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Vol.2 No.2 | February 2013

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An Electric-Powered Ultralight

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The Bearhawk LSA

An Old-School Light-Sport Aircraft

Barn Finds
Discovering hidden treasures

By Chad Jensen

There is a ton of them out there. One-offs and designs that just didn't become popular. I recently found myself in a barn in central Illinois where there was not one but two of these lesser-known types of experimental airplanes. Oddly enough, both of them were called Termites, though they were completely different. One of them was a Smitty's Termite (or Smith Special or Smith Termite), designed and built by Wilbur Smith in the 1950s after he built a Pietenpol Sky Scout in 1930. It's a single-place parasol and looks very similar to the Sky Scout. It was powered by a Kawasaki engine of unknown horsepower. The other, simply called a Termite, was a single-place biplane, powered by a very rare Lycoming O-145.

As I pored over these two barn finds, I couldn't help but wish that it was me who had found them, but I was with the gentleman who did. He is a pilot, but he was unsure of what the airplanes were or what they were worth.

That's a really tough question, and not one I need to answer here, but what I am really curious about is what else is out there? You see, I lived not 10 miles from this particular barn for 12 years prior to coming to EAA, and I had no clue these two aircraft were around. No one did, really. At least, no one ever said anything about them. So if these two airplanes have been in that barn for many, many years, even being flown up until the early 2000s, and I was unaware of them, having lived and breathed aviation in central Illinois for so many years, what else is out there right under our noses?

Now, don't go rooting through every barn you see just to check out what may be hiding inside, but if you know of an airplane hanging out in a barn or some other shed, show it to me! I'll post them on the Homebuilders HQ Facebook page…this could be interesting!

Zenith Video Update

Below you'll see the latest video update on the Zenith project that EAA staff has been busily working on. Our twice-weekly sessions have turned out a complete empennage, and by the time you read this, the wings will be nearly complete while we stare down the plans and instructions for the fuselage. The goal is still Memorial Day weekend for a first flight, and with the continued help of dedicated staff builders, this has a certain chance of becoming reality!

On the cover: Bob Barrows flies his Bearhawk LSA for EAA's cameras. (Photography by Phil High)

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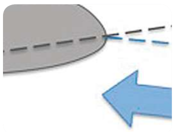

400-mph Racers

The [Reno Air Races] article [in the November *Experimenter*] leads readers to believe that several of the Sport Class planes have exceeded 400 mph. The article intimates that this was done on an official lap, that is, a qualifying [lap] or race. That is not the case.

The Nemesis NXT Race #3X…we call it the "pink beast"…is the *only* Sport Class airplane to make official laps at Reno at more than 400 mph. Our fastest laps were in 2009, our last year of racing, when we posted two race speeds averaging more than 400 mph. These were in the third heat race, averaging 406-plus mph, and the Gold Race final at 407-plus mph. All that following a 412-plus-mph qualifying blast!

The Nemesis NXT, in addition to having *all* the qualifying and race records for the Sport Class on the big Sport/Unlimited/Jet race course that all three classes share, also holds all the qualifying and race records on the smaller Sport course. Our best speed on that course was 409 mph in qualifying set in 2008…

The November article leads the reader to the [incorrect] fact that several of the current racers have gone more than 400 mph. As Tim [Kern] said in our phone conversation after the article was published, it was intimated this is a "straight line" speed, and nothing official. Well, the joke here is how do you tell when a race pilot is lying about his speed? His/her lips are moving and perhaps there is hand waving. The other joke is what is the quickest way to slow down an airplane? Put a timer or a watch on it.

To that end, the Nemesis NXT has gone close to 500 mph in testing. It was clocked on the "Valley of Speed" straightaway at Reno in 2009 at 464 mph. There is nothing "official" about those, but it's there for comparison; in this case the fingers are moving, and complete with hand waving.

Jon Sharp
EAA 239592

Experimenter in PDF Version

It would be great if PDF versions of *Experimenter* were made available to facilitate downloads and offline reading.

Harish Jadeja
EAA 746554

Some good news, Harish. It is possible to save Experimenter *as a PDF. When you're viewing the magazine online, note the tool bar displaying across the top of each page. The fourth tool in from the right offers you the choice of saving the entire issue as a PDF, or individual pages as a PDF.*

Unfortunately, this option does not work on mobile devices—that is, smartphones or iPads and other tablets. But perhaps you can save the issue as a PDF and then send it to your mobile device. That's a workaround until there's an app for Experimenter. *-- Mary*

PUBLICATIONS STAFF

Founder: Paul H. Poberezny
Publisher: Jack J. Pelton, EAA Chairman of the Board
Vice President of Publications: J. Mac McClellan
Homebuilding Community Manager: Chad Jensen
Editor: Mary Jones/EditEtc. LLC
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News Editor: Ric Reynolds
Copy Editor: Colleen Walsh
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Contributing Writers: Marino Boric, Budd Davisson, Cy Galley, Dan Grunloh, Ed Kolano, Jim Lawrence, Bill McElwee, Stephen Richey, Rick Weiss
European Correspondent: Marino Boric

ADVERTISING

Display
Sue Anderson
Jonathan Berger
Jeff Kaufman

Mailing Address:
P.O. Box 3086, Oshkosh, WI 54903-3086
Phone: 920-426-4800
Fax: 920-426-4828
E-mail: experimenter@eaa.org
Website: www.EAA.org

Need to change your address or have other membership questions, call 800-564-6322 (800-JOIN EAA).

Huerta Confirmed as FAA Administrator

Michael Huerta was confirmed as FAA administrator for a five-year term in early January, ending his one year of service as acting administrator.

Jack Pelton, EAA chairman of the board, called Huerta personally to offer the organization's congratulations. "We have had a good working relationship with Administrator Huerta, and we look forward to that continuing," Pelton said. "He has been supportive of GA in several areas, such as setting up the FAA's fuels program office that will provide leadership in finding viable alternatives to 100 low-lead fuels."

Pelton also pledged EAA's support on recreational aviation safety matters and a continued positive working relationship that seeks solutions for issues that face EAA members and GA.

