hut" in which to do the work; making it small in volume meant that he didn't need much heat *if* it was well insulated and sealed.

Pictured here is the basic 2-by-2 framing that he built around his plane. Note that he put his roll-around light stand inside with the diagonal bracing. It also gives some lateral bracing to the hut.

The 2-by-2s are on 24-inch centers. The space between the studs is filled with 24-inch-wide insulation batts, with the paper on the outside and the plastic vapor barrier on the inside. Ceiling insulation was laid on top of the hut with 1-by-2s used for support. The only real protection for the insulation is an inexpensive brown tarp that was laid on top of the ceiling insulation. It is just visible in the picture as the edges were taped down on the sides. He also taped paper around the wings to seal those openings.

There are three 3/8-inch plywood doors that are faced with insulation. You can see the front door in one of the photos. The other two are on each side of the tail so one

A door on either side of the fuselage makes walking around the aircraft easier.

Photography courtesy of Keith Williams

can get around from one side of the fuselage behind the wing without crawling under. Keith can walk around the front of the plane inside the hut, so only one front door is needed.

Because the hut is inside his hangar, it is protected from wind and rain. The top plastic tarp is used to protect the hut from condensation droplets off the metal beams of the hangar caused by temperature changes outside.

Keith built a small platform to hold parts and tools in the warm area. It also serves to protect the wing from damage.

With a small 1,000-watt electric heater as a heat source, Keith said the hut stays above 60°F inside when it is zero outside. (Incidentally, he has the brake rotors blocked so a flat tire doesn't tear open the insulation or damage the wings.)

Now for the caveats. Because the hut is sealed, that creates some serious restrictions. Never heat with combustion, such as with a torpedo heater or propane burner. Because such heaters are not vented and should not be used in a sealed area, you would risk carbon monoxide (CO) poisoning. Also, it's important to be careful with the use of solvents or paint removers. Methyl ethyl ketone (MEK) fumes are extremely hazardous for humans (particularly one's kidneys). Many quick-acting paint removers use MEK, which attaches itself to your red blood cells much like CO. It can be deadly. Check all solvent can labels.

Also, make sure you do not have any gasoline seepage or leaks. Otherwise these fumes could become concentrated in your small-volume hut, just waiting for a spark to touch them off. If you can smell gas, ventilate and remove the gas leak. Small electric space heaters should not cycle, as their thermostats arc.

Common sense is always a homebuilder's best tool. EAA

The panel in mid remodel.

A tarp on top of the hut prevents any condensation off the metal roof from dripping on the hut.

HINTS FOR HOMEBUILDERS VIDEOS

HERE'S MORE OF THE 400-PLUD VIDEOS AVAILABLE ON WWW.EAA.ORG/

Overview of Bolt Torque Issues
Dave Clark from the Vintage Aircraft Association and an A&P instructor at Vincennes University, provides an overview of issues associated with either under or over-torquing a bolt, including torque wrench usage.

Overview of Two-Stroke Carburetor Operation
Brian Carpenter of Rainbow Aviation discusses the theory and operation of the Bing 54 carburetor used on two-stroke engines. Brian is an A&P/IA, a DAR for LSA and E-AB, sport pilot instructor examiner, CFI, and EAA Tech. Counselor and Flight Advisor.

Removing and Replacing Avionics
Dick Koehler shows how to remove and then replace avionics from the instrument panel. Dick is a Technical Counselor for EAA Chapter 186, A&P aircraft mechanic with Inspection Authorization (IA), and a SportAir Workshop instructor.

Checking Propeller Blade Track
Improper propeller blade tracking can cause excessive vibration. In this video, Dick Koehler shows a simple method to check blade track.

Eric takes the original FRED for a spin in Tullahoma, Tennessee, in summer 2012.

Fifty Years of FRED Flying Fun

BY MATTHEW LONG

"NOVEMBER 3, 1963, started off quite foggy, but that did not stop us continuing the taxiing tests. Ernie [Sherry] took FRED up to the top of the hill and drove him off into the fog, returning in a very excited state, vowing he had been airborne, albeit very briefly...Fortified by the knowledge that it was possible, I really went for it in the clearing conditions and performed the first proper flight. It was just a short hop straight across the field at an altitude of less than a hundred feet."

So Eric Clutton describes FRED's first flight just over 50 years ago at the former Royal Air Force airfield at Chetwynd, Shropshire, England, in his memoir *An Aeroplane Called FRED*, including how the FRED looked a little different then—his first engine was a converted Triumph motorcycle V-twin and his wings could be removed and strapped to the fuselage sides but did not yet fold—but Eric still flies that same plane today as N4499Y in Tullahoma, Tennessee. Not many homebuilt planes are still flying in the hands of the original builder/pilot 50 years after the first flight. When that homebuilt is the original prototype of a design still emerging from garages, basements, and garden sheds around the world, that is something to celebrate.

To be sure, Eric Clutton's FRED, more formally the Flying Runabout Experimental Design, is a funny little aeroplane with Rube Goldberg charm. Eric describes it as a 1950s design with 1930s technology because the only aircraft design books to be found in Britain after World War II were from the 1930s. The straightforward wooden construction is best described as "stout," and the long-travel, coil-spring landing gear is forgiving of rough fields. The relatively low aspect ratio, folding, cantilever wing is wire-braced against twisting and uses the same Göttingen 535 airfoil as the Slingsby T.21B Sedbergh training glider with which Eric was quite familiar as a longtime glider pilot. This thick, under-cambered airfoil helps ensure FRED's docile handling while also ensuring that no FRED will ever be called speedy no matter the engine.

