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EAA EXPERIMENTER

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What they are; what they do

The Wings of Quicksilver «
Some history and current news

William Ford's Grand

Champion Lancair Legacy

Medicals and Hangars

Our most critical issues

BY JACK J. PELTON

THE FUTURE OF THE third-class medical and a modified FAA hangar-use policy are being debated in Washington, and be assured that EAA is going all out to protect and promote your interests. And we will be calling on you to make your voice heard in more than one forum.

The hangar policy and third-class medical issues are unusually complex and potentially among the most far-reaching we have faced. Changes in third-class medical standards for private flying are opposed by entrenched groups determined to maintain the status quo. And the hangar-use policy cuts both ways as protecting our interest, but if not properly written, it could possibly threaten valid aeronautical use of an airport hangar.

The hangar issue is an FAA policy that requires hangars on airports receiving FAA funds to be used for aeronautical activities. In general, this is good because it prevents unscrupulous airport management from simply auctioning off hangar space to the highest bidder to use for any purpose. The key is that some interpretations of "aeronautical use" do not include building an airplane, restoring an airplane, or even using a hangar for meetings of EAA chapters, the Civil Air Patrol, or the many other groups that work hard to promote aviation.

The FAA can preserve hangar space exclusively for aviation activity by creating a policy statement that includes homebuilding, aircraft restoration and maintenance, aviation group meetings, and even storage of furniture or other items in the unused space around an airplane in the hangar. EAA has officially insisted that be the new policy during the comment period that ended last month.

Changing the third-class medical policy is both a safety issue and a cost issue. And allowing pilots to fly for their own personal reasons using a driver's license as evidence of medical fitness has broad support. It also has more than 10 years of proven safety in sport pilot flying.

The improved safety would come from an aeromedical education requirement that EAA and AOPA support as part of third-class medical reform. Pilots who fly for personal reasons must make an assessment of their fitness to fly before each takeoff. But the third-class medical system doesn't give us any tools to make a safe and conservative decision. Through a required online training course that we support, pilots would learn how to consider a range of health issues that can impact flying safety, including use of over-the-counter medications that can degrade our piloting abilities.

The FAA has agreed, at least in some fashion, with us and issued a notice of proposed rulemaking (NPRM) just days before Oshkosh. But before that NPRM can be made public it must be approved by the federal Office of Management and Budget (OMB) and the Department of Transportation (DOT), the FAA's parent department in Washington.

So far the NPRM has disappeared into the maw of OMB, or DOT, or both. We just don't know any details. But we do know that entrenched groups, particularly a few in the medical community, are determined to resist any change opposing reform claiming there would be degradation in safety. There is absolutely no evidence that the third-class medical reform we favor would make flying less safe, but there is powerful history that education can make improvements.

In general the best route for aviation regulation reform is through the FAA, but it looks increasingly as though the FAA is handcuffed by OMB and DOT, so only congressional action can force a change. A new third-class medical policy has broad support in both the House and Senate, and bills to force a change have been introduced.

Washington is always an unpredictable place, but with midterm elections upon us, and a lame duck Congress in place for the rest of the year, it's impossible to know what can happen to move medical policy changes forward. But we must try.

EAA maintains an online system that makes it quick and effective for you to contact your congressmen and senators. To contact your representative and senators, go to www.EAA.org/rallycongress, where you will be guided through the easy steps to send an effective comment.

At this point the rulemaking system looks totally frozen, and no progress is being made. But if all of us in personal aviation join together, along with AOPA and other pilots groups, to make our voice heard loud and clear to our legislators, I'm convinced we will see action sooner than later. EAA

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Chapter Build Projects

A good idea?

BY CHARLIE BECKER

FOR SOME TIME NOW, your EAA staff has been discussing the idea of promoting chapter build projects and teen build projects. We feel that this is an area in which a program that provides a bit of structure might generate a sound payback in terms of educational opportunities, fellowship, personal accomplishment, fun, and the promotion of homebuilding and aviation.

We don't have any hard data, but it seems like there is renewed interest in this group-build concept. In many ways, this is just the original idea of chapters coming full circle. Chapters started out in the early days of EAA with a much heavier focus on homebuilding. Over the years, they have evolved, just as EAA has, to offer a wider variety of activities, such as Young Eagles rallies and pancake breakfasts. Fortunately, homebuilding has stayed at the forefront of most EAA members' interests. I believe the success of group-build projects like the One Week Wonder at EAA AirVenture Oshkosh 2014 and EAA Chapter 640's completion of Paul's *Mechanix Illustrated* Baby Ace replica has caused many EAA members to reconsider the idea for their chapter. Nothing like watching an aircraft be built in a week to inspire you!

By way of background, chapters are allowed to build aircraft. However, a chapter is not allowed to operate an aircraft. So once a project is complete, the aircraft needs to be sold. It is unfortunate that EAA has this rule, but it is one of necessity. We just recently re-examined this rule and confirmed that the extra insurance cost to allow a chapter to operate an aircraft, while protecting the assets of EAA, would be more than $8,000 per aircraft per year. This is a staggering amount of money, but it reflects the reality of the legal liability system here in the United States. The insurers know that any aircraft operated with EAA's good name on it, even if it is by a chapter, will result in EAA being named in the lawsuit if *anything* goes wrong. It doesn't matter if EAA headquarters had nothing to do with the project, there would still be the need to defend EAA and get released from the lawsuit. It doesn't take too many hours of legal time to burn up $8,000. I for one only want EAA involved in areas that can make aviation easier and more affordable, not more expensive and costly. So we have to recognize that chapters owning and operating aircraft is off the table.

The good news is that the aircraft could be owned, either from the start or later, by a group of local EAA members. Wouldn't it be satisfying to know that the aircraft your chapter built gave birth to a flying club made up of EAA members in your local area? This is exactly how Chapter 1279 at French Valley Airport, California, handled its Pietenpol build. Steve Williamson, the chapter president, and a few other members funded the project and owned the aircraft, yet every Saturday was an open building session for anyone in the chapter who was interested in learning to build. In fact, Steve even cataloged the build in a book, *Starting With Nothing: The Building of Pietenpol Air Camper NX1279Z*. The aircraft project generated a lot of activity for the chapter and now is its mascot.

If you would like to start doing some planning around how you might form a flying club, I recommend you download EAA's flying club guide here.

If your chapter has firsthand experience or has a project under construction, I'd like to hear from you. Or if you simply have an opinion as to whether this is a good path for EAA to pursue, please drop me a line at *cbecker@eaa.org* or call 920-426-6850. I will keep everyone updated on this as things progress. EAA

Busha Named EAA Director of Publications

JIM BUSHA, EDITOR of EAA's *Warbirds* and *Vintage Airplane* magazines and a frequent contributor to *Sport Aviation*, has been named EAA's new director of publications.

"It has been a lifelong dream of mine to work at EAA ever since I snuck under the fence to attend my very first EAA Oshkosh convention in 1970," Busha said. "As a grassroots airplane guy, I have never met an airplane I didn't like, and I look forward to interacting with and serving all the wonderful EAA members who share the same passions and dreams about flight."

Busha, previously a lieutenant with the Oshkosh Police Department, will lead production of all EAA print and electronic publications. His full-time addition to the publications staff will also provide the opportunity for a smooth transition as J. Mac McClellan looks toward retiring from the editor-in-chief role after April 2015.

This year Busha published a book, *The Fight in the Clouds*, a collection of stories from pilots who flew the P-51 Mustang in combat during World War II.

Jim Busha

Sean D. Tucker Kicks Off Second Pilot Sweepstakes

Sean Tucker goes up in the Extra 300 with Tristan Werner, 17, at El Cajon airport in California.

PILOTS WHO FLY at least one Young Eagle between July 1 and December 31, 2014, will be automatically entered into the Fall 2014 Young Eagles Pilot Appreciation Sweepstakes and be eligible to win one of the available prizes (to be announced soon).

This is the second sweepstakes developed by EAA Young Eagles Chairman Sean D. Tucker for Young Eagles volunteer pilots to show appreciation for volunteer pilots who give so generously of their time. He considers the volunteer pilots his "personal heroes," so this is a way to thank them for their service.

Prize winners will be selected in January 2015. (No purchase or donation is necessary to enter the sweepstakes, and a purchase or donation will not improve chances of winning.)

Hovan Retires from Ultralight & Light-Sport Aircraft Council

EAA OFFERS CONSIDERABLE thanks to John Hovan, who recently resigned as a member of the EAA Ultralight & Light-Sport Aircraft Council. A member of the council since 1999, John and his wife, Pat, were active volunteers at EAA AirVenture Oshkosh, the Sun 'n Fun International Fly-In & Expo in Lakeland, Florida, and also the U.S. Sport Aviation Expo in Sebring, Florida.

John also served as the chairman of the EAA Ultralight Hall of Fame Selection Committee, which is responsible for selecting the Ultralight Hall of Fame nominee each year. He is also a past president of EAA Ultralight Chapter 71.

John's resignation creates an opening on the council, and EAA is actively seeking a replacement council member. For information describing the qualities sought in a council member, as well as a downloadable application form, click on this link.

John Hovan

Photography by Brady Lane and courtesy of Team Oracle

First Operating Limitations Issued Allowing Use of the Additional Pilot Program

THE FIRST KNOWN ISSUANCE of operating limitations that includes provisions of the FAA's new Additional Pilot Program (APP) took place on Sunday, October 5, for a Van's RV-7 built by a builder in Plymouth, Massachusetts. Designated airworthiness representative (DAR) Jon Ross, EAA Lifetime 135637, inspected John Sannizzaro's airplane and included the APP in the operating limitations.

That provision allows Sannizzaro, EAA 578246, the option to have a second pilot on board during Phase 1 flight testing. The FAA published Advisory Circular (AC) 90-116 at the end of September and also released a deviation memo to Order 8130.2G, allowing inspectors and DARs to issue operating limitations to homebuilt aircraft that permit the use of the new program.

Sannizzaro, already an experienced RV pilot, is excited to use the APP to add an extra layer of safety during some of his Phase 1 test flights.

EAA has received several questions from the community about how APP works. The following frequently asked questions (FAQ) list was created to help clear any confusion. Stay tuned for updates, webinars, and forums on the APP. Members also may call EAA Government Services at 800-564-6322, or e-mail EAA anytime for help on this or any other issue.

How does this program work? Who is the additional pilot and when can they fly with the builder?

The APP is really split into two parts—the qualified pilot (QP) and the observer pilot (OP). The QP is a pilot who meets certain experience criteria and is permitted to accompany the builder pilot on any flight of the aircraft during Phase 1 flight testing, including the first flight.

Once both the builder pilot and the aircraft have completed a basic set of tasks to achieve the most critical flight test and familiarization goals, an OP—any pilot who is rated in category and class and is current to fly the aircraft—may fly with the builder pilot as long as there is an agreed-upon purpose for the OP's presence. Examples of such a purpose might be spotting traffic during tests, troubleshooting instrumentation, etc.

The program is administered through AC 90-116 and enabled by language in the aircraft's operating limitations. The APP may be used on any flight and is completely optional. Some builders may elect to fly with a QP on the first flight and never use the program again. Some may use one QP on the first flight and another QP on other early flights. Others may skip using a QP and fly with an OP on several flights later in Phase 1. The choice is entirely left up to the builder.

What airplanes are eligible?

The initial release of this program is limited to aircraft "built from a kit" that is listed in the FAA's Revised Listing of Amateur-Built Aircraft Kits. The aircraft must have an engine installation "recommended, supported, or provided by the kit manufacturer."

What about plans-built aircraft?

Plans-built aircraft are not included in the first run of this program. That being said, the FAA has shown a genuine willingness to expand the APP to more types of experimental amateur-built (E-AB) aircraft, including plans-built, in the near future if it is successful. EAA will likewise continue to support such a change.

How about a plans-built version of a kit plane?

The AC clearly spells out that the aircraft must be built from a kit, so these aircraft are not eligible at the present time.

Why any restrictions on aircraft at all?

While the APP will be available to more than three out of every four homebuilts, there were a few conservative steps taken in the initial version of the program. The APP represents a major shift in policy for the FAA, and that the program was implemented so quickly after its inception is remarkable. If it is shown to be as safe and effective as we believe it will be, we will have a strong argument to expand it to more aircraft.

This whole program seems contradictory to conventional wisdom on flight test safety. Why implement it?

That conventional wisdom, which states that minimum crew should always be used, is rooted in military/developmental flight testing and based on the assumption that the machine is most likely to fail during testing, not the pilot. In the amateur-built world, we see time and time again that this is not the case. The majority of accidents during Phase 1, both fatal and nonfatal, come down to human factors on the part of the pilot, who is oftentimes a builder new to flight testing, new to the aircraft, or low on flight experience during the build process. The APP allows the builder to bring into the flight-test equation an experienced pilot who adds safety, and it's supported by a recent NTSB finding that such a program would be beneficial.