FAA Still Reviewing EAA/AOPA Medical Certification Exemption Request

The EAA/AOPA medical certification exemption request remains under review by the FAA. The exemption request would allow recreational pilots to operate many popular GA aircraft by completing an online medical awareness course, carrying a valid state driver's license, and observing specified operating limitations.

The FAA is categorizing the more than 16,000 comments regarding the exemption request, nearly all of them in favor of proposal. While the FAA has never set a timeline for a decision on this exemption request, EAA and AOPA continue to urge the agency at every opportunity to review it as expeditiously as possible.

During the "quiet period" following public comments, the FAA is not allowed to discuss the status of the proposal; the FAA could approve the proposal in its entirety, approve parts of it, or reject the proposal.

EAA, AOPA, and other groups have made numerous requests to change the current third-class airman medical certification system over the past 25 years, with only incremental changes being approved, such as lengthened duration and use of driver's license medical certification for pilots exercising the privileges of a sport pilot. The current proposal looks at the challenge in a new way that aims to maintain safety and keep pilots flying familiar aircraft, while building on the medical safety record of sport pilots and those who fly aircraft such as balloons and gliders without a medical certificate requirement.

EAA Seeks Nominees for Halls of Fame

EAA is asking members to nominate worthy individuals for induction into the 2013 Homebuilders and Ultralight Halls of Fame.

The halls of fame provide permanent recognition for designers, builders, educators, pioneers, record setters, and others who have made a substantial impact on the homebuilding and ultralight movements.

Induction ceremonies will take place in the fall of 2013 at the EAA Aviation Center in Oshkosh, Wisconsin. Deadline for submitting nominations is March 1, 2013.

To nominate an individual for the Homebuilders Hall of Fame, visit www.EAA.org/homebuilders/programs/hof.asp.

To nominate an individual for the Ultralight Hall of Fame, visit www.EAA.org/ultralights/hof.asp.

FCC Seeks More Comments on 121.5 MHz ELTs

The Federal Communications Commission (FCC) is reopening a prior ruling on 121.5 megahertz (MHz) emergency locator transmitters (ELTs) to generate additional comments on their appropriate treatment under Part 87 of the FCC Regulations.

In the Third Report and Order, which resulted from a January 10, 2011 proceeding, the FCC amended Section 87.195 of its rules to prohibit the certification, manufacture, importation, sale, or use of 121.5 MHz ELTs. It adopted this amendment because, among other reasons, the international Cospas-Sarsat satellite system, which relays distress alerts to search and rescue authorities, stopped monitoring frequency 121.5 MHz on February 1, 2009.

The FCC is seeking additional comments on the proper timing and implementation of a 121.5 MHz ELT phase-out and transition to 406 MHz ELTs.

Specifically, the FCC is requesting comments regarding the following potential actions:

- no FCC certifications on new models of 121.5 MHz ELTs in light of the superiority of 406 MHz ELTs
- prohibiting further certification of 121.5 MHz ELTs immediately upon the effective date of any 121.5 MHz ELT rule amendments adopted as a consequence of this third FNPRM
- prohibiting continued manufacture, importation, and sale of existing 121.5 MHz ELT models beginning one year after the effective date of any 121.5
- adopting a specific date to prohibit the continued use of 121.5 MHz ELTs in service
- the costs associated with a mandatory transition to 406 MHz ELTs.

Comments may be filed electronically by accessing the FCC's Electronic Comment Filing System at www.FCC.gov/cgb/ecfs or the Federal eRulemaking portal at www.Regulations.gov. Filers should follow the instructions provided on the website for submitting comments. EAA will be filing comments in support of the continued use of existing 121.5 MHz ELTs before the close of the comment period.

EAA Works to Investigate Factors in Deadly Accidents

In late January, EAA participated in the third meeting of the General Aviation Joint Steering Committee's Second Loss of Control (LOC) Working Group.

The Working Group was created to investigate the factors involved in fatal GA accidents resulting from the pilot's loss of control of the aircraft during departure and en route phases of flight and to propose intervention strategies to reduce the accident rate. It is a collaboration of the FAA, NTSB, industry groups, type clubs, and academia.

The first LOC Working Group similarly dealt with such accidents during approach and landing and finished its work in April 2012. This second iteration of the group began meeting this past September.

"Loss of control is by far the most common factor in fatal accidents," said EAA Government Advocacy Specialist Tom Charpentier, who attended the January meeting. "We are confident that by the end of this process we will develop meaningful and diverse ways to help improve GA safety, from effective education on aeronautical decision making to affordable access to safety-enhancing technology. Investigating these accidents is a sobering task, but it is also rewarding to know that our efforts will hopefully save lives."

Homebuilding Community Loses Two

EAA has learned of the passing of two homebuilding notables. Michael "Mick" Myal, EAA 7978, the founder of *Contact!* magazine and a noted experimental aviation writer, passed away on November 12, 2012. Mick was known to thousands of homebuilders for attending countless air shows and from the books and magazine articles he published. Mick founded *Contact!* in 1990 and edited its first 70 issues. View an online obituary for Mick here.

Harry C. Riblett Jr., EAA 29576, passed away on December 23. Harry was an active homebuilder, but his most dedicated work was in researching airfoil designs, convinced that safer airfoils would save lives. His first book, *GA Airfoils: A Catalog of Airfoils for General Aviation Use*, shows airfoils superior to the currently available NACA airfoils. Both *GA Airfoils* and his second book, *Spin Resistant Airfoils*, are currently being used by aircraft designers. View an online obituary for Harry here.

EAA extends its deepest condolences to the families and many friends of Mick and Harry.

New Brakes from AeroConversions

AeroConversions has added the AeroBrake hydraulic braking system to its product line. The AeroBrake is the first hydraulic brake designed for use with Sonex Aircraft airframes. The AeroBrake may also be used on a wide variety of other experimental aircraft designs. While Sonex has had great success with the standard Azusa mechanical brake system over the years, the AeroBrake offers improved stopping power and smoother braking action.