Speaking of engines, Eric's own FRED has gone through many. After the Triumph V-twin (barely) got the little plane into the air, the next one was a prewar Scott Flying Squirrel from a Mignet Flying Flea, then a converted Lawrance radial GPU from a PBY Catalina, multiple Volkswagens, a small Franklin, and finally the Continental A-65 that N4499Y still sports today. Most other FREDs have used Volkswagen engines with 1835 cc being the most common displacement. Since Eric's good friend—the late Arthur Tabenor—helped develop that winning combination of airframe and engine, the design is sometimes known as the Clutton-Tabenor FRED.

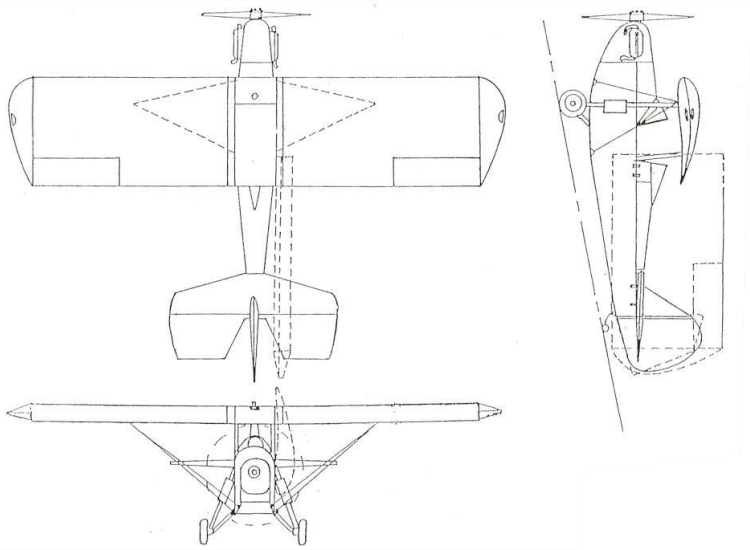
With all the tinkering with engines and propellers to get the diameter and pitch right and the inevitable crack-ups, Eric quips, "Before we finished, I would get so practiced at this propeller making that I wrote a book on it!" Eric's book *Propeller Making for the Amateur*, still available from the EAA shop, remains the standard reference on both sides of the Atlantic on how to carve your own wooden propeller.

Photography by Matthew Long

Over the years, FRED's design was tweaked as new features were added. The original removable wings were upgraded to quick-folding ones to facilitate solo rigging and trailering home on its own wheels with an addition of a towing hitch and frame. The angular all-moving rudder was joined by a more curvaceous mode, and then some 30 years later, a fixed vertical fin option was added because, in Eric's words, "In my old age I wanted FRED to be less lively in rough air." Most FREDs still use the all-moving rudders. Eric even added a small cockpit access door to make entry and exit easier for aging legs.

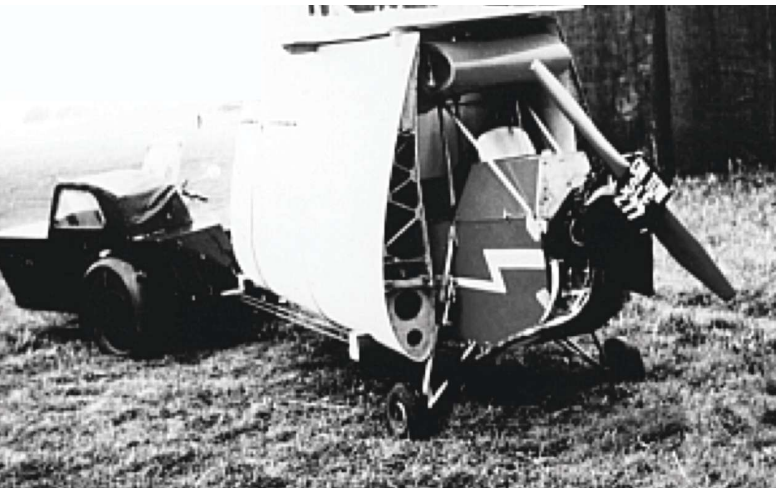
Eric's original FRED is still airworthy but not flown much anymore. Eric is now in his eighties, and getting in and out of the open cockpit is not easy even with the access door. Eric is hoping to see FRED go to a museum or private collection, ideally in the United Kingdom, while Eric plans to continue flying his beautifully restored Luscombe as long as he can.

It's hard to say exactly how many FREDs have taken wing. About 25 appear on the British civil register and as many more on the inactive list; two are flying and at least one more is undergoing restoration in New Zealand; and at least one was completed in the United States in addition to Eric's own imported prototype. Something between 60 and 70 probably have been completed worldwide. The newest appears to be Greg and Dianne Shepherd's G-BWAP, which first flew on October 5, 2013, just a few weeks before FRED's 50th anniversary, which perhaps makes G-BWAP *the* official 50th anniversary FRED. At the other end of the spectrum, Abraham Leket of Israel is making great strides on a new FRED project that was begun in October 2013 and documented in a detailed build log on HomebuiltAirplanes.com. Abraham says, "Looking at those $20,000 to $50,000 proj-



Evan Belworthy's ZK-FRD ready to take off from his home field in Cust, New Zealand, for a commemorative FRED 50th anniversary flight on November 3, 2013.

Photography by Evan Belworthy



ects that take years to build, FRED is really the only project for the common people."

Perhaps the best-known FRED after Eric's own prototype is Evan Belworthy's ZK-FRD, completed down in New Zealand with his father, Alan, back in 1979 when Evan was still a teenager. ZK-FRD is modified with a one-piece, non-folding wing, cantilever spring gear, and a rudder with an artistically profiled Fred Flintstone mascot. Evan wrote to Eric on FRED's 50th anniversary, saying, "Fantastic effort, Eric, FRED turning 50. To mark the day our FRED went for a fly...great aeroplane, great fun." Evan's words neatly sum up the spirit of Eric Clutton's FRED: great aeroplane, great fun. Not bad for a 50-year-old design! EAA

Matthew Long (EAA 389203) is the volunteer editor of the FRED fan site *www.CluttonFred.info*, in consultation with Eric Clutton.