I am a DAR. How do I enable an applicant to use this program under the current guidance on operating limitations?

A deviation to Order 8130.2G has been published that allows ops limits referencing AC 90-116 to be issued to eligible aircraft. *EAA*

Jon Ross (left) with John Sannizzaro and his RV-7.

Cleco Pliers Reinvented

CHRISTOPHER BRAUN, EAA Lifetime 808722, of Roseville, California, has reinvented the 80-year-old cleco pliers design after using the traditional tool on his Zenith CH 750 STOL project caused hand and wrist pain. Called the Clecall Cleco Pliers, it's 70 percent lighter than the original, has an upright orientation allowing easier access when working in tight areas, and results in far less fatigue from continuous insertion and removal of clecos, according to Braun.

After creating various cardboard and aluminum designs, he employed 3-D printing to fashion a working plastic prototype, then fine-tuned it to create an aluminum prototype. They first became available in September, and initial market response was extremely positive.

"The builders and mechanics that we have spoken to are very excited about the feel of the new cleco pliers and the speed in which it can be used on projects," he said. "Clecall is thrilled that users around the world will begin to experience less pain and headache when using the ergonomically designed tool."

The Clecall is sold exclusively through Aircraft Spruce & Specialty Co. (www.AircraftSpruce.com) for $39.95.

Belite SeaLite Takes Flight

BELITE PRESIDENT JAMES WIEBE flew the Belite SeaLite amphibious ultralight off the water in mid-September. Even with difficult conditions for a seaplane—light winds, 90-degree-plus temps, 3,800-foot density altitude—it performed well. The SeaLite took around 20 seconds to get airborne off the water.

The Belite SeaLite is powered by a 50-hp F23 Hirth powerplant, coupled with a solid carbon-fiber, three-blade propeller. The plane was solid on the water, in light chop and in smooth water, and broke out of the calm water by lifting a float first.

In its amphibious (land/sea) configuration, the SeaLite is priced at $60,000; in straight float configuration (no wheels, just floats), the SeaLite is priced at $50,000.

The Belite SeaLite is a variant of the Belite UltraCub. The amphibious version incorporates carbon-fiber floats, coupled with trailing link retractable landing gear. The straight float version uses the same carbon-fiber floats in a water-only (no wheels) version.

For more information, call 316-253-6746 or e-mail info@beliteaircraft.com.

CubCrafters Offers Aerocet Floats

CUBCRAFTERS HAS partnered with Aerocet to offer amphibious floats specifically designed for CubCrafters' CC11 airframes, which include the popular Carbon Cub SS, Sport Cub S2, and Carbon Cub EX kit models. Aerocet's Model 1500 amphibious floats represent an entirely new design approach for the company and feature an all-carbon-fiber hull for light weight (only 245 pounds) and durability.

"We've worked with the Aerocet team on this project for almost three years," CubCrafters General Manager Randy Lervold said.

Aerocet's new Model 1500 amphibious floats include a carbon-fiber version of the company's double-fluted hull design that weighs less but affords superior strength. The rivet-free construction eliminates leaks, and with all-stainless-steel hardware, precludes corrosion. The floats contain six watertight compartments, and large storage lockers can accommodate fuel cans.

The Aerocet Model 1500 amphibious floats are available from CubCrafters as an option for new aircraft, kits, and installation on existing aircraft. Contact CubCrafters or your CubCrafters Certified Sales Center for more information: visit www.CubCrafters.com.

Mandatory Rotax Service Bulletin Requires Carb Checks

ROTAX HAS RELEASED a mandatory service bulletin (SB) that may affect your carbureted Rotax engine. Owners/operators should pay special attention to the requirements of this information release and in particular the details and requirements as outlined in the actual SB. Compliance to this SB is a mandatory requirement and affects serial specific engines and carbs as well as any engines or carbs that may have been serviced with new floats (Part Number 861 184) from spare parts that were produced from approximately June 1, 2012, onward. (Check SB for details—http://legacy.rotaxowner.com/si_tb_info/serviceb/sb-912-065.pdf.)

The issue stems from a possible manufacturing deviance leading to some floats absorbing fuel, which increases their weight affecting the float level in the carb. Possible effects may be a rough running engine especially at low speeds, engine stoppage, and/or fuel leakage in the area of the carburetor venting.

Rotax has developed a quick test method using a special assembly of parts. (See SB for the specific list of parts required to make up the test tool.) In most cases, the process allows for checking the float level while the carbs remain installed on the aircraft.

For this test, you must run the engine for two minutes to ensure the float chambers are full, then after shutdown, remove the carb vent line and the choke plate cover (four screws). And using the special test tool, you inject a measured amount of fuel into the carb float chamber until it just starts coming out of the carb overflow. At this point, you measure exactly how much fuel you injected into the chamber by which you can determine if it falls into the correct range or not (between 23 milliliters to 40 milliliters).

If it fails, then you must remove both floats and weigh them together on a precision gram scale (+/- tolerance of 0.1 gram), and if the two floats together weigh over 7 grams, then they both need to be replaced. (Floats are supplied in pairs.)

Until Rotax comes up with a new float design, all floats that have come from replacement parts since June 1, 2012, or which are already installed in carb serial numbers and/or engine serial numbers affected by this SB, must be checked every 25 hours of run time or every 60 days, whichever comes first.

An important point to keep in mind regarding this SB is that even if you replace your floats with a new or the same part number, 861 184, the mandatory 25-hour/60-day checks are still required until such time as Rotax can supply a completely new design of float. Each time the test is performed, a new choke cover gasket, Rotax Part Number 950 030, must be installed.

EAAer Launches WingBoard Project

IMAGINE BEING towed through the air behind an airplane, like a wakeboarder or water-skier being towed by a ski boat. That's the general idea behind the WingBoard, which is being developed by former Young Eagle Aaron Wypyszynski, EAA Lifetime 579057, and president of EAA Chapter 190 in Meridianville, Alabama.

Wypyszynski is launching an effort to get the product—what he calls "a wakeboard in three dimensions"—off the ground through his company, Wyp Aviation. The sport involves a close coordination of the rider, towrope, and composite WingBoard. Its shape has a stable center of gravity while the rider, attached to the board with a binding, stands upright and leans and twists in all directions to maneuver the board. The unique towrope design provides stability and also reduces forces on the rider.

The phase one prototype is a 1/6-scale model using a remote-controlled airplane that tows the WingBoard with a 3-D-printed human model on board. Wypyszynski claims the prototype has proved the aerodynamic stability and control of the design. Next up is work on a phase two prototype, a 40-percent-scale model and final stepping-stone toward the development of the full-scale prototype. EAA

An Eye For Detail

A different kind of Ford-built airplane

BY BUDD DAVISSON

Photography by Tyson V. Rininger

The Lancair has come a long way from the original 10- hp, 0-200-powered version as witnessed by William Ford's 310-hp grand champion Legacy.

Attention to detail is evident throughout William's Legacy. To attain more speed, every effort was made to make sure everything fits flush.

The retractable gear of the RG-550 Legacy contributes to its 275-mph max cruise speed.

WHEN THE NAME "FORD" is paired with the word "airplane," it's understandable that the first image that pops to mind is of a corrugated metal airplane with a long, fat wing and three round motors. However, there's a decidedly different visual definition of this Ford airplane. It's a slicker-than-a-raindrop, superfast, and hyper-detailed composite bullet that's known as a Lancair Legacy. But N11LL is a Ford Legacy, as in built by William Ford of Durango, Colorado (no relation to that other Ford). In 2014, this Ford Legacy was named the EAA AirVenture Oshkosh Grand Champion Kit Built, which, considering the competition, is saying a lot.

Inasmuch as there have been a number of Legacys crowned grand champion in recent years, it could easily be said that Lancair's current incarnation of the little Lancair 320 is the favorite way for perfectionists to display their talents. That is not necessarily the case with William Ford.

"I don't do things to be perfect," he said, "but I often do things with an eye toward curb appeal. And at places like AirVenture, that means everything has to be done right. And that's what I try to do. Make things right."

Regardless of what William said, there's basically only one definition of the word "right," and it happens to be pretty much the same definition as "perfect." So, while he doesn't see himself as a perfectionist, casual observers (and the EAA judges) do. Or at least they see the results of his handicraft as being perfect. This is an interesting contrast to his day job, which finds him swinging around in trees, wielding a chainsaw as an arborist. While there is an artistic element to his work, superfine detail is usually not part of the equation.

When it comes to aviation, William is the third generation of Fords to claim the third dimension as his own. He explained, "My granddad flew a Jenny in 1925 at the age of 18 and eventually went into the CAA, then FAA, where he had a hand in a lot of DC-3 certifications. My father tells me that my granddad had a professional relationship with Paul Poberezny back in the early days. It's not clear how well they knew each other or if they flew together, but they did cross paths a number of times.

"My dad also soloed at age 18 in an Aeronca 7AC, after which he earned his PPL. My first memories of flight go back to about eight years of age, when my dad took me out for a scenic flight over Ventura County in Southern California in a Grumman Cheetah.

"When I was ten, I got really heavy into R/C sailplanes and at 13 bought an FAA ground school manual. So, I was hooked early. In high school, I took an aviation class that qualified me to take the PPL written. Then it was flying lessons at 16 and a PPL at 17. However, even though there was a lot of aviation in my family, neither my dad nor grandfather were EAA members or exposed me to sport aviation or experimental amateur-built aircraft. That is something that I discovered on my own.

 Photography by Tyson V. Rininger

“I was 22 years old when I saw my first homebuilt going together, and that was a Lancair 235. I spotted it being built in a garage as I drove down a street. I parked and went up and introduced myself to Ray Modert. As I was to find out, homebuilders are eager to share what they’re doing, so I got a tour of his airplane and the building process, which set my brain off in a new direction. That was in 1989, but unfortunately, I had neither the time nor the garage nor the money to get into actually building anything. That didn’t happen for another 10 or 12 years.”

William originally started his entrepreneurial adventures in Thousand Oaks, California, which by the new millennium had resulted in him having the garage he needed to indulge in his homebuilding dreams. Inasmuch as a Lancair was his first choice, that chance visit to a neighborhood garage must have had a lasting effect.

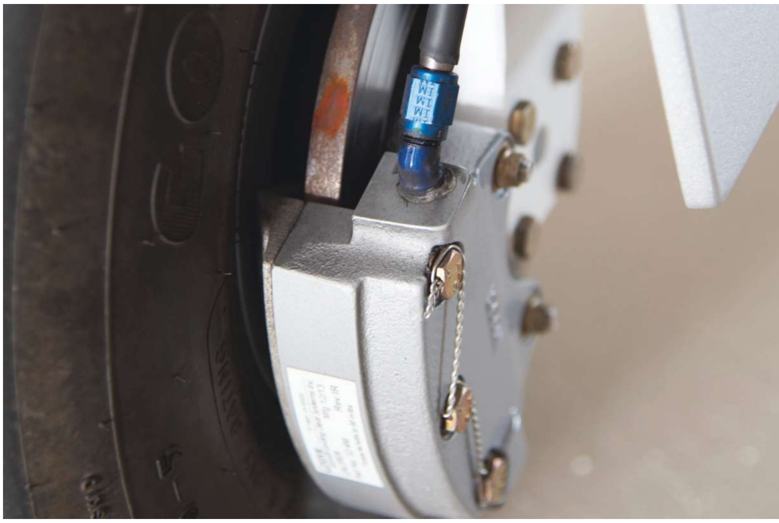
“In late January 2002, I picked up my dad in a rented Mooney M-20C, and we flew up to Redmond, Oregon, to visit Lancair,” he said. “This was just as the Legacy was being introduced. I fell in love with the smaller Lancairs, but the concept of having so much more motor and room really appealed to me. So about three days after returning home, I called Kim Lorentzen at Lancair and put a deposit down on a Legacy kit. That was ready to be picked up in October of 2002.”

Starting to build an airplane, especially one as sophisticated and high performing as a Legacy, takes a certain amount of confidence, which often is based on past experience. This was not necessarily the case with William Ford.

He said, “My confidence came from associating with other builders and bumming around hangars where other projects were underway. This goes back to way before I got involved with my own build project. I suppose confidence in my ability to see this project through to completion/flight also came from my experiences as a teenager building and flying radio-controlled sailplanes and powered models. I recall walking out of the hobby shop with a box and then eventually watching the finished project take to flight. This happened many times, so you can imagine the almost overwhelming emotions and feelings that came over me when this 11-year, life-sized, sit-in-it-and-go aircraft took to flight for the first time late last year. Additionally, I knew I could do it and would see it through because I’ve always been very good at reaching goals that I set for myself…not only in aviation but other areas of life as well.

“Since I had little or no experience with composites, I opted to go through Lancair’s Builder’s Assist Program, which in retrospect was one of the smartest things I’ve done. I spent five days with Lancair tech Kerry Dowling looking over my shoulder as we bonded the major components together. This included bonding the wing center section to the fuselage, closing the horizontal stabilizer and bonding it in place, and closing the main wing panels.