The AeroBrake uses a unique non-caliper design that allows convenient and easy removal of the wheel assembly for maintenance of tires, wheels, and bearings, and a simple disk as a bolt-on addition to standard Azusa-1137 or equivalent wheels. The AeroBrake assembly retains the same axle-to-wheel spacing as the traditional Azusa drum brake installation, and the entire installation weighs the same as a drum brake installation. Designed to use a ¾-inch axle, builders may use bushings to adapt the AeroBrake for use with smaller axles.

Full installation kits are available for Sonex/Waiex/Xenos or Onex aircraft installations, including a simple and robust master cylinder, allowing builders to retain Sonex Aircraft's trademark universal braking with the existing brake handle form and function, including use of the parking brake detent. Builders may use their own alternative master cylinder(s) to mount the brake control to the stick or if differential braking is desired. Installation kits also include new laser-cut wheelpant mounting plates designed specifically for AeroBrake installation.

The AeroBrake is competitively priced, with packages starting at $350. Upgrade price for new Sonex Aircraft Complete Airframe Kit or Sub-Kit is $300. AeroBrake packages will be in stock and available for shipping during the month of February.

For more information, visit www.AeroConversions.com.

Geared Drives Moves Forward

Stuart Davis has purchased the assets of Geared Drives and has moved the company to his hangar on Hicks Airfieldt (T67) northwest of Fort Worth, Texas. He will do business as Auto PSRU's LLC with a new website, www.AutoPSRUs.com.

Turbo Power for the Kitfox

Kitfox Aircraft is now offering the turbocharged Rotax 914 engine as an option on both its ready-to-fly light-sport aircraft (LSA) and its experimental/amateur-built kits. By doing so, Kitfox Aircraft expects the performance of the Super Sport 7 to increase dramatically.

"The Kitfox is a good performer on 100 horsepower," said Kitfox President John McBean. "But with turbocharged 115 horsepower, it is a beast. We use our factory airplanes in the Idaho backwoods quite often, where summertime temperatures can make for very high density altitudes. The Rotax 914 is capable of maintaining takeoff power (115 hp) up to 8,000 feet and continuous power (100 hp) to 16,000 feet. As a result, the 914-powered Kitfox will take off shorter, climb stronger, and cruise faster than the 912 machine at these altitudes."

The first ship to carry the Rotax 914 is being used for flight instruction in the Boise area. "The benefit in flight training is that the turbo 'extends the day' for students and instructors alike," said McBean. "The less time needed to climb to altitude or reach a remote field, the more time can be spent teaching and practicing landings."

The lightweight Kitfox has true STOL capabilities. The non-turbo Kitfox takes off in 320 feet and lands in just 330 feet, and it still cruises at 122 mph. Performance testing of the turbocharged 914 version is under way and is already substantially better than that of the 912. Ready-to-fly Kitfox LSAs start at $95,995 equipped. Prices for the 914 installation package have not been set.

For more information, visit www.KitfoxAircraft.com.

Sensenich Offers New RV Prop

Sensenich has introduced its latest in a long line of ground-adjustable composite propellers for light-sport and homebuilt aircraft. Designed specifically for Van's RV class of aircraft, the new propeller features Sensenich's proprietary airfoils on a semi-scimitar planform for improved takeoff and climb performance. The blades are internal pressure molded using prepreg carbon fiber and fiberglass, featuring a co-cured leading-edge erosion shield and including an anodized aluminum hub.

"We have been testing and refining this prop for three years, getting it right before introduction to the public," said Donald Rowell, president of Sensenich. "This is the first composite prop available for the RV series of aircraft that complies with the requirements of ASTM [Standard] F2506 and offers a high-performance alternative for builders of Van's designs."

The RV prop features easy pitch blade indexing, with no need for protractors or other such tools; both blades achieve the same pitch simultaneously. Then tighten the bolts, put on the available balanced precut carbon spinner, and fly. Changing pitch on any Sensenich ground-adjustable propeller takes literally less time than it takes to remove the spinner.

The current 72-inch-diameter RV prop is designed to work on Lycoming O-320 engines, with more engine options currently being tested. Total weight of the complete prop is 18 pounds. The Sensenich RV prop is available for $3,500 through Sensenich OEMs, retailers, or factory direct, with deliveries starting in March 2013.

For more information, visit www.Sensenich.com, e-mail propsales@sensenich.com, or call 813-752-3711.

Belite Offers Aluminum Cabin for UltraCub

Belite Aircraft is now offering an all-aluminum cabin for its UltraCub. Company President and CEO James Wiebe has written several articles on his blog detailing the construction of this cabin.

Belite also reports that it has an UltraCub kit left for delivery in March, available at $6,995, with a $2,500 deposit and the balance due 30 days before shipping.

For more information, call 316-253-6746 or visit www.BeliteAircraft.com.

An Old-School Light-Sport Aircraft

Bob Barrows' new Bearhawk LSA

By Budd Davisson

Photography by Phil High

There is an assumption by some that because an airplane is a light-sport aircraft (LSA) that it is a compromise and can't fulfill the functions expected of a "real" airplane. It's assumed it will be lighter, smaller, and slower. Of course that isn't necessarily true, and in the case of some aircraft, specifically Bob Barrows' new Bearhawk LSA, it isn't even close. Barrows' new design is so normal looking, maybe even old school, that if you didn't know it was LSA-compliant, you wouldn't know it was an LSA.

First, a bit about Bob Barrows and his airplane. Working from his shop on his personal grass runway outside of Fincastle, Virginia, Barrows' approach to design may seem to be of amateur quality. When you meet him, his general laid-back, nothing-fancy countenance supports that assumption. However, don't kid yourself. Bob is a clear case where you can't judge a book by its cover; he's a longtime (40-year) professional engineer, and his LSA is the latest in a long line of homebuilt designs going back to the 1970s. Curtis Pitts once told me that

Wearing a signature Bob Barrows' maroon-and-cream paint job, the Bearhawk LSA clearly shows its family resemblance to Barrow's earlier four-place Bearhawk and two-place Patrol. The Bearhawk LSA originally flew with a Continental A-65 and showed outstanding climb and cruise.