SPECIFICATIONS

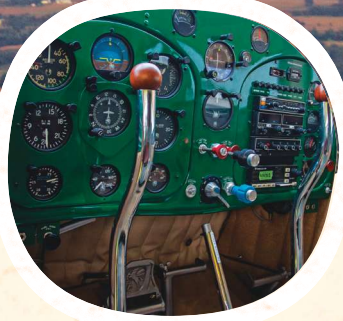
CLUTTON FRED SERIES 3

Wingspan: 22 feet 6 inches (6.86 meters)
Wing chord: 5 feet (1.52 meters)
Wing area: 111 square feet (10.32 square meters)
Length: 16 feet (4.88 meters)
Aspect ratio: 4.5
Empty weight: 550 pounds (249 kilograms)
Maximum weight: 800 pounds (363 kilograms)
Engine: 40–65 hp*
Cruising speed: 71 mph (114 kph)
Maximum speed (Vne): 100 mph (162 kph)
Stall speed: <40 mph (<64 kph)
Rate of climb: 350–400 fpm (1.8–2.0 m/s)
Takeoff run: <300 feet (<91 meters)

*Note that these specifications reflect a ~45-hp, 1500-cc Type 1 engine turning a 56 x 26 inch wooden propeller at 2900 rpm in cruise. Most FRED builders have settled on 1835-cc VW conversions with a resultant increase in performance, especially climb rate.

Through the years, Eric's original FRED has had many guises: 1) Triumph-powered first flights (note motorcycle and sidecar towing vehicle); 2) neat red-and-white colors and a VW engine; 3) a "FRED Baron" color scheme complete with faux Spandau and a four-cylinder Franklin; and 4) coming over to the Allies in RAF trainer yellow with a Continental A-65.

Photography by Eric Clutton, Tony Oliver, and Rick Coombe



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Frank Beagle with his Easy Riser after flying 250 miles to Oshkosh in 1982.

EAA's Hall of Fame Ceremonies...

And Ultralight & Light-Sport Aircraft Council notes

BY DAN GRUNLOH

THE EAA HALL OF FAME ceremony and dinner held each November at the EAA AirVenture Museum is a terrific event if you want fine food, excellent appetizers, two kinds of wine on each table, and the company of some of the most accomplished people in the world of sport aviation.

A social hour before the dinner provides the opportunity to meet EAA leaders and Hall of Fame inductees chosen for their contributions to the world of ultralights and homebuilts and aerobatic, vintage, and warbird aircraft. All the various boards, councils, and affiliates are in Oshkosh for annual meetings that week. As a result, there is a lot of aviation talk at that dinner in that building filled with historic airplanes. Two names on the 2013 list are familiar to ultralight enthusiasts. Phil Lockwood was chosen for the Homebuilders Hall of Fame by the Homebuilt Aircraft Council, and Frank Beagle was the inductee to the Ultralight Hall of Fame. Read the personal history of the 2013 EAA Hall of Fame inductees.

The EAA Ultralight & Light-Sport Aircraft Council is a group of volunteers who meet and advise EAA staff on matters of interest about ultralights and light planes. Read about the members here. We have monthly telephone conferences and meet each year for two full days at EAA Headquarters. The members take their responsibility seriously because it's a terrific opportunity to communicate directly with the top EAA leadership. The Council also supervises the selection process for the Ultralight Hall of Fame. A

Photography by Dan Grunloh

rotating group of volunteers, chapter leaders, and Council members read all the nominations, and voting in secret, rank the nominees. No one knows the winner until all the rankings have been received. View the list of past inductees and think about whom we are missing. Sometimes when a person dedicates himself to a cause, we may begin to take it for granted after a couple of decades. Do we thank them enough when we still have the chance? Please download the Hall of Fame nomination form and send in your suggestions for the 2014 award before March 1, 2014. We need your input.

When it came time for the Ultralight Hall of Fame presentation, a short video about Frank Beagle was shown. Anyone who has watched ultralights flying at EAA Oshkosh for the last quarter century has heard Frank's voice as the ultralight announcer. His enthusiasm and knowledge of the sport made a significant contribution. After the video, Frank's family was asked to come to the stage and accept the award. That's when I saw his wife, Nancy, rise from the next table and begin to walk to the stage with her wine glass still in hand. For a second I thought it was a mistake until I saw his son, Frankie, and daughter, Cathy, do the same. Something was coming.

Frank Beagle is not gone; he will always be with us, thanks to that family of EAA friends. Cathy asked us to raise our glasses for a toast and a "woof" to Frank.

A TOAST AND A 'WOOF'

In the acceptance address, Cathy said she has come to recognize that Frank had a larger family than simply his own. She understands that Frank had a family of EAA friends from all over the country and that he was very important to us. Frank Beagle is not gone; he will always be with us, thanks to that family of EAA friends. Cathy asked us to raise our glasses for a toast and a "woof" to Frank. For those who don't know, "woof" is not a nickname for

Frank Beagle's family offering a toast and "woof" during November's Hall of Fame ceremony. (L-R) Nancy, Cathy, and Frank Jr.

Frank but instead a call he would give to greet friends or announce his presence. It became his trademark, and we would reply with a "woof" when we heard it. So at the dinner, we all raised our glass in a toast and a final "woof" to our departed friend.

The presentations for the other Hall of Fame inductees provide a window into the lives of some of the most accomplished people in sport aviation. Phil Lockwood was recognized by the Homebuilt Aircraft Council, taking the ultralight community a little by surprise. We should have already inducted him into the Ultralight Hall of Fame for everything he has done for ultralights. His support for Rotax engines of all types has helped to keep us flying for decades. Here is Phil Lockwood's video.