Lancair and Hartzell Propellers cooperated on development of the scimitar-style propeller.



William’s attention to detail extended to all mechanical systems.

The tail number refers to the time it took Willaim to build the Lancair Legacy.

Carefully designed GoPro camera mounts are located on the wings and tail.

The interior was done by Sturgis Design in Corpus Christi, Texas.

Porsche leather is used throughout the interior.

This requires a lot of precision to make sure everything is straight. Build a straight airplane and it will fly straight.

"Just building the jigs would have been a major and very critical project. Their jigs are absolutely perfect, extremely rigid, and bolted to the floor so nothing can move. Since what you're building there, the center section and fuselage, are essentially the foundations for the airplane, this is time and money well spent and gives you a huge head start on the project. Besides saving many months work and giving a measure of peace of mind, working with the materials under the guidance of experts gives you experience you'll need many times later on in the project. For me, it was very beneficial. But that just gets you started. After that, it becomes a matter of learning as you go and learning as needed."

When he left the factory, William's trailer carried what looked like the hollow husk of an airplane. Having something that actually looks like an airplane right at the beginning gives a psychological boost to any homebuilt project. For many homebuilt aircraft, it is months or years before any of the dozens of disassociated pieces come together and give visual confirmation that you are, indeed, building an airplane. This can be discouraging. When a builder takes advantage of a builder assistance program, he has spent some money, but in exchange, he has gotten the project launched in a way that almost guarantees completion. In William Ford's case, however, life got in the way and brought things to a screeching halt.

He explained, "In 2006, I had to mothball the whole project while we relocated to Durango. The project stayed like it was for almost four years while we got everything sorted out in the new location, had our business up and going, and I had a proper workshop. Then I got on it with a vengeance."

When choosing an airplane design to build, a family man always has to consider how the airplane is going to be used and whether it will fit the goals of the family. "My wife, Tracy, has been quite supportive of the project from start to finish," said William. "Even when things slowed down following the move, she was all in favor of my getting back on it rather than selling the parts. Regaining momentum can be a tough thing, but she helped with that by giving the nod to additional expenditures and loads of my time being invested, which of course came at her expense.

"When I started building, I was looking carefully at whether I could put a child seat in the baggage area because we had a 6-year-old son, Garrett. Of course, this project has taken long enough that Garrett is now 6-foot-2, so it's just as well I didn't go for the child's seat."

N11LL's powerplant is a far departure from the little Continental O-200 the first 1984 Lancair 200 had in front of the firewall. The race for more horsepower has culminated in the Legacy, which has more than triple the original horsepower.

William added, "The engine is a factory remanufactured Continental IO-550-N that is rated at 310 hp at 2,700 rpm

Photography by Tyson V. Rininger

at sea level. I purchased it through Lancair, then shipped it out to Barrett Precision Engines in Tulsa, Oklahoma. Their makeover included disassembly, thorough inspection, balancing, CermiNil-coated cylinders, chrome here and there, and custom paint on the case.

"For a propeller, I went with a Hartzell three-bladed, constant speed with a 'scimitar' design. This particular propeller was designed as a cooperative effort between Lancair and Hartzell to match the prop to the Legacy's airframe and performance envelope."

The engine is fed from a 32-gallon tank in each wing, with a left-right-both selector valve in the center console. The system includes a two-speed electric boost pump and a mechanical pump on the engine.

William recalled, "Once I got started back on the airplane, I was putting in all the time I could: late nights, weekends, full time during my company's off-season. I'm often asked how many hours I have in it and I honestly don't have an answer. Fact is, I'm not even sure I want to know...too many! Some of the time is because I really like working on small details, which is part of the curb appeal I mentioned earlier. A lot of times people will look at an airplane and know that it's really well done without knowing why they think that. Unless you're a builder, you're not likely to pick out individual details that are done well because they sort of blur together. However, they add up in such a way that almost anyone looking at an airplane knows whether it was done right or not. It's all in the detail and the symmetry."

He described an example: "I made sure the PFD and MFD instrument screens line up with both the pilot's and co-pilot's centerline so everything was visually lined up."

It's interesting to carefully study the layout of his panel. You will notice that there are multitudes of things that are different sizes. However, he stresses the symmetry, and you'll notice that the edge of components line up with the edge of something else. There are no randomly placed items. None. When glancing at the panel, it's not immediately obvious that everything lines up; however, just a one-second glance tells you that something about it is "right," but you can't put your finger on it.

William said, "I have to give Valin Thorn at Starflight credit for the fiberglass instrument panel frame and center console as well as some other molded parts they made for the airplane. The four-lever throttle quadrant that's part of the center console and the overhead/hung rudder pedals are also from Starflight. I spent a good bit of time doing bodywork on the interior components to get a perfect surface with flawless transitions. The time spent was well worth it. I think the final result matches the lines of the airplane perfectly.

"After installing all the electrical components (lights, servos, antennas, motors, etc.), I did all the airframe wiring myself, terminating the various circuits to plugs and connectors at the backside of the instrument panel. About a year before the completion of the project, I began working on the equipment selection and layout of the actual panel. Aerotronics of Billings, Montana, assisted with this process, and after about eight layout revisions, I said, 'Build it!' They fabricated the instrument panel, and in my opinion, did an outstanding job of it.

"I see the Legacy as being a very state-of-the-art airplane. So, that being the case, I tried to take advantage of as much advanced technology as possible. That's why I have a dual-screen Garmin G3X and the Garmin GTN 750. What's a glass airplane without a lot of glass in the panel, right? And in case the 'glass' breaks, top center in the panel are three Mid-Continent backup primary flight instruments.

"The fun part of those kinds of touch screen electronics is that you feel as if you're constantly working with an iPad. It's truly amazing, the vast amounts of data that is literally at your fingertips. Thanks, Garmin.

A Starflight panel surround, console, throttle quadrant, and rudder pedals are used. William is proud of the panel's symmetry and clean look.

Looking at his airplane and his attention to detail, it's hard to believe that William Ford is an arborist and regularly wields a chainsaw.

"I have built-in oxygen systems and a TruTrak autopilot because I plan on using the airplane for serious cross-countries. And it all works beautifully."

Everything about the airplane oozes quality, and its interior adds to that. William said the look is the result of the work done by Willy Sturgis of Sturgis Design in Corpus Christi, Texas, and the really nice leather that is the same as used in Porsches. That all seems very fitting, considering the airplane's performance.

It is the rare builder, especially those building composite aircraft, that does his own finish paint. Part of this is because composites lend themselves so well to smooth finishes, and smooth finishes exaggerate any surface imperfection. So, most builders have a professional do the prepping and blow the final paint. However, in William's case, he did everything except actually hold the gun for the final coats.

"I completed all the fit-and-finish body work myself," he said. "It was weeks of filling and sanding, filling and sanding. I got it right up to prepaint quality, applied two coats of WLS primer (one rolled on and one sprayed on) and then enlisted the help of an overqualified local painter named Dwight Tulfer of Animas Aero Designs. Together we did the final 'micro bodywork' and the final prepaint prep work. Dwight applied the paint and I assisted in any way I could. The paint is Matrix Systems Andromeda silver (metallic) with Candy Red tint faded into the tail and wingtips. Then a lot of clear coat went on, and that was followed by two weeks of color sanding, polishing, and reassembly. The paint work alone took two-and-a-half months."

While the drudgery of weeks of sanding in preparation for paint can wear on a builder, William said that wasn't the biggest challenge he faced. "The most difficult part of the whole project was building and installing the canopy. Excluding any bodywork that had to be done, I have approximately 150 hours invested in fitting the canopy. I knew it was going to be a real chore and I wasn't looking forward to it. But it had to be done.

"The finished canopy consists of the frame, which is where the initial fitting and critical alignments are dealt with. The hinge and latch hardware are installed, and then the Plexiglas is bonded to the frame. Finally an outer skin is installed to clean it all up. Then begins hours and hours of bodywork to get all the transitions up to 'show quality.' It felt as if it was never going to end.

"In August 2013, I had a friend, Ron Gregory of Ron Gregory Composites of Carlsbad, California, come out to Durango to oversee the final assembly and put another set of eyeballs on all the final details and critical components. At that point in time, the fabrication part of the project ended and it was time to let the flying begin. For N11LL, that was at 4:36 p.m. on September 18, 2013. At that exact instant in time, N11LL became an aircraft!"

William remembers the day well. "I entrusted my airplane to Ernie Sutter, another overqualified individual. Ernie is a career pilot and has been flying his own Legacy for about 10 years, including racing it at the Reno National Championship Air Races (Race No. 66). He made the first three flights, totaling about 2.5 hours. All systems checked out and the airplane flew great! In fact, he wanted to trade airplanes. I said, 'No thanks.'"

Before flying the airplane, William went through an extensive transition training program with Ernie Sutter, who is a CFI in addition to being a test pilot. William said, "My first flight in the airplane was wow! It was a surreal coming together…the airplane and me. After so many daydreams, after developing so many expectations, and finally I was flying it. And the machine really delivers! Acceleration, speed, climb, views, responsiveness, maneuverability—it was an absolute thrill!

"The normal takeoff is quick, with very positive acceleration, but it tracks straight with little effort. You raise the nose at 60 to 65 knots, hold takeoff attitude, and just let it fly itself off the runway. It has some noisy airframe vibrations until the gear is raised, then everything smoothes out and you feel the acceleration again…up and away."

According to William, N11LL's best power cruise is 240 knots at 8,000 feet, and he's burning about 15 gph at that speed. Economy cruise is 218 knots at 14,000 feet (Remember his O2 system?) where the big Continental is burning 9.8 gph. He also said that at sea level his rate of climb at 140 knots is 2,000 fpm at gross.

He reports that his normal approach is 100 knots, bleeding it to 90 knots over the fence, followed by touchdown at 70 to 75. But he added, "Currently, the shortest runway I'll land on is 3,500 feet, but the Legacy is capable of shorter. Even high and hot, it does really well. With density altitude at 9,500 feet, which is quite common here at Durango, fully loaded it's up and away. Sure, it takes a little more pavement, but the departure is not in question. Here at my home base airport we have more than 9,000 feet of pavement. My challenge is to not get lazy and let my skills diminish.

"Basically, the Legacy is everything I dreamed it would be. It's a real performer and a pure joy to fly. And it's an excellent cross-country aircraft. Because of its speed, it makes a country the size of the U.S. quite manageable, navigable, and doable. And then there are the local weekend flights… flying in the mountains, out to Lake Powell…the views are amazing! I fabricated and installed three different GoPro camera mounts on the airplane—what a great video platform it is. I look forward to posting some of these online, but I gotta get them edited first."

Now that his Legacy is finished and flying, what would he change or do differently? "I wouldn't change a thing!" he said. "Every time I walk into the hangar, I can't help but get a big smile on my face and a couple of butterflies in my stomach."

After 11 years of building, you can't ask for any more than that. EAA

Vortices, VGs, and Fences...Oh, My!

What they are, what they do

BY LYNNE WAINFAN, PH.D., EAA LIFETIME 50408

IF YOU'RE AROUND experimental airplanes very often, you probably have seen little things sticking up from the airplanes' wings, fuselages, and tails. You may have figured correctly that they are meant to redirect airflow, but what do they do and why are they good?

This article covers three of the most popular of those protuberances—vortex generators (VGs), fences, and vortilons. Each of them looks a little different, and each of them affects the air in different ways, with their own pros and cons.

WHY ARE THEY THERE?

Some people consider these devices to be "fixes" for surprises that are discovered during flight testing. Others believe that they allow airplane producers to improvise ways to save on tooling (or the certification process) between different versions of similar airplanes. Aerospace engineers know that many times these are indeed the reasons to attach aerodynamic devices to an airplane, but sometimes there is an additional reason. An airplane designer has to compromise on various performance goals; they can't design the perfect airplane, because improving performance in one area makes it worse in another. Vortilons, vortex generators, and fences are air "tweakers" in an aerodynamicist's toolbox—tools that let the designer affect the air in order to deal with surprises and compromises as the designer improvises a solution.

These devices are not only available to designers but also to owners, if they are legally allowed to modify their airplane to get performance different from the stock configuration. However, you must not change the aerodynamic configuration of your airplanes without knowing what you're doing. This article does not give sufficient information for you to modify your airplane. Instead, it is meant to present an overview of vortilons, vortex generators, and fences. After reading this, you will at least know some terminology so you can go talk to an expert without embarrassing yourself.

Before we describe what these devices are and how they work, it is important to know some basic aerodynamic concepts. There is no math here, just pretty pictures.

WHAT IS A VORTEX?

Vortices are easy to see in water: When you watch the swirling motion of water going down the drain, you're seeing a vortex. If you look up at planes during the right atmospheric conditions, you can sometimes catch the swirling white-tip vortices forming a spiral behind the wing. Sometimes the clouds help us see an airplane's tip vortices, as in Figure 1 below.