"Bob Barrows is a real redneck engineer, like me. He gets the job done as light and as simply as possible." High praise, indeed.

The best-known Barrows design is the four-place Bearhawk, with something more than 100 examples flying. It's one of the few designs that can be built from a kit, from plans, or from a little of both. He followed that up with the Bearhawk Patrol, which is a wider, roomier, new-millennium approach to match the Super Cub but combining traditional rag-and-tube construction (all-aluminum wings) with up-to-the-minute aerodynamics, featuring a Riblett airfoil, airfoiled tail surfaces, and the signature Barrows gigantic flaps. Both aircraft are kitted by AviPro Aircraft (www.BearhawkAircraft.com), and pilots of both aircraft rave about them.

Bob's passion in life is designing airplanes. And while he had no idea whether there was actually a market for an LSA version of the Patrol, he really didn't care. He explained, "I was getting bored because I wasn't designing anything. I honestly didn't think there was enough market support for such a design, but I just wanted to design and build it. That's what I do for fun.

"Rather than design an LSA from scratch, I was constantly being asked whether the Patrol could be made into an LSA with an engine much smaller than the standard 180 Lycoming and by eliminating a bunch of stuff. So, that's where I started. The Patrol can be built with a Lyc O-320/O-340 at about the same weight as the Carbon Cub, so it was a good start on the LSA.

"When I was designing the Patrol, I looked at the Super Cub and the shortcomings it has in the modern world and decided to design a Super Cub as we would do it today, knowing what we know today. Plus, in the Patrol, I wanted an airplane that was fast enough to be a good cross-country airplane but could do really good short-field work without a lot of piloting skills. And I wanted it to handle like a modern airplane: fairly good roll rate and easy to fly at all speeds. On top of all of this, I wanted to try a Riblett airfoil, which is quite a modern family of airfoils, to see if it gave any real advantage at those speeds. I also wanted to try airfoiled, rather than flat, tail surfaces to see if the increased efficiency was noticeable."

The calculations and textbooks all said that his aerodynamic improvements should actually provide better performance, but numbers are just numbers, and it isn't until the airplane is in the ultimate wind tunnel—the sky—that a designer knows whether his calculations work or not.

"I was really pleased with the way the airfoil worked on the Patrol," said Bob, "and the 6-inch-wider cabin and higher-mounted wing made the cockpit really comfortable. I'm 6 foot and guys much taller than me are comfortable in it.

"When I decided to do the LSA, everything about the Patrol looked as if it would work well as an LSA, if I could get it light enough. However, when your goal is to remove weight from what is already a fairly light airplane, you start looking for ounces, not pounds. The Patrol, with a 180-hp engine, big flaps, and constant-speed propeller, is right at 1,000 pounds, and I wanted to get it down to 750 pounds to make it work as an LSA and still have a significant useful load."

Since the structure of any airplane is designed around various load parameters, such as speed and gross weight, Bob's first move was to reduce those general parameters and re-engineer new loads for everything in the airplane.

"First, I reduced the gross weight to 1,320 pounds, as opposed to the 2,000 pounds of the Patrol," he said. "I also designed it to a VNE (do-not-exceed speed) of 145 mph IAS (indicated airspeed), as opposed to the 165 mph IAS on the Patrol. These two changes greatly reduced the load requirements of the structure so I could maintain the same strength margins but with lighter materials."

Reducing the overall requirements of the structure set in motion a whole chain of changes Bob could make that would get the airplane weight down, and at the same time, result in better performance.

He said, "The list of really small changes is long, but they got me down to the weight we needed with a reasonable margin. I took weight out of everything. The ailerons, for instance, are dynamically balanced, not statically balanced, so they have no heavy counterbalance weights. Also, there are no balance weights in the elevators. The wing skins came down from 0.020 to 0.016. The spar cap strips are smaller and the wing struts smaller."

Because he was working with less power, Bob chose to increase the aspect ratio and lower the span loading of the wing by making it both longer and narrower.

"The span went up a foot while the chord came down from 66 inches to 60 inches," Bob said. "At the same time, since we'd be feeding a smaller engine, fuel came down from 55 gallons to 30 gallons. That alone dropped a lot of weight, and the fuel lines didn't need to be as big, so they dropped from 3/8 inch to 5/16 inch. I know these sound like small changes, but they all add up quickly. Just narrowing the wing also had the benefit of reducing the fiberglass wingtip weight by ten percent because they are shorter. You can't find a piece of the

Bob admits to being an analog guy in a digital world and thinks simple and round is the way to go in panel design.

It's not evident in this view, but the flight deck is a full 6 inches wider and quite a bit taller than a J-3.

airplane that didn't get lighter, because all of the numbers said I could go down one size in almost everything. Then I did things like making the bottom half of the door stressed skin aluminum and eliminated the tubing framework. The entire door half weighs less than 3 pounds. I also eliminated the flaps, which got rid of all of the support structure and the actuating mechanism. Everything helps."

The list of weight-saving changes would go on for pages, but the final result was an airplane that weighs 730 pounds, plus or minus, depending on the engine, which is another place Bob worked his LSA magic.

"Initially, I installed a stock A-65 Continental," he said, "and that's what was in it when I did most of my flight testing. I flew 35 hours with that engine and found that the stall was 30 mph and the climb varied from 700 to 900 fpm depending on load and fuel. I was getting a cruise of 110 mph IAS; so the performance on only 65 hp was very acceptable, and fuel burn was 4 gph to 4.5 gph depending on speed. However, I had another engine I wanted to try in it."

Plans for the Barrows'-designed, locking/steerable tailwheel are available separately.

The elegantly simple throttle is now controlling a 100-plus hp engine that is a combination of Continental C-85/0-200 parts.

Bob's other line of business is, and has been for probably 40 years, rebuilding engines for homebuilders. He does everything from A-65s to fire-breathing O-540s. Along the way he came up with an interesting combination of parts that lets him build a light, reliable engine he can sell for a reasonable price.