The presentations for the other Hall of Fame inductees provide a window into the lives of some of the most accomplished people in sport aviation.

The Warbirds of America Hall of Fame inductee, Lee Lauderback, came with impressive credentials—20,000 total flight hours in airplanes and helicopters, including 8,800 in Mustangs and 2,000 hours in sailplanes. Lee didn't fool around in his short acceptance address. He said, "I am very proud to be a member of EAA and want everyone to realize the contribution that EAA makes to the freedom we have to fly warbirds, ultralights, and the other aircraft. Without the EAA, and its leadership, I don't think we would have this privilege today."

ULTRALIGHT COUNCIL NEWS

The Ultralight & Light-Sport Aircraft Council started its annual meeting with a status report from EAA staffer Timm Bogenhagen. The FAA registration database as of October 2013 indicates there are 6,848 experimental light-sport aircraft (E-LSA) in the nation. A little more than 6,000 of them are converted ultra-

The Ultralight & Light-Sport Aircraft Council meets. Seated around the table (left to right) are: Scott Severen, EAA Vice President of Marketing Rick Larsen, EAA Chairman Jack Pelton (standing), Rotorcraft Chairman Geoff Downey, Timm Bogenhagen, Jeff Skiles, and Jim House. Seated just out of view of the camera are Jim DiMatteo and Carla Larsh.

lights, and the rest are kit-built E-LSA or special light-sport aircraft (S-LSA) converted to experimental status. The S-LSA category (factory-built S-LSA) listed 2,070 fixed-wing aircraft, 130 weight-shift trikes, and 88 powered parachutes for a total of 2,288 S-LSA registered. The LSA total is 9,136 aircraft. EAA also maintains a voluntary registration for ultralights, with 3,318 vehicles listed. There are 28,005 experimental amateur-built aircraft listed on the FAA Registry.

Operations and activity in the Ultralight/Light Plane area during EAA AirVenture Oshkosh 2013 showed a significant increase from 2012, due in part to the excellent weather. There were 142 pilots registered compared to 105 in 2012. The amount of fuel sold (626 gallons) and takeoffs logged (2,216) also increased by about 40 percent. The rotorcraft flying from the Ultralight runway logged about 500 additional flights.

A new system of security roads through the area at AirVenture 2013 took away some of our space, but it also made it easier to bring people and airplanes in and out. At its peak, the Ultralight/Light Plane area was full up, and we were parking ultralights outside our area south of the runway next to the amphibious floatplanes. The Council spent considerable time trying to rearrange the layout in an acceptable manner that would provide more parking space, but we kept coming back to the existing plan. We simply need more space to park aircraft.

NEW ATTRACTIONS COMING TO THE ULTRALIGHT RUNWAY

Expect that headline to be repeated a number of times in the near future. It's clear from our Ultralight & Light-Sport Aircraft Council discussions that AirVenture planners have come to recognize what a wonderful resource we have with the Ultralight runway. There is serious talk of bringing top flying attractions into our area where spectators can get a closer look at sport aviation. Those attractions would have to be aircraft that can be safely operated from a 1,200-foot, short-takeoff-and-landing runway, which is the only clue I can give at this time. Other attractions have already come to our area, including the daily tethered hot-air balloons, the weekend balloon launch, and the 5K run. We believe these events draw more spectators in to see the ultralights and light planes. The new roads help that effort.

LSA RULE NEARLY 10 YEARS OLD

FAA Administrator Marion Blakely introduced the new sport pilot and light-sport aircraft rules on July 20, 2004. The newborn was larger and more expensive than some parents may have wanted. The rate of adoption by the flying community was less than some optimistic forecasts. About the time it was really getting started, however, the economy suffered a major recession. Nonetheless, there are nearly 2,300 new airplanes in service (imagine them all parked on one field) and nearly 10,000 aircraft flying under the new rules. We want to have a birthday party at AirVenture 2014, with a special parking area for S-LSA somewhere down near the Ultralight/Light Plane area. Maybe it will be like the LSA Mall, or something else, but otherwise LSA will be scattered all over the convention grounds north to south. The celebration is also about the sport pilot rule, too, so a pin or badge for every sport pilot walking the grounds would be cool. I want mine.

BETTER LODA NEEDED

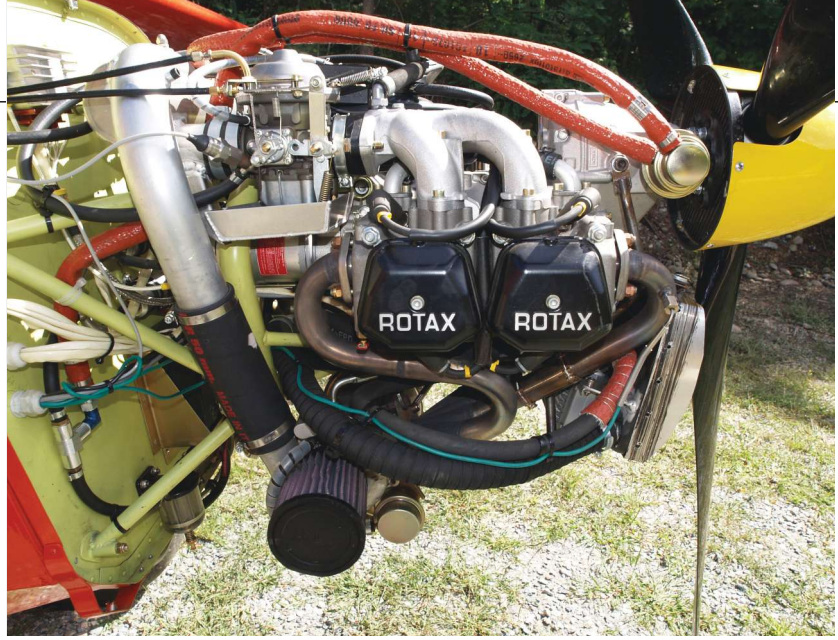
The most urgent issue facing the ultralight (and sport pilot) community is the lack of instructors. It was the first thing mentioned when EAA Chairman Jack Pelton stopped in for a brief visit to the Council and asked what our community needed most. Ironically, we had just had a conversation with Jeff Skiles, who asked where he should go for an introductory flight with a powered parachute instructor. The opportunities to take an introductory flight in some LSA are so scarce that potential newcomers can't find out if they might like the sport.