Figure 1 – Wingtip vortices enhanced by clouds.

In this case, the air starts swirling because the high-pressure air on the bottom of the wing wants to go toward the low-pressure air on the top of the wing. The air can go around the wing most easily at the wingtip, so a tip vortex is particularly strong.

Fundamentally, a vortex is a swirling mass of fluid. Yup, aerodynamicists think of air as a fluid. That's why many aerodynamicists use computational fluid dynamics (CFD) tools.

Photography courtesy of flyingindian.wordpress.com

WHAT IS A BOUNDARY LAYER?

If you visualize yourself flying and looking out at your right wing, you can imagine that the air touching the wing moves slower—relative to the airplane—than the air 10 feet above the wing. Why is this? Air is a little viscous (sticky) and is slowed down by being dragged along the wing. At the wing, the air molecules that stick to the wing are at zero velocity (relative to the airplane). If you move up from the wing, the air molecules right above the ones stuck to the wing stick to the air molecules below; they are not moving at zero velocity, but they are moving slowly. As we move farther upwards, the air moves faster and faster until it reaches "free-stream" velocity.

The boundary layer is the thin layer of air between a surface and the air that is going 9 percent of the free-stream velocity. Boundary layers are not very thick—generally less than a half inch during cruise. Boundary layers exist on anything that touches the air—fuselages, fins, stabilizers, etc. From here on, we will only consider boundary layers on the wing.

There are two types of boundary layers. Laminar, or layered, boundary layers occur when the air motion can be thought of as following the shape of the wing. The reason it is called "layered" is because as you go farther and farther up from the wing, the airspeed changes at a uniform rate. The other type is a turbulent boundary layer. Here the air is unsteady—changing with time—and swirling.

Laminar flow has less skin-friction drag than turbulent flow, but laminar flow is very difficult to maintain as the air moves across a surface. Any imperfections, such as fuel caps, lights, antennas, rivets, seams, ripples, hinges, and even bugs can trip the flow from laminar to turbulent.

On a conventional wing, the boundary layer starts out as laminar at the leading edge and then transitions to turbulent as the friction of the air against the wing slows the air. This transition occurs over a segment of air called the "transition zone." Figure 2 below illustrates the laminar flow, the transition zone, and the turbulent flow as the air moves from the leading edge toward the trailing edge of the wing.

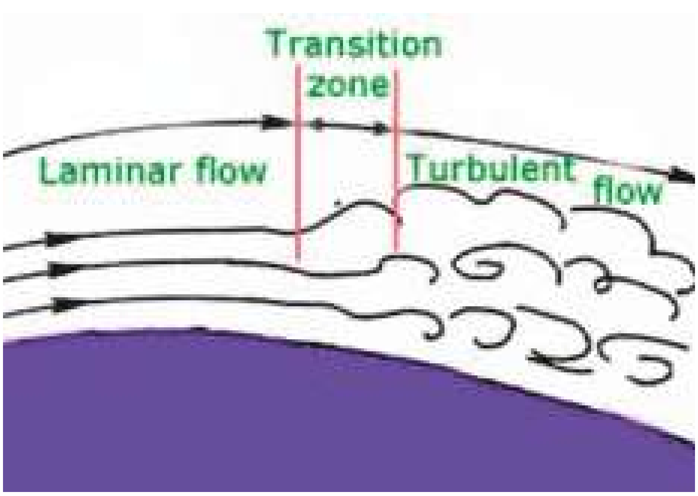


Figure 2 – Laminar flow.

Where does this transition point occur on a wing? It depends on a number of factors: airfoil shape, angle of attack, surface ripples, surface roughness or cleanliness, and other factors that were described by my aerodynamics professor using Greek letters and graphs.

Aerospace engineers love to see flow transitions. We search almost obsessively, in rivers, faucets, traffic, and even pictures of Jupiter. We are on duty even while watching movies. In Figure 3, Humphrey Bogart holds his signature cigarette. Near his cigarette, the smoke shows that the flow is laminar—it is in a neat column. As it rises, however, the flow transitions to turbulent. This leads to an important warning: Excessive interest in aerodynamics can cause you to watch for flow visualization opportunities rather than sexy movie stars.

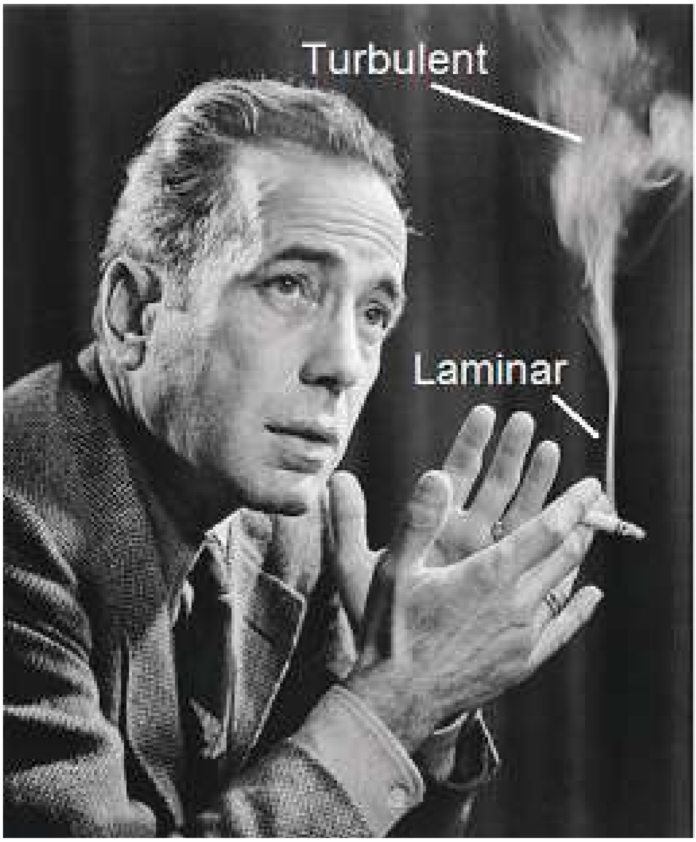


Figure 3 – Humphrey Bogart's cigarette exhibits laminar flow.

WHAT HAPPENS TO THE WING NEAR STALL?

Let's imagine that your airplane is flying straight and level. As you raise the nose, you increase the angle of attack—the angle between the oncoming air and a reference line on the wing. For small angles of attack, the flow follows the shape of the wing. As we increase the angle of attack, the air has a tougher time following the entire top of the wing—it separates. Figure 4 shows a CFD drawing of this effect.

There are a few things to note in the drawing in Figure 4. The light gray lines represent streamlines—the path that the air takes as it moves past the airfoil. At the wing, the streamlines

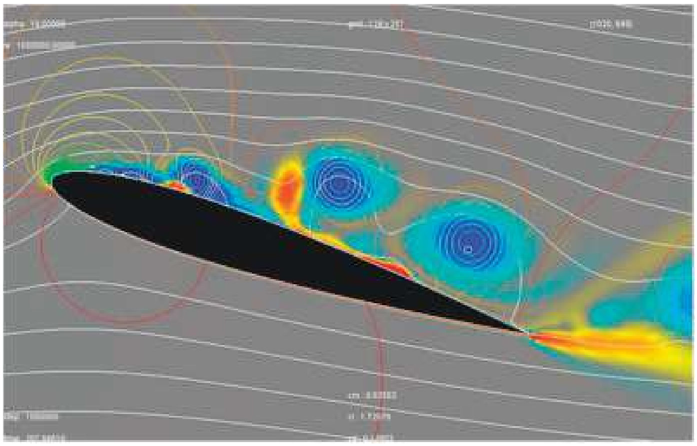


Figure 4 – As angle of attack increases, air has a tougher time of adhering to the wing.

flow around the wing. Farther away, they are less affected by the airfoil. On the left side of the illustration, we can see the streamline that comes up from below to hit the wing perpendicularly. If a bug were to be flying in that streamline, it would hit the wing directly and not slide off. For a wing at zero angle of attack, this "stagnation point" is typically right on the leading edge. As the angle of attack increases, the stagnation point moves to a point below the wing. In Figure 4, this is the point below where the green flow forms. Also note that the air on the top of the wing near the leading edge is still following the shape of the wing. Do you see how it starts out laminar (the green flow) and then transitions to turbulent (the blue flow)? At this point, the flow is not separated—you can see from the streamlines that it pretty much follows the shape of the wing.

This is an important point that we'll return to later. But then about halfway to the trailing edge, the flow moves up from the wing (the big orange blob). Continuing aft, you can see that the air behind this has trouble following the shape of the top of the wing. It follows the swirling air instead. Because the air is no longer following the shape of the wing, the flow is considered separated. This separation produces a much broader wake than would be there if the air were still attached. This large wake after separation increases drag. Separated flow produces dramatically lower lift. It also can affect the airflow behind it—if an aileron were in separated flow, you can imagine that it wouldn't be as effective as it would be if the flow were attached. Sometimes flow separation can affect flight surfaces way behind it as well—a horizontal tail or elevator flying in that wake might lose effectiveness too.

Another important observation from the figure above pertains to the boundary layer. Of course, we would expect the laminar portion of the boundary layer to be attached to the wing. You can see this in the green area near the leading edge. The streamline above it is roughly parallel to the wing. But here's the surprise—the turbulent boundary layer in Figure 4 (the blue zone right behind the green zone) also has attached flow. You can squint and see that the boundary layer is thicker when the flow transitions to turbulent, but it still follows the shape of the wing. This is somewhat counterintuitive, turbulent air following the shape of the wing. Even more amazing is that turbulent flow can stay attached longer than laminar flow—farther down the wing—or a golf ball.

Figure 5 shows the wind tunnel results of a sphere in regular flow (left) versus a sphere whose boundary layer has been tripped to turbulent by a small wire attached at about 25 percent "chord." See how the flow on the left picture starts out laminar (where the boundary layer is so thin that it is barely visible) and then transitions to turbulent at around 40 percent chord. This produces a big wake, and therefore, high drag. The figure on the right shows how the air starts out laminar, and then transitions to turbulent early, at the wire—if you look closely, you can see the very small swirls in the turbulent boundary layer at around 60 percent chord. But notice that the more turbulent flow configuration's wake is much smaller than the ball on the left. Tripping the boundary layer to turbulent earlier—more forward on the shape—actually lowered the drag. This is the main reason that golf balls have dimples; they trip the boundary layer to turbulent earlier than it would transition normally, like the wire in the figure. This produces a smaller wake and reduces the golf ball's drag.

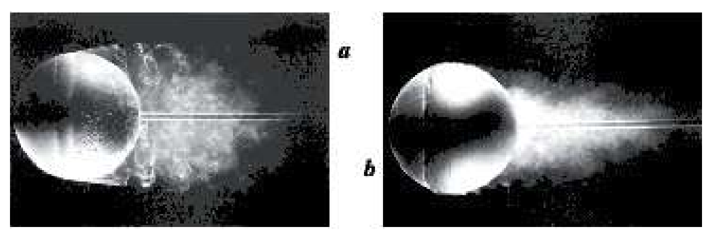


Figure 5 — The wind tunnel results of a sphere in regular flow (left) versus a sphere whose boundary layer has been tripped to turbulent by a small wire attached at about 25 percent "chord."

But let's return to our colorful wing. As the angle of attack increases, the separation gets worse until the flow fully separates and the wake becomes quite large. This wing is stalled. Figure 6 shows this condition.

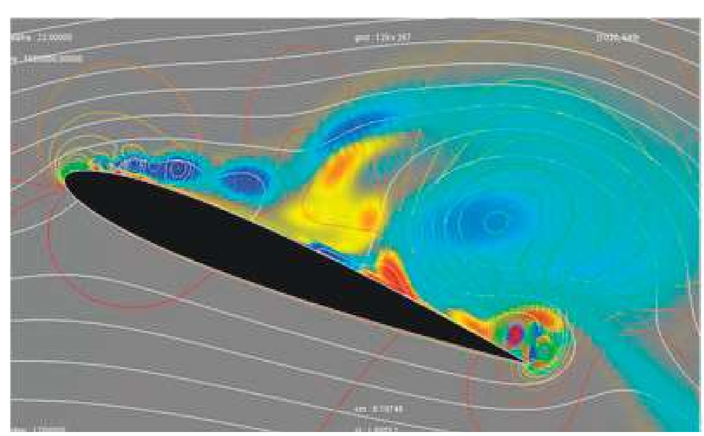


Figure 6 — As the angle of attack increases, the separation gets worse until the flow fully separates and the wake becomes quite large. This wing is stalled.

Illustration courtesy of Institute of Space and Astronautical Science

It is helpful to stop and summarize the difference between two related concepts: flow transition happens when the airflow changes from laminar to turbulent. This is distinct from the concept of flow separation, where the air can no longer follow the shape of the wing. Separation is bad: Drag increases, lift reduces, wings stall, and control surfaces behind the wake can become less effective. Turbulent flow—unless the flight attendant has just handed you your coffee—is not necessarily bad, as we have seen with the golf ball and will see with planes.