"I start out with a C-85-8 case," said Bob. "Then I install an O-200 crank, which is a 1/4-inch stroke over the stock C-85 crank. I use O-200 jugs with an O-200 cam. This gives me about an 8.8 compression ratio so I can burn 93 octane mogas, which I usually do. What we wind up with is an engine that is light and relatively inexpensive but puts out 100 to 110 horsepower. I haven't done any serious flight test with this engine yet, but it cruises a solid 120 mph IAS and far outclimbs the A-65, which means it's climbing really well."

As of today the Bearhawk LSA is a plans-built airplane only, but AviPro is tooling up to build quick-build kits for it. So, like all Bob Barrows aircraft, it will be able to be built as a scratchbuilt airplane or a 51-percent quick-build, or you can buy wings or fuselage or anything in between. Being a Barrows design, it is as simple and as straightforward as an airplane can be, both in its flying characteristics and the way it builds. Bob doesn't like complicated things, which is why he loves his Bearhawk LSA.

This is not only an LSA for big guys, but it's a full-size airplane that can perform a variety of "real" airplane roles with real airplane handling while burning a really small amount of fuel. So, what's not to like? EAA

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


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Reddy Kilowatt Meets the Ultralight

Backyard innovator Randall Fishman continues his quest for personal electric flight

By James Lawrence

Electric flight pioneer Randall Fishman pilots his ElectraFlyer ULS motorglider.

Wasn't it Han Solo of *Star Wars* who barked "Never tell me the odds"?

Enter Randall Fishman, the lone-wolf pioneer who's led the charge to volts-only Volksplane-like airplanes for years now. He's that guy who came out of nowhere to zap everybody's socks off at EAA AirVenture Oshkosh 2007 with his ElectraFlyer trike—a Millennium Falcon-worthy outlier if ever there was one—powered solely by a battery-powered electric motor.

No proof-of-concept, one-flight wonder was this trike, and it remains an affordable *production* electric aircraft. Still, Fishman never styled himself as an entrepreneur looking to create the next Quicksilver market buster. (Some 15,000 Quicks have been sold since the 1980s.) His talents lie in crafting technologically proven components into usable, affordable electric aircraft. Fishman just wants to get people flying…now…on electricity, not gas.

In 2008, the wily tinkerer dropped our jaws again with his ElectraFlyer-C, a single-seat, modified Monnett Moni, all-metal kit motorglider with a 29-pound, 18-hp electric motor and 78 pounds of lithium polymer (LiPo) battery packs. The C cruised at 70 mph for an hour per charge, with a half-hour reserve. That singular accomplishment won him the prestigious Dr. August Raspet Memorial Award and admission to a select group of aviation innovators that includes Burt Rutan.

Photography by James Lawrence

A two-seat, all-composite light-sport aircraft kit, the ElectraFlyer-X, was promised next. That prototyped but still-unproduced beauty is on hold, a victim of FAA's ponderous process of formulating an electric power specification for the light-sport aircraft category.

The motorglider's wings are removable for ease of storage and trailering. The twin tail booms have twin rudders, and the wings have a mild dihedral angle to help the aircraft track well, Fishman said.

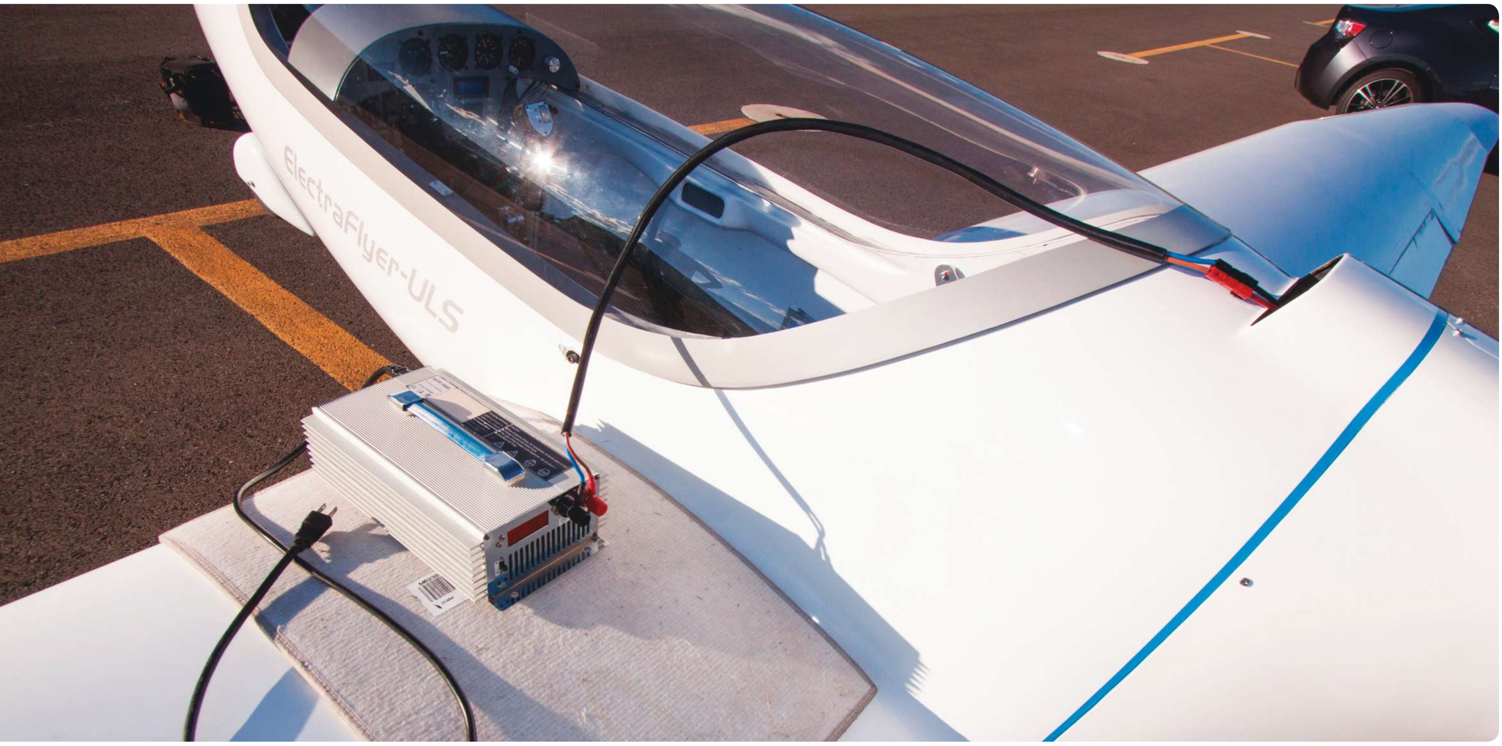
Undaunted by the languors of officialdom, Fishman returned to the air show circuit in 2012 with the ElectraFlyer ULS, a drawing-board-fresh, single-seat, 245-pound ultralight (gross weight 520 pounds, useful load 266 pounds).