Operations and activity in the Ultralight/Light Plane area during EAA AirVenture Oshkosh 2013 showed a significant increase from 2012, due in part to the excellent weather.

In 2011 the FAA published a Letter of Deviation Authority (LODA) process to enable experimental aircraft to be used for compensated primary instruction under limited conditions. It was supposed to address the instructor shortage, but the limitations were such that very few instructors applied for the privilege. It was (and is) limited to legacy trainer aircraft that cannot be rented for solo flight needed to complete a certificate, and it can be canceled at any time by the local flight standards district office for unspecified reasons. The Ultralight & Light-Sport Aircraft Council has been working on a request for changes to address those limitations. We will rely on the advice of Sean Elliott, EAA vice president of Advocacy and Safety, as to how to proceed and what changes are feasible.

Please send your comments and suggestions to dgrunloh@illicom.net. EAA

Dan Grunloh, EAA 173888, is a retired scientist who began flying ultralights and light planes in 1982. He won the 2002 and 2004 U.S. National Microlight Championships in a trike and flew with the U.S. World Team in two FAI World Microlight Championships.



A 120-hp Turbo Kit for the Rotax 912

A European option

BY MARINO BORIC

IN THE PAST TWO YEARS, several manufacturers have shown up on the European engine market with new engines and Rotax 912 engine tuning kits. For most aircraft owners, new engines are interesting news, but experimental and experimental light-sport aircraft owners don't always need a new engine. An inexpensive tuning kit for the existing engine might provide an alternative. If there is an 80-hp Rotax 912 engine under the cowl, there are several tuning options. The solution offered by the Italian company Marc Ingegno seems to be an interesting one; it promises 40 additional horsepower for $4,800 U.S. (3,600 euros).

The idea of squeezing additional power out of an existing four-stroke engine with the addition of a supercharger or turbocharger is nothing new. Almost all modern diesel-cycle automotive engines and an increasing number of new gasoline engines on the market are turbocharged nowadays. Modern gasoline engines are increasingly under "pressure," too, mostly because of the downsizing process.

Manufacturers are downsizing existing, big displacement engines, lowering the engine displacement and number of cylinders with the result that the engines are subjected to higher working pressure and develop more power with less cylinders, less weight, and smaller volumetric displacement. One way to achieve this is the reintroduction of turbocharging.

In aviation, turbocharging or forced induction makes more sense simply because the power of our engines decreases dramatically with altitude since air density drops. Lower air density means less oxygen; so less fuel can be burned in the engine, and the engine develops less power. This power loss can be compensated by the addition of a turbocharger.

While this may sound easy, in reality it is not, because of the legal problems (warranty loss, insurance) that make the installation of a self-developed turbocharger kit for a private person not feasible. In Europe, there are several companies that are selling turbo kits for the Rotax 912 engine; that is usually the only viable solution for higher-power engines in experimental aircraft or for experimentals based on LSA (E-LSA). The general problem is that most of those turbo kits are produced in very limited quantities and installed in even less aircraft. Most of those kits demand considerable work for proper installation, and the

Photography courtesy of Marino Boric

average private/builder quickly reaches his technical and financial limits.

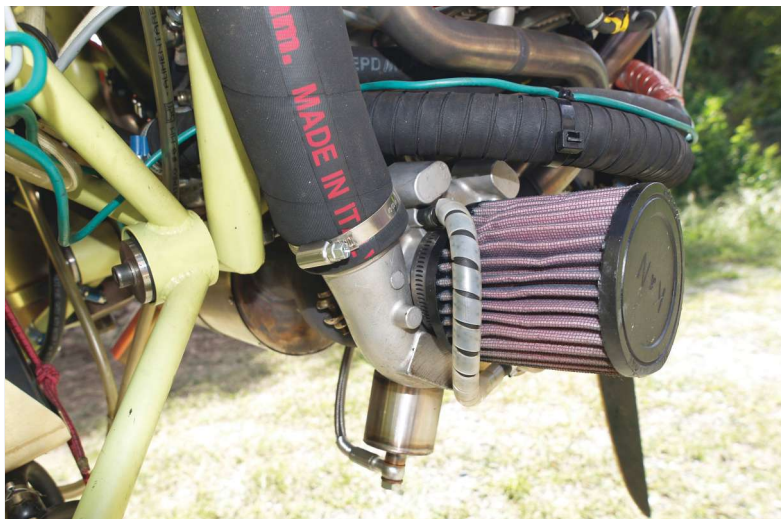
A few months ago during a flight test, I encountered one engine installation that could become one of the best power augmentation turbo kits for the stock 912 (80-hp) engine. The Italian manufacturer Marc Ingegno was, until 2013, known only as an aviation components supplier for things such as wheels, brakes, and gear/suspension parts. The metal processing company manufactures parts for fixed-wing aircraft, military helicopters and jets, automobiles, and motorcycles. During the 2013 AERO Friedrichshafen, it introduced its first aircraft, the Parrot.

Alberto Marchini, owner of Marc Ingegno, leads the company that is located in the northernmost part of Italy, close to the Swiss border, in the town of Varallo Sesia. The company has sold more than 50 turbo kits, which weigh about 22 pounds (10 kilograms), with the majority installed in aircraft and in daily use. I was able to test-fly the Parrot, which was fitted with the 912 engine and Marc Ingegno's turbo. The flight showed that the engine was delivering good performance, even in low density altitude in the Italian Alps.