Okay, now that you've had your introductory aerodynamics lesson, let's get back to aerodynamic devices.

VORTEX GENERATORS...WHAT ARE THEY?

Vortex generators are typically small plates that stick up perpendicular to the wing surface. Their height is usually about 80 percent of the boundary layer thickness. Often they are placed right in front of the transition zone shown in Figure 7, where the air goes from laminar to turbulent. The figure below shows an example of vortex generators.

Figure 7 – Vortex generators are often placed right in front of the transition zone where the air goes from laminar to turbulent.

Vortex generators (VGs) can be found in other places beyond the wing transition zone. For instance, they can be placed farther aft on the wing, just before the control surface's hinge. VGs also can be placed on surfaces other than wings. They can be seen on the horizontal stabilizer to improve control effectiveness of the airplane's elevator. They can be seen on engine nacelles, turbine blades, and even cars. VGs are sometimes placed on airplane fins to improve flow over rudders, as shown in figure 8.

Not all VGs are small plates—other shapes can generate vortices as well. Figure 9 shows a weight-shift trike with round VGs: small cylinders with a conical top.

As you may know, cylinders are extremely draggy. How draggy are cylinders? Figure 10 shows two shapes—an airfoil and a cylindrical wire—with the same drag.

Figure 8 – Vortex generators are also used on other surfaces, such as the elevator.

Figure 9 – Vortex generators on this trike wing have a conical top.

The first shape is a big, old airfoil, and the bottom is a tiny round object. If something the size of a wire has the same drag as that airfoil, then surely these round VGs would be very draggy—what was the designer thinking?

All designers face trade-offs. In this case, the first trade-off that led to the round VGs was effectiveness versus user-friendliness. Yes, the round VGs have more drag than conventional VGs, but these are mounted on a fabric airplane. Conventional VGs would slice through the fabric when the wing folded; these are made of rubber and they just bend out

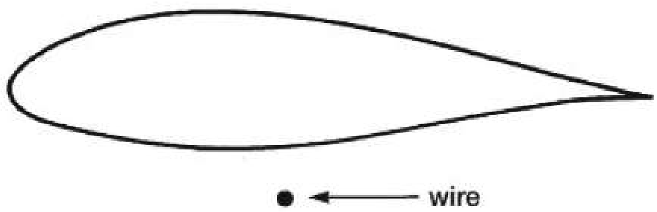


Figure 10 – How draggy are cylinders?

of the way of the other wing.

Another tradeoff faced was effectiveness versus simplicity. Yes, the round VGs are taller than one would expect, and again draggier. But these round VGs are off-the-shelf parts—no fabrication is needed. As you can see, there are many factors to consider—and trade-offs—when designing aerodynamic devices.

As an interesting side note, VGs are not new and are not always designed by engineers. The figure below shows a duck (or a "canard" in French), with VGs popped up for landing.

Figure 11 – Natural vortex generators.

HOW DO VGS WORK?

Notice from Figure 7 that the red VGs aren't aimed into the apparent wind; they are angled. As the air hits the VGs, vortices are formed, which energizes the airflow. This helps to keep the boundary layer attached when it might separate otherwise.

Figure 12 illustrates the airflow with and without VGs, for different angles of attack.

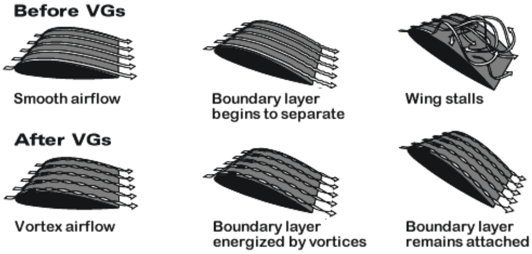


Figure 12 – Airflow with and without VGs.

For this top wing without VGs shown in Figure 12, the boundary layer is laminar until it begins to separate at some angle of attack (middle top picture). At a higher angle of attack, the flow becomes almost completely separated—the flow swirls around in a big way—and the wing stalls.

As the lower left-hand picture of Figure 12 shows, VGs create a small vortex all the time. At higher angles of attack, the flow stays attached because the vortices energize the boundary layer. Moving to the rightmost drawing, you can see that the boundary layer remains attached even at higher angles of attack, whereas the boundary layer without the VGs separates.

Similarly, for VGs placed in front of control surfaces, flow can stay attached longer. Figure 13 shows how vortices could be created to help to improve flap effectiveness.

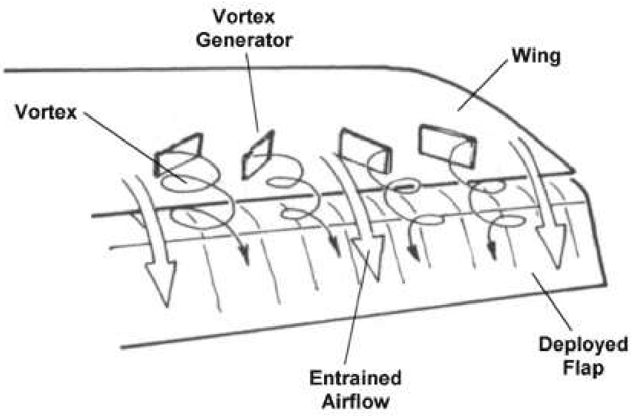


Figure 13 – VGs can also improve flap effectiveness.

WHY ARE VGS GOOD?

VGs can be helpful in many ways. As described above, the first benefit is to improve the stall characteristics of the airplane—flow stays attached at higher angles of attack than without the VGs. They can lower the stall speed of the aircraft.

Another way VGs can help is to improve control surface effectiveness. Since flow separation is more likely near the trailing edge of the wing, stabilizer, and fin, then ailerons, flaps, elevators, and rudders have lousy air flowing over them if the flow is separated. A control surface in separated flow means that the pilot may not be able to control the aircraft. To improve control surface effectiveness, VGs can be placed just ahead of the control surface. Figure 8 shows the VG positioned ahead of the rudder in order to maintain its effectiveness.

VG DRAWBACKS

VGs introduce a few problems when added to experimental aircraft. The first is that they increase drag during normal flight conditions. Anything sticking up into the air will increase the skin-friction drag of the airplane. Not only are they perpendicular surfaces directly in the boundary layer airflow, but the flange that attaches the VG to the airplane is draggy also. By

Photography courtesy of WingSailor.com; Illustration courtesy of Micro AeroDynamics now you should know that since the air touching the wing is at zero velocity, the flange for the VG is not very draggy at all. The VGs themselves are angled relative to the oncoming wind, which is even more draggy.

The extra drag of VGs during cruise flight is the price we pay for their effect near stall. The small vortices they produce create more drag than the bare wing would have. But at high angles of attack, VGs can keep the flow attached longer. Attached flow, with its smaller wake, is much lower drag than separated flow.

Whether VGs are net positive or negative, dragwise, depends on many factors including the airfoil, the amount of time the airplane spends in cruise condition, the VG configuration, etc.

VG placement affects their drag and their usefulness. If VGs are placed too far forward, they will trip the flow from laminar to turbulent too early, increasing drag, compared to the no-VG configuration. On the other hand, if they are placed too far aft, they won't be very effective. The best place to put the VGs is in or slightly upstream of the boundary layer's transition zone illustrated in Figure 7.

VGs have other problems as well. VGs are yet another surface protruding from the aircraft that may break off. In addition, they may be problematic during icing conditions. If they are taller than the boundary layer, they could pick up ice. This is especially worrisome if you are flying through supercooled drizzle drops or freezing rain. On the other hand, if you are flying through those conditions, you may have bigger problems with icing on other parts of the airplane.

Another problem with VGs is that they can be costly. The manufacturer has to design, flight-test, manufacture, insure, and distribute VGs. For certificated aircraft, the VG certification process is quite expensive: The FAA requires that most, if not all, of the airplane's original flight testing be repeated. This certification can cost upwards of $500,000 for a lightplane. Since the market for VGs is somewhat small for each type of aircraft, the certification cost must be spread over a small group of customers. Even for noncertificated aircraft. Extensive analysis and testing of VGs are required to determine the VGs' configuration: where on the surface they go, how tall they should be, their shape, how far apart they should be, how many VGs to put on a surface, how they will be mounted, etc. After the final configuration is determined, flight testing is necessary to evaluate their effectiveness—and more importantly—to ensure that the VGs do not adversely affect the airplane. This is why it is important to let a professional design and test vortex generators.

WING FENCES: WHAT ARE THEY?

Sometimes called "boundary layer fences" or "flow fences," wing fences are nonmoving plates attached perpendicular to a wing. Unlike slanted VGs, fences are aligned with the free-stream airflow. They typically extend no farther than one-third of the wing chord and often—but not always—wrap around the leading edge of the wing. They stick out above the boundary layer, farther than a VG would.

Fences are not a new invention; the patent was filed in 1938. Figure 14 shows an example of an old-fashioned wing fence.

Figure 14 – A wing fence.

This fence is unusual in that it is not flat—the curved ridge makes the fence stronger than a flat plate would be.

Although most wing fences are on the leading edge of the wing, the photo below shows one mounted on the trailing edge.

Figure 15 – A fence attached to the trailing edge of a wing.

Fences at the wingtip are distinct from winglets; tip fences extend aft of the trailing edge of the wing. Figure 16 contrasts winglets from fences. The red winglet on the Boeing 737-800 does not extend beyond the trailing edge of the wing, like the yellow fence on the Airbus A319 does.

Figure 16 – A wingtip winglet.

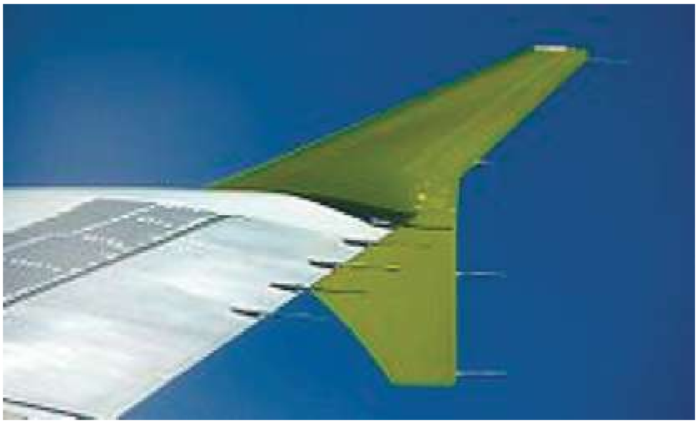


Figure 17 – A wing fence shot from the wing

HOW DO FENCES WORK?

The exact workings of wing fences are somewhat complex and still being analyzed. However, here is a simplified way of thinking about them: Fences are boundary layer control devices used to help the air move to the back of the wing rather than toward the wingtip. Generally, high-pressure air from below the wing wants to flow toward low pressure. Normally that would be toward the back of the wing. However, for some configurations, most notably swept wings, the air wants to flow "spanwise," or down the wing toward the tip. The air along the wing has more or less tendency to do that.

At the wing root, the air has a slight desire to flow spanwise, but it really wants to do that at the wingtip. This spanwise flow can cause the flow to separate on the outer wing, which leads to a variety of ills, most notably really bad stall performance.

To understand this poor stall performance, imagine a swept-wing airplane whose spanwise flow has caused the tips to stall. The tips are behind the rest of the wing, so losing that lift at the back of the wing means that the plane would pitch up. A pitch-up during a stall doesn't correct itself when the pilot backs off from the nose-up command. The plane continues to pitch up, worsen-

Photography courtesy of Lynne Wainfan and Boeing

ing the stall. At some angle of attack, the horizontal tail stalls, and the pilot cannot push the nose down to recover from the stall.

A fence can reduce this spanwise flow, redirecting the air so it moves toward the trailing edge instead of toward the tip. Another way the fence works is somewhat like a VG. When the spanwise flow tries to move toward the wingtip, some of it spills over the fence and creates a vortex. This energizes the boundary layer outboard of the fence. Both of these modes—the redirection of the air to the trailing edge and the vortex—can delay separation/stall and improve control surface effectiveness.

There are other ways a fence can work. Some are used on the back of the wing between the flaps and ailerons to improve aileron effectiveness. This placement is shown in Figure 14. Alternatively, Airbus advertisements say that their wingtip fences reduce wingtip vortices. Wingtip vortices energize the flow behind the wing, where they don't do any good. Airbus fences don't produce useful vortices; they reduce drag.

The detailed design approach for fences is not well documented—this is still an art that some companies do not share because they see it as a competitive advantage. However, there are some design principles that are generally true: Fences are taller than VGs because they must stick out above the boundary layer. It is believed that increasing the fence length to beyond 50 percent of the chord is not useful. Similarly, fences rarely extend past the leading or trailing edge of the wing more than one-third of the chord length.