The ULS will also be offered with a gas-powered engine. Intended as a motorglider, this graceful bird sports an 11.2-meter (36.75-foot) wingspan and is already in production with a 90-day delivery. The sticker price of $59,000 ($64,000 with the "full" battery pack) seems a mite stiff for the category, but this is no ordinary ultralight.

First and foremost, the ULS is all-electric and thus one of a select group that includes the Yuneec E430 and FlightStar eSpyder (still unproduced prototypes); and Pipistrel's Taurus Electro G2 two-seat sailplane and Fishman's own purpose-built electric trikes (which are in production).

Other available electrics include the single-seat PC-Aero Elektra One and Lange Antares 20E, but those beauties cost $145,000 to well over $200,000 respectively. Isn't $59,000 looking better already?

The ULS is a sleek, purpose-built, carbon-fiber/foam composite lovely with near 2-hour endurance and



Preparing to charge the batteries of the electric-powered aircraft. The batteries can be charged in the aircraft, if you're planning to make a couple of flights during a day, or the batteries can be removed for charging at home.

respectable soaring performance ("...with an honest 22-to-1 glide ratio and 1.2 meters/second (236 feet/minute) sink rate," said Fishman). It comes with Fishman's personally specced and tested motor, motor controller electronics, and LiPo battery packs.

Fishman is a one-man operation, a kind of electric flight general contractor. His creations live in a flux of constant refinement and innovation as he works closely with airframe and electric power designers, funds the research and development phase, tests prototypes, then has the components professionally produced.

Still, his shirt-sleeve approach has kept him in the forefront of an often well-funded field with many exotic prototypes, but precious few production aircraft. Electric flight remains a Wright/Curtiss/Bleriot experience for now.

The ULS airframe, manufactured under contract overseas in Europe, arrives at Fishman's hangar in Sebastian, Florida, for final assembly, rigging, avionics install, and test flying. Power comes from his own third-generation, 20-hp "outrunner" brushless motor, similar in concept to what you find in remote-controlled models. Outrunners feature a ring of magnets fixed to the inside of an outer shell that rotates around coils of copper windings.

"I know what I want," he said about electrifying airframes. "I give the motor designer the power output, torque and rpm, shaft specifications, and approximate dimensions of the motor. Then I turn him loose."

"This new motor has terrific torque. It's designed specifically for aircraft propulsion and runs at 2,500 rpm max. I think 20 hp (15 kilowatts) is plenty for this efficient, light airframe. It gives us a lot of extra running time without draining the batteries too quickly. The ULS has such a low sink rate; it only needs 3 kilowatts of power to maintain straight and level flight. That still leaves us with a 12-kilowatt surplus for climbing."

Diameter of the clean, compact mill is 9.5 inches, and just 3.5 inches thick!

Fishman has logged 20 hours on the ULS personally. He's even done motor-off soaring at his summer home, the Northeast hang gliding mecca of Ellenville, New York.

The aircraft comes with a two-blade fixed propeller, but it's also available with a folding carbon propeller, a common feature of high-ticket German motorgliders.

The ULS' interior is constructed of carbon and aramid materials. The rudder pedals and seat back are adjustable to accommodate pilots of any height. A four-point seat/shoulder harness are standard equipment.

When the motor is shut down in flight, the centrifugally opened prop automatically folds back from the hub like a dragonfly's tail, to dramatically reduce drag.

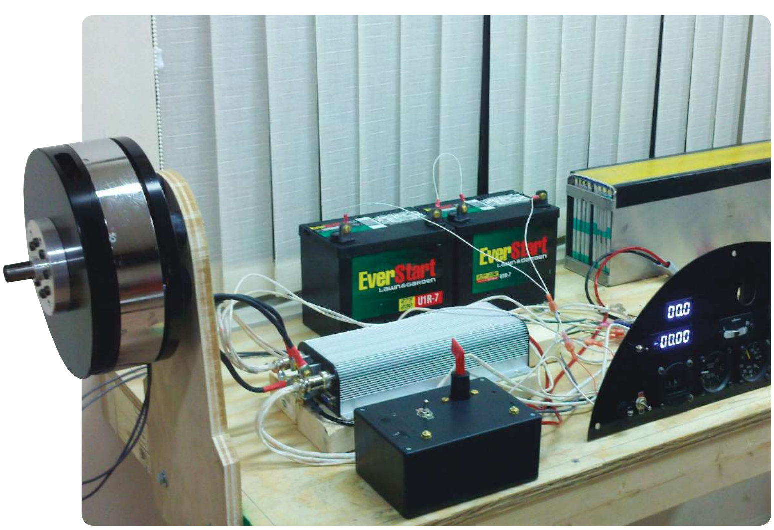
"We're still tweaking the prop," said Fishman. "We had a bit of tip flutter in the earlier, nonfolding prop; it was too noisy. We're working with more carbon/less foam now, which we think will be the solution. It's already showing plenty of thrust and a good climb."

His longtime test pilot, soaring enthusiast Joe Bennis, did the initial test hops on the ULS. "Overall control is great; it's very stable," said Fishman. "If you can fly a Cessna 150, you can fly this. It feels a bit like a sailplane but needs less rudder."