Almost all modern diesel-cycle automotive engines and an increasing number of new gasoline engines on the market are turbocharged nowadays.

The kit carries a complicated name, the MI8120PA00 REV0 Kit. It includes all needed parts for the conversion of any stock 80-hp Rotax 912 engine:

- four-in-one stainless-steel exhaust manifold
- turbocharger (Mitsubishi automotive) with waste gate for max 1.4 Bar barometric pressure (41.34 inches/mercury) (0.4 Bar/11.8 inches/mercury overpressure at sea level)
- silencer
- air filter
- two electric fuel pumps
- fuel pressure regulator



The air filter on the suction side and the oil return line with a small oil-tank below the turbo.

Marc Ingegno's Parrot during the test flight is landing in a river bed in Italian Alps.

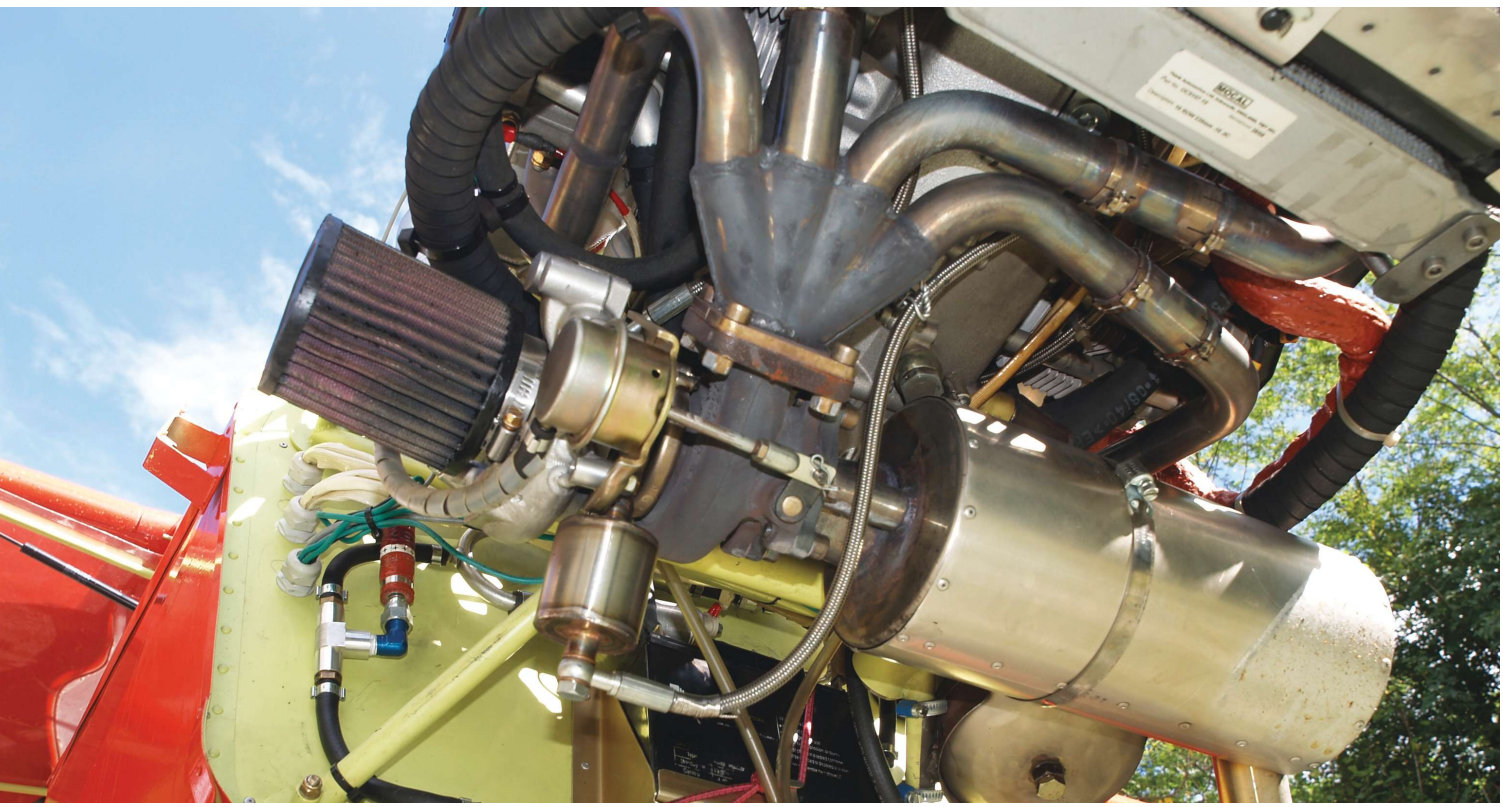
- jets for the original carburetors
- additional oil pump for the turbo
- oil lines
- aluminum air-box
- carburetor sleeves
- turbocharger – air-box sleeve
- ties

This "altitude corrected" fuel-presure regulator is very sensible component that a specialised manufacturer developed and calibrated for this turbo-kit.

The total additional weight of the turbo kit is 22 pounds. According to the manufacturer's dyno measurements, the engine showed an average of 121 hp with a fuel consumption at full continuous power of 5.54 gallons/hour (21 liters/hour).