WHY ARE FENCES GOOD?

Like VGs, fences can delay flow separation and lower stall speed; they can improve control surface effectiveness at high angles of attack; and they can reduce the airplane's tendency to tip stall, improving stall recovery performance. Fences may reduce drag by minimizing wingtip vortices. An additional benefit is that if fences are placed correctly, they can shield the pilot from the glare of the wingtip lights!

THE DRAWBACKS OF FENCES

Like VGs, fences are devices that scrub against the moving air and therefore they create skin-friction drag. On the plus side, fences are lined up with the airflow whereas VGs are slanted into the wind. On the minus side, fences stick up out of the boundary layer where the air is moving fast, producing more skin-friction drag than a VG. Fence shape seems somewhat straightforward, but where to place the fences and how long they should be are still somewhat proprietary information. Like all aerodynamic devices, they must be carefully designed, placed, and tested.

Fences should not be installed on ailerons as this can excessively load the aileron and drastically reduce the aileron's effectiveness.

Because fences are designed to control spanwise flow, they are used almost exclusively on swept-wing aircraft. There is some spanwise flow on straight wings. But it is so small that a fence's effectiveness would be small, and it probably wouldn't be worth the drawbacks. However, fences are placed on a straight-winged aircraft between the flaps and ailerons could improve aileron performance when the flaps are deployed.

These considerations lead us to the last of our aerodynamic devices.

VORTILONS: WHAT ARE THEY?

Like wing fences, vortilons are nonmoving plates attached perpendicular to a wing, lined up with the free-stream airflow. Vortilons are smaller than fences and extend from the bottom of the wing to beyond the wing's leading edge. Figure 18 shows two examples of vortilons.

Figure 18 – Two types of vortilons.

There is evidence that vortilons were invented for the DC-9 airliner. When the DC-9 designers moved the engines (and pylons) from the DC-8's under-wing placement, they saw less lift in the landing configuration. Douglas engineers didn't know why this happened, but when they put the old engine pylons from the DC-8 onto the DC-9, the lift returned. Rumor has it that the engineers gradually trimmed away the pylons until the lift degraded again, and then they added some back. What was left of the pylon made up the first vortilon. The word "vortilon" comes from the fact that they are vortex-generating pylons.

HOW DO VORTILONS WORK?

From the two photographs in Figure 18, you can see that the first vortilon is more rounded than the ones in the bottom picture and sticks out in front of the leading edge more. Vortilon shapes, placement, and amount of protrusion past the leading edge are not standardized. In fact, there is not much information available about vortilon design.

However, we know a bit about how they work. Recall that at higher angles of attack, the stagnation point (where the air smacks perpendicularly into the wing) moves to a point below the leading edge of the wing. This is shown by the grey streamline under the leading edge in Figure 19.

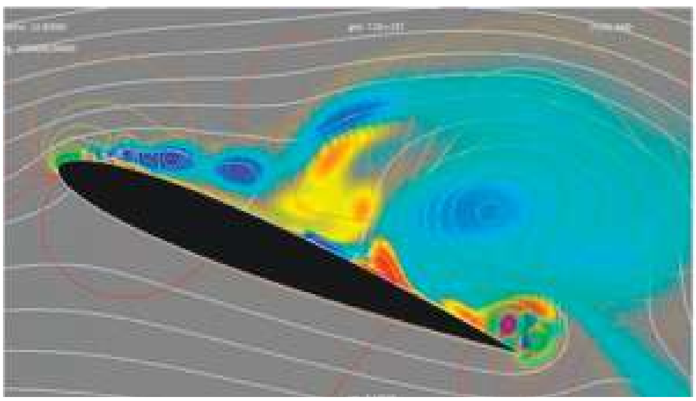


Figure 19

For some angles of attack, this high-pressure air on the bottom of the wing actually flows "up" around the leading edge to the top of the wing before proceeding "down" to the trailing edge.

For swept wings at high angles of attack, the air wants to travel toward the tip. This spanwise flow hits the vortilon, creating a vortex that travels up, around the leading edge, and over the top surface of the wing. Just like a VG or a fence, this vortex helps to delay flow separation over the top surface of the wing and can help control surface effectiveness.

The vortilon acts as a mini fence, reducing the spanwise flow. This reduces the tendency in swept-wing airplanes to tip stall. Another vortilon effect was discovered when Douglas found that at high angles of attack its vortilon produced an "upwash field" inboard of the vortilon that affected the airflow over the plane's horizontal tail. The effect was to produce a nose-down pitching moment at the stall.

WHY ARE VORTILONS GOOD?

There's a lot to love about vortilons. Like VGs and fences, they can delay flow separation, which delays stall and reduces drag. They also can improve control surface effectiveness. They can help to create a nose-down pitching moment near stall. Unlike VGs, they do not produce a vortex except at high angles of attack where you may need a vortex. In addition to this drag improvement, they are lined up with the direction of flight so they do not have the frontal area drag of VGs. Vortilons have less surface area than a fence, so they have less skin-friction drag.

THE DRAWBACK OF VORTILONS

Vortilons are only effective when there is the problem of spanwise flow, for instance, on swept-wing airplanes. VGs would be more effective for straight-winged airplanes. Vortilons are not a cure-all for poor stall characteristics. Very little has been written about vortilon design: their shape, amount of protrusion in front of the wing, where they should be placed, how many of them are desired, etc. This makes experimenting with them difficult, time-consuming, and dangerous if you don't know what you're doing.

SOME FINAL THOUGHTS

As with any aerodynamic changes, one must proceed with caution. There are several ways you could get in trouble slapping on your own device and going flying. The first is that the device may adversely affect some characteristic of your airplane. Another is that you may find that the device works as planned, for instance, delaying stall; but in high, hot, or humid conditions, your engine does not have a similar device. Then there's the problem of the device falling off. Not only would you lose the benefits of the vortilon, VG, or fence, but you might lose it on one side and not the other. Also, a device that comes off in flight might fly back and hit something on the back of the airplane. There are other failure modes, but you get the picture: Don't experiment with these at home unless you know very well what you are doing, or unless you have confidence that the devices others have designed have been carefully configured and fully tested.

All these aerodynamic devices have been proved useful for some planes in certain situations. VGs are the most common of the three devices, and a number of companies sell VG kits that have been flight-tested on specific aircraft types, including many experimental planes. Some of the VG kits come with a contact-paper-like template that makes installation easy and accurate. You stick the template down onto the wing, and glue the VGs onto the wing through the holes in the template.

This approach takes much of the guesswork out of the process of installing VGs. Fences and vortilons are sometimes specified by the designer for a particular type of experimental airplane, but they have not been designed or tested for the vast majority of experimental airplanes. Just because a device is useful on one aircraft type, it doesn't mean that it will work on a different type. As we gain more experience with fences and vortilons, we may see something similar to VGs in the future. Companies may invest their time and money designing and testing these devices to make them reliable and easy for homebuilders to use. EAA

Lynne Wainfan has been a private pilot for more than 30 years. Originally an aerospace engineer, then a manager at Boeing Space, Lynne now consults and teaches at California State University, Long Beach. Readers may remember the Facetmobile experimental airplane, which was built by Barnaby and Lynne Wainfan and Rick Dean.

Illustration courtesy of Institute of Space and Astronautical Science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The Wings of Quicksilver

BY JAMES LAWRENCE

Photography by James Lawrence

The Quicksilver MX II Sport.

WHEN I SAW DAVE CRONK for the first time, I was 29 years old and a bushy-haired, bell-bottom-jeans-wearing new pilot. We were both at the early mecca of soaring—the wonderful Torrance Beach bluffs in Los Angeles—where hang glider pilots flocked every day, and particularly on weekends, to try their hand at soaring the onshore Pacific winds.

On any given day, scores to a few hundred observers would park and walk to the north end of the bluffs that rose higher southward toward the Palos Verdes Peninsula. They came to see this crazy new flying magic up close and personal.

It was 1974. Other than a few zanies like myself, the world knew little about the Rogallo wing design or foot-launched flying in general. Most people thought we were a bunch of hippiefied misfits with one common trait: a death wish.

I had come to mecca—with a couple months of glides and not a single soaring flight under my belt—to worship the masters, learn from them, and most of all, join that still-elite group of pilots who could magically work the lift band to fly for more than a handful of ground-skimming moments.

At one point as I was setting up my Seagull III glider in the sand, a flash of white caught my eye. I looked up to see a hang glider that was dramatically different from the pointy-nosed Rogallos that dominated the scene. This craft had a fairly high aspect ratio, a rectangular (decidedly *not* Rogallo-shaped) wing, and a conventional tail complete with a horizontal stabilizer and a movable rudder.

It was a gorgeous bird: the crisp, all-white Dacron sail-cloth wings and tail were set off by a sparkling airframe made entirely of bronze-anodized aluminum tubing. The handsome pilot was equally striking. He was lean and athletic, with a serious demeanor, and his long brown hair flowed back in the wind. In that moment, I wished I could be just like him, to be so at ease plying the lifting air in his angelic craft.

I noted, too, his distinctive head-forward slouch, seated in the "harness"—little more than a playground swing seat—and was reminded of a sprinter lunging for the finish line tape.

Dave Cronk flies the original Quicksilver No. 1.

"Wow," I said to another pilot. "What the heck is that?"

He followed my gaze and said, "That's Dave Cronk and his Quicksilver C. He's the head designer at Eipper-Formance."

I knew about Dick Eipper, the pioneering hang glider company he formed, and its popular line of quality Flexi Flyer Rogallos. Eipper leaped ahead of the garage-builder crowd with a well-marketed operation and never looked back. And the Quicksilver C was apparently its latest innovation.

I marveled at the performance of the Quick. While the rest of us struggled in the 12-mph ocean breeze to achieve that elusive dream of sustained flight along the rising ridge at Torrance, Dave made everybody look like a bunch of neophytes. Where we beginners were lucky to gain maybe 100 feet above the top of the ridge in one pass before losing the lift, Dave navigated the lift band at will, like he was one of the local seagulls.

Taunting us, he'd ease straight out from the ride to float beyond the waves, exploring the upwind edge of the lift band, then swinging in a graceful arc back toward the ridge...and still end up higher than everybody when he got there.

It wasn't the last time I'd share the air with Dave Cronk...or the Quicksilver.

A SHAPE OF DESTINY

That iconic wing/tail design, for so long a mainstay of hang gliders, ultralights, and now special light-sport aircraft (S-LSA), did not begin life in the fertile brain of Dave Cronk. The monoplane twinkle in his eye originated, probably in late 1971, with fellow Eipper-Formance designer Bob Lovejoy's original High-Tailer.

The High-Tailer had excellent performance, but it also had one shortcoming: It was too stable and didn't turn worth a darn.

Back to the drawing board.

The Quicksilver A that emerged from the High-Tailer's redesign used the same 30-foot-span, 4-foot-chord wing. But in place of the twin vertical tails was a horizontal, A-frame tube arrangement angling back from the trailing edge of the wing. A cable-braced, fixed horizontal stabilizer and rudder finished off this new "fuselage." The rudder was moved by lines fixed to either side of the simple plastic swing seat. As the trailing edge of the rudder's C-shaped frame was unsupported, the rudder distorted a lot. It was still effective at yawing the tail sufficiently for the dihedral of the wings to come into play and effect a turn. A stiffer "D"-frame rudder solved the distortion problem.

Cronk and Lovejoy kept tweaking the design. Load testing uncovered weakness in the trailing edge and that was fixed. Once the Quicksilver B model debuted, ready-to-fly for all of $965 (twice of what a Rogallo cost), the Quick legend was on its way to glory.

Before long, the Quicksilver C debuted with an increased span of 32 feet, a deeper chord (to 5 feet), and a larger tail. The airfoil camber was reduced from 12 to 8 percent camber. Jack Schroeder, another free-flight pioneer, joined Dave Cronk to fly

Photography by James Lawrence

The GT 400

the C model in the 1974 U.S. Hang Gliding Nationals. Jack won the event in the rigid-wing class.

BRING ON THE HORSES

For a few years in the 1970s, Quicksilver was the superior-performing hang glider of its day. In time, other rigid wing designs, including the Icarus II and V, Manta's Pterodactyl Fledgling, and ultimately Rogallo flex-wing designs themselves, began to challenge, then eclipse Quicksilver's reign as top glider in the soaring stack.

Eipper-Formance saw the handwriting on the wall, and the wall said, "Power!" While some die-hard souls hung power units on flex wings, the Quicksilver's "conventional" aluminum frame offered the best platform for motorized flight.

Soul-weary at the number of friends and flying comrades he'd lost to the sport, Dave left Eipper around the time he and his partners were bought out by Lyle Byrum. Lyle was a slick dude, high roller, former Texan car dealer, general aviation pilot, and one clever cookie when it came to business. He and a group of investors figured the powered Quick would sell like hotcakes. He bought the company and renamed it Quicksilver.