The ULS has twin tail booms (and two rudders) along with mild dihedral, which helps it track well. He said, "I initially wanted a single tail boom, but the airframe designer preferred two. I've grown to like the hard points it adds for the landing gear, which is a light weight, trailing link suspension, which avoids the need for a heavy spring gear."

Two-thirds-span flaperons and spoilers give it serious soaring chops. Spoilers help degrade glide angle during landings. Without spoilers you're in for long, challenging final approaches.

The ElectraFlyer ULS in flight.



Testing and adjusting all the components of the electric motor system.

A bit more about electric "fuel": Current research promises manyfold increases in *energy density* battery capacity—the energy output per pound of weight—in the future. For now, lithium polymer (LiPo) and lithium iron phosphate (LiFePO4) are the name of the game.

Fishman designs his own powerpacks with reliable, well-tested LiPo cells. He has tested cells from many different producers since 2006 and is happy with the quality from his current supplier. The ULS sports a stainless-steel battery box in each wing root for protection in case of fire: LiPo cells, if badly mistreated, can catch fire. (Of course, so can gasoline.) Each steel wing box measures 21 inches wide, 17 inches across, and 3 inches deep.

The ULS comes with two battery packages: the "half" pack provides 3.35 kWh (kWh = kilowatt hours) total. The "full" pack serves up nearly 2 hours of flight per charge.

To help understand what the ultralight's full-pack capacity of 6.7 kWh actually means, let's use a real-world example. Say you use 0.75 kWh of energy to climb to 2,000 feet by running the motor at its maximum 15-kilowatt power setting for three minutes.

Then you throttle back—*way* back to perhaps 20 percent—to a 3-kilowatt power setting for sustained cruise. Fly around for an hour at that setting, and you've drained a little more 3 kWh—kilowatt hours, remember?—from the batteries. That leaves your battery "tank" about half full. The meter says you have around 3 kWh left: enough for another half hour of cruise, with maybe a half hour (1.5 kWh) of reserve. Capiche? Descent is done at 0 or low discharge rate.

Thirty years ago FAA worded the FAR 103 rule to allow ultralights "a maximum fuel capacity of five U.S. gallons." That meant single-seat ultralights could weigh 284 pounds with full fuel.

Since no one was addressing electric flight for ultralights 30 years ago, the topic needs re-examination. How to translate 5 gallons of gas into battery weight? As 5 gallons in equivalent *volume* for the batteries? Or 5 gallons in gas *weight*, which is 30 pounds? At that crossroads lies the potential for design freedom…or imprisonment.

"It's still up in the air," said Fishman, although he's optimistic the volume interpretation will eventually carry

This view shows the standard fixed two-blade prop that comes on the ULS, as well as the twin rudders. Fishman discusses his ElectraFlyer ULS in this video.

the day. "But a full 5 gallons of volume would be about 110 pounds of batteries."

Fishman expects the issue to come down on the side of *time in flight*, so let's revisit the concept of *energy density*. Current battery technology supplies perhaps 1/72 the energy density of gasoline. If we consider the greater efficiency of electric propulsion, the ratio narrows to 1/20. Restricting battery capacity to the gas equivalent weight of 30 pounds (5 gallons x 6 pounds/gallon) will allow for only about 30 minutes of power due to the higher discharge rate.

Fishman isn't worried. "I'm working on this with EAA," he said. "We're asking FAA to set an energy equivalent to a specific volume of gas, say one gallon."

One gallon of gas produces the equivalent of 36.6 kWh of energy, but gas engines are much less efficient than electric motors. So perhaps a 7- to 10-kWh equivalent storage capacity would be a reasonable battery capacity for ultralights.

In LiPo cells that's about 100 pounds, very close to Fishman's 90-pound "full packs" for the ULS. And the aircraft still conforms to the sport flying spirit of the ultralight rule, with decent endurance and a traditional safety reserve.

The limitations of batteries are why motorglider designs still dominate electric flight: Small motors, reasonable weights of batteries, and efficient aerodynamics equate to sips rather than gulps of electric "fuel."

Fishman projects the life of his 2-hour packs at 800 recharge cycles, 1,600 hours of flight time. For the average pilot who flies 100 hours per year, that's around 15 years!

If ultralight-style electric motorgliding isn't quite your cup of electric tea, ElectraFlyer is working on an all-composite, two-place experimental kit plane. Fishman will be overhauling his website, www.ElectraFlyer.com, soon, so check there for updates.

Let's be clear: The ULS is an impressive step forward, but these are still the early days of electric flight. Within 5 years, we may well have two- and four-seat electric aircraft that cruise beyond 100 knots for 2 hours and more. Meanwhile, with the ULS, Randall Fishman proves yet again that the electric future is already here. Yes, we are still living in the pioneer days…but how completely cool is that? Every major effort requires a first step. EAA

James Lawrence is a frequent contributor to a variety of aviation magazines.

The Last Zero Mechanic
Building a Japanese replica

By Bill McElwee, EAA 376289

Don Osmundson (EAA 114643) believes that he may have the only flyable Japanese Mitsubishi A6M5 Zero replica in the world. It is only half scale, to be sure, but Don knows that it is an authentic representation of the Zero. He knows a lot more about the real Zero than perhaps any other American. The story begins at the Battle of the Coral Sea.

As a young sailor and aircraft mechanic, Don had a close encounter with the real Japanese aircraft when his carrier, the USS Lexington, was so damaged by Japanese attacks that it had to be abandoned and then sunk by one of our destroyers. Next Don spent a few months at San Diego getting the first F4U Corsairs ready to go off to the war, and then he was sent to the Hebrides Islands where his aviation engine overhaul unit overhauled 1,000 engines a month on Grumman fighters, which were being worn out fighting the Zero. Then it was off to flight school. But about the time he got to fly N3N biplanes, the war was ending, and the Navy decided no more pilots were needed.