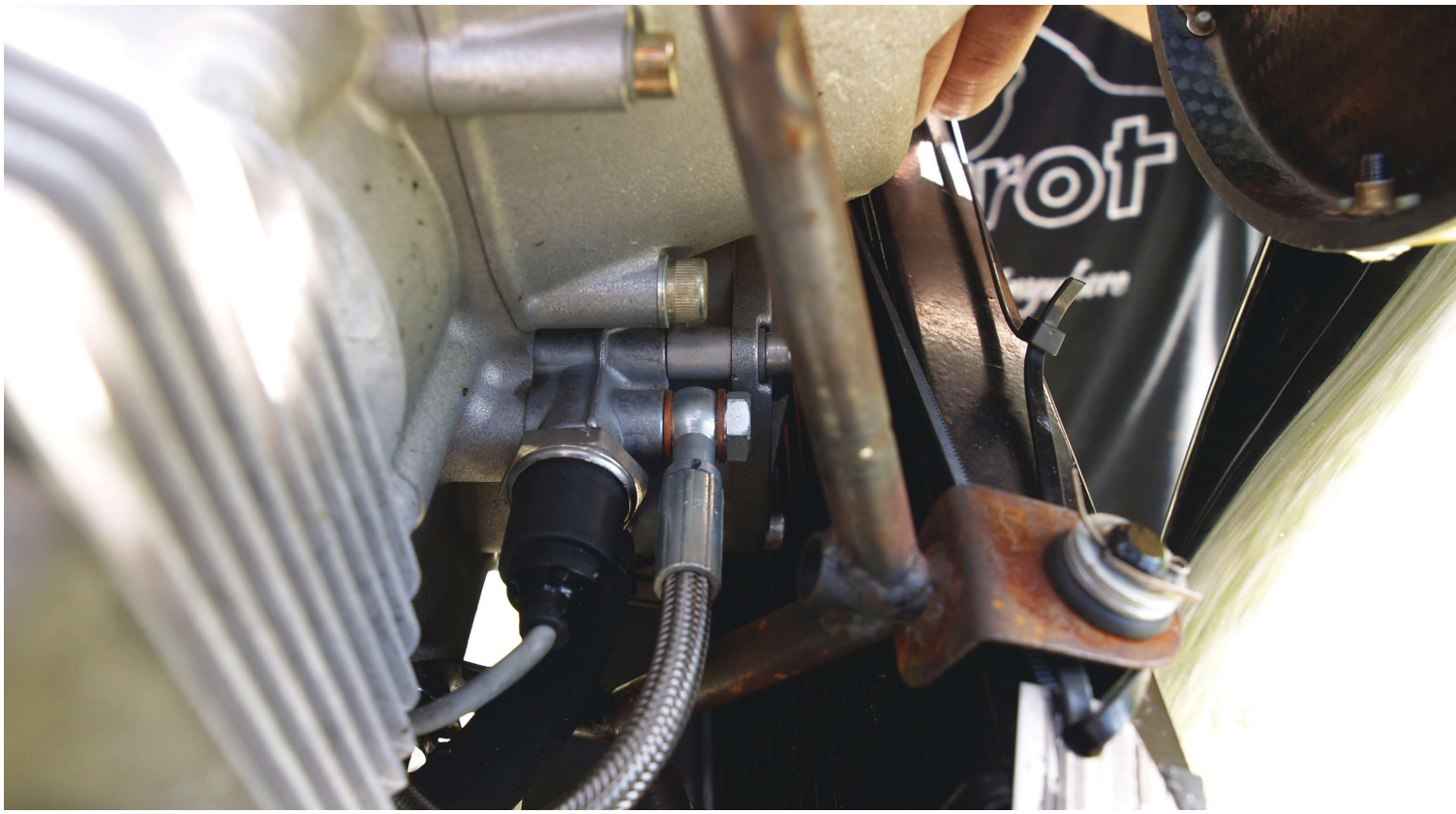
The installation on the manufacturer's demonstrator aircraft looked clean and professional. In talking with Alberto Marchini, a lot of useful and hidden details came out. For example, the fuel delivery system was developed with the help of a race specialist and is performing well because its pressure regulator is constantly adjusting to the aircraft's density altitude. There are two electric fuel pumps on board, with one always on. The starting procedure is similar to any other 80-hp Rotax engine. There are two fuel-pump switches, one for each fuel pump. Interestingly, the turbo-converted engine retains the original (membrane) fuel pump despite two Pierburg electric fuel pumps on board.

According to Marchini, this original engine-driven fuel pump allows the aircraft to fly with reduced power, even in case of failure of both electric pumps. An additional oil pump that solely serves the turbocharger is located on top of the original 912 oil pump. To prevent the turbocharger from being flooded by the oil after the engine shutdown, a dedicated valve closes the oil flow as soon as the oil pressure drops after engine stop.



The view from below to the turbo assembly; note the silencer that is directly bolted to the "hot" side of the turbo charger.

Photography courtesy of Marino Boric



The original oil pump gets an additional part (layer) especially made for the turbo charger .

The stainless-steel silencer is fitted with a cabin warm air supply orifice; warm air for carburetor heating is not necessary in a turbo installation because the compressed air is much warmer after passing the turbo than the air in front of the charger. For hot environments and those who would like to minimize engine thermal stress, Marchini is testing an intercooler for the compressed air behind the turbocharger. It will be offered as an option beginning in 2014.

The turbo kit power-to-altitude graph is not yet available, but the manufacturer gave us the following data: 120 hp at sea level, 100 hp at 14,700 feet.

As for engine reliability, Marchini believes that in normal use (not full-time wide-open throttle/full power) he expects that a new 912 engine with the turbo kit will reach 1,500 hours. Of course, Marchini noted that all depends on how the engine is used, adding, "All our customers are happy with the kit, and on our test aircraft we have logged 250 hours without any problem; all our factory engines together have cumulated more than 1,000 hours."

Just before publication of the article, Marchini told us that he is testing 90- and 100-hp versions of his turbo kit that are able to keep the engine output constant up to an 18,000-foot altitude. It should be available in two to three months.