And man, were they right, as in Dan Johnson once referencing the Quicksilver as "*the J-3 Cub of ultralights!*"

The first powered Quicksilver was the C model. It sported the classic weight-shift sling seat but now included

The Quicksilver Sport 2S, which is now available as an experimenter light-sport aircraft kit.

a cranky McCulloch MAC-101, 12-hp engine with a V-belt reduction drive, pusher prop, and all of 1.7 gallons of fuel. It still had to be foot launchable—the FAA hadn't evolved the ultralight regulations yet to accommodate wheel launching.

The first production powered Quicksilvers had a much more reliable 15-hp Yamaha engine. There was a spring-loaded throttle on a down tube, but the landing gear was still the pilot's legs. It cost $3,995, a tidy sum in those days, but for a complete airplane, including engine, that you

The GT 500 was the first Primary Category aircraft certificated in 1993. Very few aircraft took advantage of that category.

The original High-Tailer red tail that evolved into the original Quicksilver design.

didn't have to lug to the top of a hill to fly, it was a bargain anyway you looked at it.

A short word about the laudable Quicksilver kits, past and present: All the parts came shrink-wrapped on large cardboard sheets, clearly labeled and identified. The assembly manual was a work of art. All the instructions were step-by-step, with copious illustrations to guide you through construction. Dave Cronk, engineer/artist that he was, made those wonderful manuals what they were.

One of my happiest memories of the time was cruising alongside a road near Salinas, California, in 1981, 100 feet up in the air, feeling the morning wind in my face and enjoying the gentle manners of the Quicksilver. I'd wave at cars that would honk as they raced by—my airspeed was all of 30 or 35 mph. The "airplaney" Quick in time became *the* way so many people realized similar flight desires, without the hassle of having to go to an airport. What a heady, free time; it was at the beginning of ultralight flying as a sport and an industry.

SUCCESS SECRETS

Two prime reasons for the Quick's enduring legacy were its ease of assembly and the fact it was a cupcake to fly. Forgiving, sufficiently responsive, and sheer fun, it was the perfect ultralight for a world hungry for grassroots aviation. Call it OWT—on the wing training—many of us learned about powered flying by flying our ultralights.

Before long it became clear the Quick would surpass even Byrum's original vision; it did sell like hotcakes: 15,000-plus and still counting.

New models were developed, including the Quicksilver MX, which evoked Byrum's desire for three-axis control instead of simplified two-axis (weight shift for pitch, rudder for yaw-roll coupled banking). The first MX (for Multiple aXis) had a movable elevator for pitch, and because pilots asked for true three-axis control, Dave tried spoilers on top of the wing.

 Photography by James Lawrence

Nope—didn't do much, so back to the drawing board. Next came ailerons and that did the trick: The Quicksilver was now a three-axis airplane. This new model, the MXL (for aiLeron), sold like *blueberry* hotcakes.

Quicksilver parlayed its success into an expansive dealer network and new models. Training aircraft were needed, so Dave and company created a two-seat Quick. These birds existed in a quasi-legal gray area. They were too heavy for the ultralight category and carried two people. FAA let them pass as trainers, but many abused the privilege by using them for two-person recreational flying.

When the sport pilot rule came out in 2004, two-seaters could be grandfathered in as experimental light-sport aircraft (E-LSA), with proper inspection and some paperwork bureaucracy...but only until 2008. Those owners who didn't get with the program missed the boat. Two-seater "ultralights" could then be registered as experimental amateur-built (E-AB) and used for ultralight training...as long as dealers didn't charge for it. There went a lot of revenue and many dealers closed up shop.

The ultralight industry had gone through a major slump after the disastrous mid-1980s "exposé" (journalistic hatchet job) by ABC's *20/20* TV program. The public, believing the program's lies and distortions and horrified by the gruesome graphics of showing a pilot falling to his death, reacted predictably: Within six weeks of that show, half the orders for *all* ultralight companies were canceled. Ultralight flying, which had been well on its way to filling the skies with aircraft, was dealt a near-fatal blow from which it never fully recovered.

Quicksilver Aircraft continued as a market leader, although it too felt the pinch. Most ultralight companies folded even quicker then they had opened. In the meantime, Quicksilver introduced the GT line, designed by Dave Cronk, who had returned to the fold, and Tom Price. The enclosed cockpit, double-surface-winged, three-axis single-seat GT 400 was a legal ultralight. The later two-seat GT 500 was too heavy and fast for the FAR 103 ultralight category. It was offered as an E-AB kit or ready-to-fly airplane (Sportplane Class) in the new FAA category of Primary Aircraft.

Along the way, Lyle Byrum sold the company. It languished and was sold again in 2012 to Will Escutia and Dan Perez. They renamed it as Quicksilver Aircraft. Escutia is the president; Perez wrangles the day-to-day operations at Quicksilver HQ in Temecula, California. The new management team has big ideas for the future.

THE QUICK REBORN

I tracked down Will Escutia at EAA AirVenture Oshkosh this year to get a sense of his vision for the company. He said, "I loved the feeling of flying a Quicksilver from the first flight. I thought, 'Flying is a universal dream. And here's an opportunity for all to do it.' I stayed engaged with this idea, and in 2012, purchased the company with the help of investors."

ON QUICKSILVER WINGS

Quicksilver Aeronautics offers a full line of ultralights, special light-sport aircraft (S-LSA), and experimental amateur-built (E-AB) kit aircraft:

Sport 2S – two-seat (side-by-side) open-cockpit E-AB kit (starting at $23,999) (three models available)

S-LSA Sport 2SE – ready-to-fly ($39,999)

GT 500 – two-seat (tandem) E-AB kit, currently in S-LSA certification process (starting at $29,900)

MXII Sprint – (side-by-side) ultralight-style E-AB kit

MX Sprint – single-seat ultralight (starting at $19,999)

MX Sport – single-seat ultralight

Get all the details here: www.QuicksilverAircraft.com.

Escutia and Perez inherited a company struggling to stay aloft and only producing kits. In less than three years, their re-energized Quicksilver Aeronautics has made significant strides.

"We love kits and continue to make them, but we wanted to take the company into the S-LSA arena as well," Escutia said. After 19 months of certification rigors, the S-LSA certification was awarded to the Sport 2SE two-seater in June of this year.

"Our principal idea for going the S-LSA route was twofold," he continued. "We want to give non-builders a ready-to-fly, affordable airplane. And we want to grow our dealership network by giving them an aircraft they could legally train in and be able to charge for that training. We also want to help them increase profits by providing them with E-LSA kits that they can either sell outright or build for their customers."

E-LSA kits do not have the same restrictions as E-AB kits: They can be built almost entirely by a dealer.

"We feel that's good for the customer by giving them more options, and good for the dealer, too," Escutia said. He plans to grow the world dealer network as well.

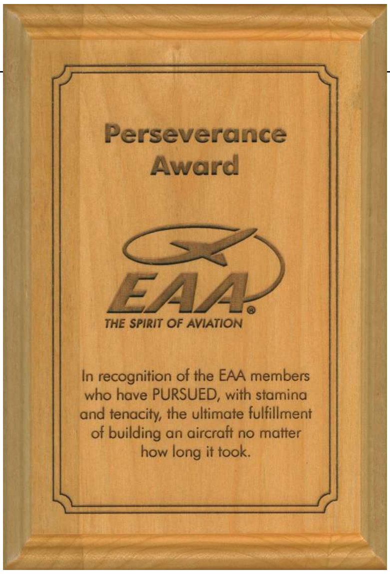
"China, India, and other countries are like the U.S. was 20 years ago: A new generation of pilots wants to experience ultralight flying," he said. "The Quicksilver is geared toward that market. It doesn't require a lot of construction. It's easy to fly safely."

Quicksilver just sold 77 airplanes to its first dealer in China. The sleeping civilian pilot giant is about to awaken in that vast country.

I asked Will what he likes most about flying the Quicksilver.

"The ability to take off from a small field...that's freedom for me," he said. "To fly and see things up close—it's very exciting. When you land at a different airfield, you meet new people who come over to talk to you about the airplane. I like to encourage them to try this kind of in-the-open flying.

"Most of my flights are alone, but the ones I remember best are with other people. Two-seat flying gives you that flexibility, and you remember the story of the flight you shared very well." *EAA*



2014 Perseverance Awards

Celebrating more builders' success

BY JOHN MANGOLD

CONTINUING THIS MONTH, EAA is happy to recognize several homebuilders who brought their aircraft to EAA AirVenture Oshkosh for the first time since completing it. Each year, those builders are recognized with a Perseverance Award to acknowledge the work and investment they made to complete their projects.

The Perseverance Award was founded by Doc and Buddy Brokaw (now deceased) who built and flew a Brokaw Bullet for many years. The award continues in their honor and to fulfill their wish that homebuilders be recognized for their perseverance.

Over the next few months, we will share photos of several aircraft that made their first appearance at Oshkosh 2014. *— Mary Jones*

RV-8, C-GHZZ

Richard Noel and his wife are from Quebec City, Quebec. Their RV-8 was certificated on June 9, 2014, and made its first flight the next day. The airplane took 3 years to build, of which two years and three months were part time while Richard operated his own business. He received an offer he couldn't refuse to sell his business and began working full time on the RV project, finishing it in the next 9 months.

RV-10, N413BS

Brian Steeves flew his RV-10 to Oshkosh from Wahpeton, North Dakota. N413BS took 4.5 years and 3,800 hours to complete. The airplane was certificated and first flown in August of 2013. Brian felt that he received good support from the factory. His first build was a kit car, followed by a Challenger II, and then the RV-10.

Photography by John Mangold

F1 ROCKET, N115TP

Bruce Topp's F1 Rocket took six years to build and was certificated in October 2013, with the first flight occurring in the same month. Bruce flew to AirVenture from Minneapolis, Minnesota. The aircraft is powered by an IO-540-D4A5. Its paint scheme was inspired by hot rods Bruce has seen over the years. This is his second homebuilt aircraft; the first was a Velocity he sold to a pilot in South Africa. A 21-year-old pilot from the Buffalo, New York, ferried the plane to South Africa; the trip took 21 days.

HATZ BIPLANE, NX501P

Rick Hansen's Hatz biplane, NX501P, won this year's Sun 'n Fun Grand Champion Homebuilt Plans-Built and then was named Grand Champion Plans Built at EAA AirVenture Oshkosh 2014. (See the September issue of *Experimenter*.) This is the third Hatz biplane Rick has built. This time he built it light to meet the definition of a light-sport aircraft. The airplane has an empty weight of 829 pounds and a gross weight of 1,320 pounds, and it's powered by a certified O-200-D engine. It is also equipped with Grove light-sport brakes and wheels.

HATZ CB-1, N805RF

Kevin Conner built his version of the Radio Flyer wagon with his plans-built Hatz CB-1. He used Airtex fabric and PPG paint to re-create the look of a Radio Flyer. The airplane took 11 years and 11 months to build and was certificated and first flown on July 3, 2014. He flew it to Oshkosh from Oklahoma.

RV-10, N24EV

Myron Nelson flies for Southwest Airlines. The nose art on his -10 is dedicated to Herb Kelleher. The RV was first flown in May 2014, after 7.5 years to build. Myron flew the airplane from Mesa, Arizona, to AirVenture. The stick grips on the aircraft are out of a Boeing 737; all the switches are functional. The "EV" in the N-number is a reference to his wife, Evelyn.

RV-7A, N921PM

This RV-7A is Mike Reid's second RV project; the first was an RV-8A. The -7A was certificated in May 2013 and first flown in July 2013 after 6 years of construction. The airplane is powered by a Lycoming O-360 of 180 hp. The "921" in the N-number is a reference to his and his wife's wedding anniversary, and "PM" are Mike and his wife's first initials. His youngest daughter, age 16, designed the paint scheme. Mike bases the aircraft out of the airport in Buffalo, Minnesota.

RV-9A, N956GT

Gregory Targonski purchased the tail kit for this RV-9 at EAA AirVenture Oshkosh 2006. Six years after starting the building process, N956GT was certificated and first flown in September 2013. The aircraft is powered by a 160-hp O-320 and painted like Gregory's favorite model aircraft from his younger years. N956GT is equipped with a full Dynon SkyView system and sheepskin seat covers. Gregory flew to AirVenture from Peachtree City, Georgia. EAA

Pipistrel Launches An All-Electric Light-Sport Aircraft

BY MARINO BORIC

PIPISTREL CAUSED A BIG buzz at the French *Salon de Blois* fly-in at the end of August by presenting the WATTsUP, an all-electric, two-seat light-sport aircraft (LSA)/European microlight. While the whole world is mainly talking about the feasibility of electric propulsion in aviation, Pipistrel presented a near-to-production aircraft. Pipistrel is still fine-tuning the airplane and in few months will be able to deliver an LSA-compliant aircraft. This is Pipistrel's fifth electric aircraft project (the second to result in a commercial product) and probably the first two-seat LSA on the world market.