To learn more about this engine, visit *www.Marc-Ingegno.it*. EAA

TURBOCHARGING EXPLAINED

Don't fear—we are not going to get too technical and theoretic. Nowadays, turbocharging and supercharging are commonly used for engine power augmentation. Both systems press more air into the engine compared with a "normal" atmospheric engine, with the result that more air and oxygen under higher pressure gets into the cylinders where, once ignited, it produces more power than the same engine without turbo- or supercharging devices.

Each system has its pros and cons, and there are even some crossovers of both systems. A normal atmospheric four-stroke engine is "breathing" air/fuel mixture through the downward piston movement (roughly compared with the suction action of a bicycle air pump) that sucks in the air. Because of this suction of air through the filter, carburetor, intake manifold, and intake valve, the pressure and air density in a cylinder—when the piston is in its lowest point—are lower than the atmospheric pressure. To compensate for this pressure, air (even air pressure higher than atmospheric pressure) can be compressed/blown into the cylinder via a compressor or blower.

Two different systems are commonly used: the turbocharger or supercharger. Both systems are forced induction devices. The key difference between a turbocharger and a supercharger is that the supercharger is mechanically driven from the engine crankshaft (by means of belt, chain, gear, etc.), whereas a turbocharger—a centrifugal compressor—is driven by the engine exhaust gasses passing through a turbine. Compared to a mechanically driven supercharger, turbochargers tend to be more efficient but less responsive.

Stall-Proof Airplane?

How's your nose wheel?

BY ED KOLANO

BELTS TIGHT, LOOSE ARTICLES stowed, clearing turn complete, airplane trimmed, power set. You slowly apply increasing back-stick, keeping the deceleration to a nicely controlled 1 to 3 knots per second, feet dancing lightly on the pedals to keep the slip/skid ball centered. More pull, slower speed, more pull, even slower now. Then nothing. The stick is all the way back, but the airplane doesn't stall. Eureka! The perfect pilot-proof airplane.

Maybe. Maybe not.

Wing rock, yaw excursions, power effects, entry rate, stall warning, control effectiveness—all important, but let's save them for another time. For now, let's assume the airplane is rock steady with full aft-stick.

An airplane that remains unstalled with full back-stick applied is said to be elevator limited. Full trailing-edge-up elevator produces the minimum flying speed but not a sufficiently high angle of attack to stall the wing. Might sound good up and away, but this seeming safety feature can have an effect on your landing.

In a traditional configuration airplane, the air flowing over the horizontal tail has first encountered the wing. A lifting wing creates vortices or air rushing around the wingtips from the higher pressure beneath the wing toward the lower pressure above the wing. This swirl imparts a downward component to the air leaving the wing's trailing edge, creating a downwash. The angle between this downwash and the horizontal tail's chord line is the tail's angle of attack.

When the airplane descends to within about one wingspan of the runway, ground effect begins, and the lower the plane gets, the more pronounced the ground effect becomes. Ground effect has several...well...effects on the lift and drag of an airplane. For example, the closer the wing is to the runway, the less room there is for the wingtip vortices. Because those vortices are a by-product of lift creation, decreasing them results in significantly less induced drag. Inhibiting these vortices has the same effect as increasing the wing's aspect ratio, which means more lift in ground effect than outside ground effect for the same angle of attack. Both of these effects contribute toward floating down the runway. Carrying a few extra knots into the flare can result in a much longer landing than expected.

The physical presence of the runway also redirects the remaining downwash coming off the wing. The runway prevents the normal downward flow and forces it more parallel to the runway. Less downwash means less angle of attack at the horizontal tail. In other words, the deeper you descend into ground effect, the more trailing-edge-up elevator you need.

Now let's get back to our elevator-limited airplane. If the plane can't be stalled with full aft-stick outside ground effect, it surely won't stall in ground effect where the full aft-stick angle of attack of the tail is less. So-called full-stall landings would be impossible in this airplane. That means faster touchdown speeds and longer landings than might be aerodynamically achievable if the elevator were rigged differently or if the incidence of the wing and tail were different. That's the good news.

A little less good news is the fact that this plane is essentially still flying when it lands. That is, if the wing was

Photography by Jim Koepnick

not stalled with full aft-stick outside ground effect, it's even more not stalled in ground effect.

And you can forget about aerodynamic braking. I suppose you could land at a fast enough airspeed with enough back-stick still available to raise the nose wheel while keeping the mains on the runway. This would likely be a delicate maneuver, since the airplane is probably still going fast enough to fly. Even if you managed to accomplish this balancing act, the airplane's pitch attitude is likely to be insufficient for any meaningful aerodynamic braking.

An issue of more concern is whether this airplane has enough elevator control authority in ground effect to ensure the main wheels land before the nose wheel. Whatever the plane's pitch attitude was during that full aft-stick non-stall outside ground effect, it could become progressively less as it descends into ground effect.

As soon as the main wheels contact the runway, the elevator's moment arm shortens. In the air, the plane rotates about its center of gravity, but on the runway, the main wheels become the pivot point. Since the main wheels are farther aft than the center of gravity, the elevator's pitch authority is less. Sure hope there's enough to prevent the nose wheel from slamming onto the runway shortly after the main wheels touch.

These ground-effect implications of an elevator-limited airplane are there during takeoff as well. Rotation speed is faster than necessary. Immediately after rotation, when the moment arm extends from the main wheels to the plane's center of gravity, it's possible that a corrective forward-stick adjustment will be required. While this is true for all airplanes, it could be more pronounced in a plane where full aft-stick and a bunch of extra knots are needed just to unstick the nose wheel. Aborted landings also fall into this category.

So, maybe that unstallable airplane ain't all that after all. In the amateur-built world, there's no requirement that an airplane be stallable, and there's a high likelihood that no two amateur-built airplanes are exactly the same. So, if you find yourself with an unstalled airplane at altitude during your first test flight (not even going to get into whether you should be stalling the plane on its—and your—first flight), be prepared to deal with the potential consequences during your first landing. EAA

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