WATTsUP had its maiden flight on August 12, 2014, in Slovenia. By September 10, it had logged more than 30 flying hours. Pipistrel developed WATTsUP in partnership with the German company Siemens AG, which provided the main electric propulsion components, and Siemens is still on board in other Pipistrel electric projects.

WATTsUP represents the next generation of Pipistrel electric aircraft, and it has a great potential to become a bestseller. In the past 25 years, Pipistrel has proved to be quite capable of designing innovative and efficient aircraft, of being able to manufacture them on an industrial scale at a high-quality level, and its aircraft are long-lasting products with good resale value. All of this plus the pretty conventional look of the WATTsUP suggest the best ingredients for a successful product start.

According to Pipistrel CEO and owner Ivo Boscarol, this aircraft is "opening a new class in the aircraft world." On that warm and sunny Saturday morning in Blois, we got our first look at a pretty conventional-looking two-seat microlight/LSA built in traditional Pipistrel style. If it hadn't been decorated with electronic print-board decals, nobody would have identified it as a new and game-changing aircraft.

Its conventional look is one of the reasons why this aircraft likely will be successful. The airframe uses proven features from hundreds of Pipistrel's aircraft flying around the world. An attentive observer will find an uncommonly fat, two-bladed propeller that features twice the blade chord length than what's usually found on conventional aircraft of the same type. Other differences are hidden to the occasional observer. Behind the propeller, the removable engine cowling is shorter than normal; where the Rotax 912 engine would typically be, there is now an extraordinarily compact electric propulsion unit. The 85-kilowatt electric motor weighs 31 pounds and is reportedly more powerful than the Rotax 912. This lightweight propulsion unit can supersede not only the 912 but even the Rotax 914 turbo engine in performance.

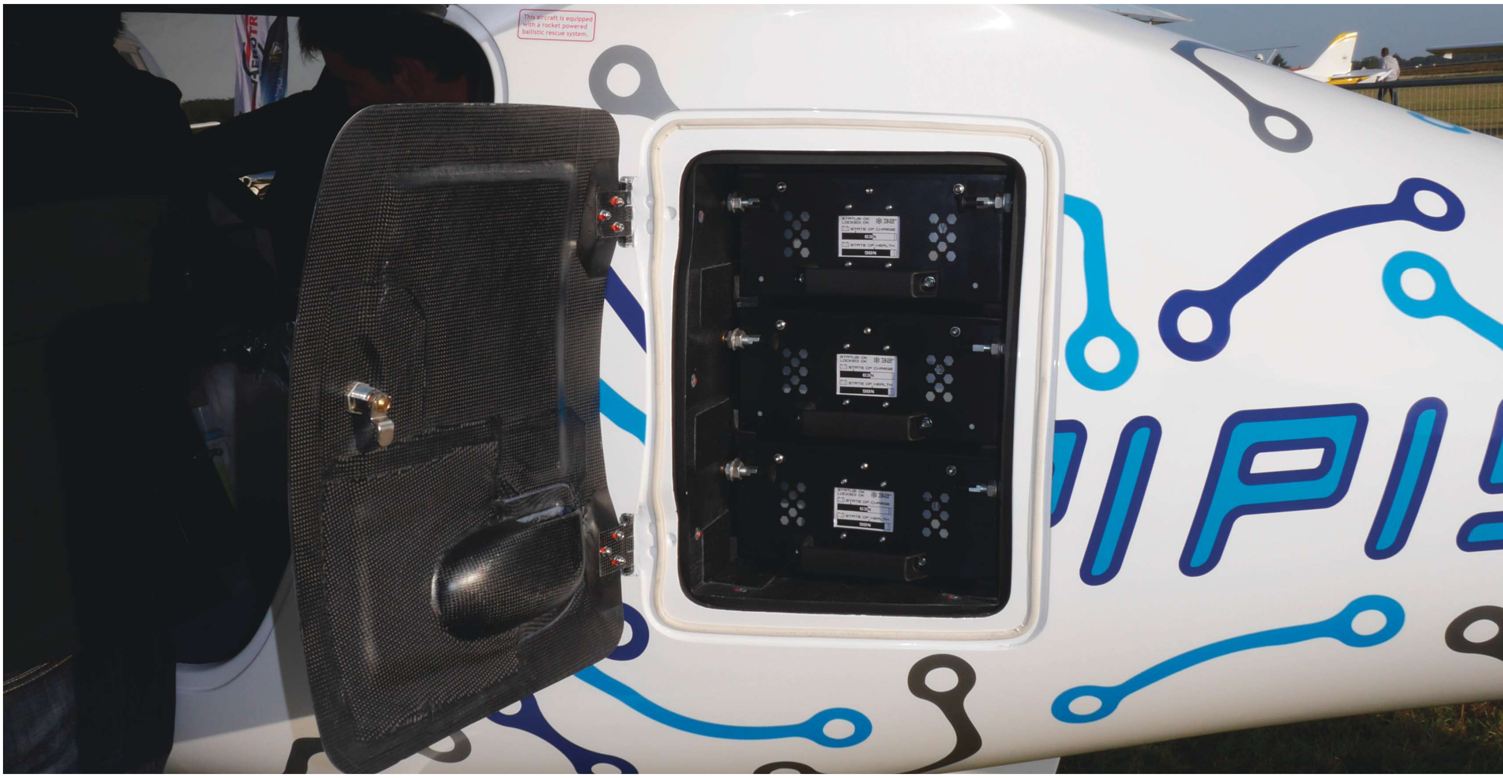
Photography by Marino Boric

According to Tine Tomazic, Pipistrel's head of Research and Development, this electric propulsion package does not have any temperature limitations. It is designed for operating in a temperature range from -4°F to +122°F (-20°C to +50°C). On the right side of the firewall just behind the engine, an overflow bottle is located, indicating that the electric motor is liquid cooled. Most details of the compact electric motor/drivetrain are still unknown, and even several direct inquires to the Siemens headquarters in Germany haven't brought any details; so we have to wait a bit for more insight. I understand that the weight of the propulsion unit might increase from 31 to 35 pounds (14 to 16 kilograms) in an effort to lower production costs.

The second crucial part of the system is the batteries, which were developed by Pipistrel. The two 17-kilowatt-hour battery packs are dual redundant and designed to be either quickly replaceable within minutes or charged in less than one hour, thanks to the next generation of Pipistrel's battery management technology. There are two battery compartments on board; one is accessible from the right side, located just behind the firewall, while the second is accessible from the left side, behind the cabin. Both compartments are built as a protective box that is fireproof, and they are air cooled through appropriate vents installed in easy-to-open doors. Each of two 8.5-kilowatt-hour battery packs consists of three single independent battery cases weighing 44 pounds (20 kilograms) each.

WATTsUP's current empty weight without batteries is 573 pounds (260 kilograms). With one battery pack, it weighs 700 pounds (320 kilograms), or 830 pounds (380 kilograms) with two battery packs. Boscarol said in mid-October that the aircraft will lose some 66 pounds (30 kilograms) prior to entering production, indicating that its empty weight will drop to about 500 pounds (230 kilograms).

The Siemens propulsion package weighs only 31 pounds; it's all you need under the cowling.



The rear battery compartment door. At the lower end, the air intake duct is visible. In the middle of each battery is the easily readable battery status display.

With both battery packs on board, WATTsUP can stay airborne theoretically for 90 minutes, or, translated in more realistic pilot's language, it can fly one hour and still have 30 minutes of reserve power. With only one battery pack, the times are halved.

The battery packs are removable in a matter of seconds. Officially, only two minutes are needed for a complete battery change. Each battery case or unit (one of three in a compartment) has its own status annunciator display with readability similar to Kindle white paper devices. The Li-Po (lithium polymer) batteries will be delivered with a proprietary trolley that doubles as the charging station. The batteries can be charged on board of the aircraft, too.

This is the power train/battery annunciator panel, running in a flight simulation mode indicating 2235 rpm and 54 percent battery capacity .

WATTsUP is able to fly immediately after the battery loading process, even if the batteries are not completely charged. Every system of this aircraft is designed for a 2,000-hour TBO, and Pipistrel said the batteries are made for 1,800 cycles; after that period, the batteries will have lost only 20 percent of their initial capacity.

Tomazic opened the WATTsUP press conference with these words: "This is the first aircraft (in the world) to have shorter charging time than flight time." He listed the charging times as:

- 30 minutes for a 45-minute flight
- 45 minutes for a 60-minute flight
- 1 hour and 20 minutes for a 1 hour and 30-minute flight.

Tomazic and Boscarol said the electric propulsion unit and the aircraft will enter production after AERO Friedrichshafen 2015 (in April 2015). Boscarol told me in mid-September that customer interest after Blois was so strong that Pipistrel was forced to start taking orders with deposits that will guarantee the first buyers a 99,900 euros price tag (approximately $127,000 U.S.).

At AERO Friedrichshafen 2015, the final version of the aircraft will be presented, and the price will probably go up. It is almost certain that the current name, WATTsUP, will be changed, too.

RELIEF FOR FLIGHT SCHOOLS

The two-seat electric trainer is tailored primarily to the needs of flight schools, and its (speed) performance will match other gas-powered aircraft. A short takeoff distance, the possibility to

The WATTsUP instrument panel.

Photography by Marino Boric

Tine Tomazic demonstrates how easy it is to remove the single battery block. He said, "If you can't do this, don't fly."

tow gliders, a powerful 1,000-plus-fpm climb, quiet operation, and 90 minutes endurance make this aircraft almost ideal for pilot training. Boscarol said WATTsUP is optimized for traffic pattern operations and flights around the airport where 13 percent of its energy is recuperated on every approach to landing (this is the reason for the "fat" propeller), increasing endurance and at the same time enabling short-field landings.

Tomazic added that there is no need for flight schools to buy a spare battery pack for a single airplane as the flight training sessions usually don't last longer than 45 minutes. And the student exchange time on the ground, together with a short flight review, already provide enough time to charge the batteries. An additional spare battery pack might be useful for operators of two aircraft, where the batteries could be exchanged in a rotation system.

According to Pipistrel, WATTsUP's purchase price can't be compared directly to gasoline engine–powered aircraft, because "in the purchase price of this aircraft, the fuel is already included." The price for electric energy needed to recharge the batteries in Europe is approximately $1.32 (1 euro) per traffic pattern or $10.50 (8 euros) per flying hour. The price in the United States is almost 50 percent less because of lower energy prices. Pipistrel's WATTsUP doesn't put any special requirements on airports/airfields where it will operate; a normal AC power outlet is all that is needed.

Boscarol said, "With the ever-growing cost of fuel, it is time to rethink pilot training. Our solution is the first practical, all-electric trainer. Technologies developed specially for this aircraft cut the cost of pilot training by as much as 70 percent, making flying more affordable than ever before. Being able to conduct training on smaller airfields, closer to towns, with zero CO2 emissions and minimum noise is also a game changer! WATTsUP meets microlight and ASTM LSA criteria, as well as standards for electric propulsion, and it is already certified in France. More countries will follow soon, and we are applying for an exemption with the FAA to allow training operations as special LSA."

The electric motor is liquid cooled. The bottle with the red cap/liquid is the overflow bottle.

Frank Anton, executive vice president of Traction Drives, Large Drives for Siemens AG, said, "Siemens is developing electric drive systems with the highest power-to-weight ratio for aircraft propulsion. Only with innovation can we solve the problems of rising fuel costs, rising passenger demands, and rising environmental regulations." Anton initiated electric aircraft development at Siemens. "Innovations used in the WATTsUP will be instrumental in making aviation more sustainable in the long run," he said. "As electric drives are scalable, we can expect that in the future larger aircraft will use electric propulsion. The world is becoming electric, whether in the air, on land, or at sea."

The cabin of the WaTTsUP is roomy and comfortable, making it a fun-to-fly future trainer.

According to Boscarol, Pipistrel will offer this power-train system to other aircraft manufacturers as a plug-and-play system. The price is not yet known.

Hypstair, another Pipistrel and Siemens project, will integrate batteries and a power train into a modified Panthera four-seat airframe. This is an attempt to bring the world's first certified hybrid aircraft to market. Besides Pipistrel and Siemens, the University of Maribor in Slovenia, the Italian University of Pisa, and MB Vision, a specialist in providing visual information, are all involved. Siemens AG is providing an "ultralight-weight integrated drive train" for the aircraft. The Hypstair will be powered by a serial hybrid drive that will lead to a much quieter aircraft with greater fuel efficiency. The power system will turn a five-bladed propeller at low rpm, ensuring a low rotation speed and low noise. A dedicated battery management system will actively balance cells in the battery pack, ensuring optimum performance in all flight phases. A true single-lever power control will be used where the position of the power handle will directly correspond to the airplane's power output.

For more information about Pipistrel's activities, visit www.Pipistrel.si. EAA

Photography by Marino Boric