Next came the most interesting part of Don's life. He was sent to the Tactical Air Intelligence Center in Washington, D.C. Fifteen captured Zeros had been brought there from Saipan for testing and analysis. Don and his unit assembled five flyable Zeros from those 15 fighters so test pilots could put them through their paces. While he didn't get to fly one, Don did get a lot of taxi time in them. In those months, Don got to know the A6M5 Zero in and out.

Don went on to get his A&E (then known as an airframe and engine rating) and his IA (inspection authorization) following the Navy, from which he retired in 1959, having added 10 years of Naval Reserve service to his record. He has been honored by the FAA with the Charles Taylor Master Mechanic Award and has been designated a technical counselor (#1781) by the EAA.

Given all this background, it is not surprising that Don began thinking about building a one-half scale A6M5 Zero of his own in his spare time. He found that kits for a number of other replica warbirds were available, but no one had done a kit for the Zero. When he asked what plans might be closest to the Zero's fuselage, he was told the Focke-Wulf Fw 190 might do, so he started there. Arranging a pulley system, he would store his work above the customer planes he was repairing and maintaining.

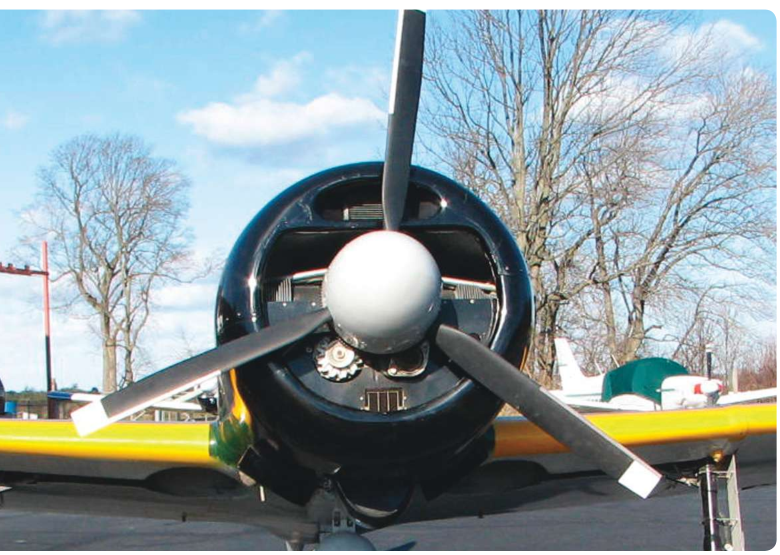
It took more than 20 years to complete the project. Over the basic wooden structure the fuselage and wings were built up with closed cell polyurethane foam and epoxy resin on fiberglass. The exterior surfaces were all handlaid, not molded, and conformed strictly to what Don knew from firsthand experience to be the shape of the A6M5 aircraft. It is powered by a 135-hp Lycoming O-235 engine with a three-bladed prop.

Next came the most interesting part of Don's life. He was sent to the Tactical Air Intelligence Center in Washington, D.C. Fifteen captured Zeros had been brought there from Saipan for testing and analysis.

Don knows of one other Zero replica that was built on the West Coast and was told it is now in a museum at Eugene, Oregon. The builder of that aircraft, EAA member Bill Coffey, assisted in the early stages of Don's project. However, Don says that his aircraft is configured much more closely to the original design than the museum example.

By the time the Zero was ready to fly 10 years ago, Don, now 93, had lost his medical due to a heart attack, and so a friend at his home base, Flying W Airport in Medford, New Jersey, did the test flying. Richard Denisar, EAA 334966, has been an EAA member since 1989 and has built both an RV-4 and a beautiful Lancair 320, which he is used to cruising at more than 200 mph, not to mention having considerable taildragger time, so he was comfortable taking on the Zero.

Don Osmundson and his half-scale Zero replica.



Richard says he raised the gear right after liftoff and was soon surprised to find himself screaming along at 180 mph. Pulling back the power he settled in at 140 mph, then completed a short evaluation. He says the airplane was quite nimble at 140 mph, while the controls were very stiff at 180 mph. It stalls around 65 mph. The flight and the landing were uneventful.

In discussions following the flight, Don remembered how, during the war, F4F pilots would escape the Zero by diving to the surface and pulling out abruptly. Those stiff controls at high speeds would prevent the Zero pilot from pulling out before going into the ocean. The half-scale Zero seems to retain characteristics of its forerunner.

All in all, Richard says it is a nice flying airplane and very stable, and being quite slippery it is very fast. It was flown four times, at approximately six-month intervals while Don made minor adjustments. It last flew about three years ago.

Don is a member of the greatest generation; he had experienced combat in World War II and had unique familiarity with this now rare warbird. He wishes he could find a good home for his creation but says there is not much of a market in this country. He wonders whether putting it on eBay in Japan might get a bite. There was a Japanese pilot training for the instrument rating at Flying W who was very much interested in it and asked Don for permission to fly it. But the man had no tail-dragger time, so that was not possible. Meanwhile Don has a Sunday morning coffee klatch of buddies who sit around the airport hangar and shoot the breeze. There must be some really great stories told. EAA

Video of the Month

Jeff Joern attended EAA AirVenture 2008 looking for an airplane for back country and cross-country flying that would be easy to maintain. A Kitfox Model VII fit that bill. Jeff and his son spent a week at the Kitfox factory in early 2009 to learn about the building process. Jeff also took some tailwheel instruction. Now, he's having fun learning about back country flying and exploring his home state of Montana.

Wax
The multiple uses for this simple product

By Cy Galley

Wax is known for making your painted plane shiny, but it has other uses, too. Unlike oil or grease, wax doesn't attract dirt and grime, which can work into bearings and other parts, creating wear. Many bicyclists routinely remove their drive chain and place it into a vat of molten paraffin wax to lube it. WD-40 and the LPS series of spray lubes are wax based, as is Boeshield.

There are places on your airplane where a dry, clean lubricant is very desirable—places such as door latches where you need smooth actuation, but the handle needs to be clean so that your clothing and hands don't pick up the dirt and grime that come when using a grease or oil. The solution? Rub the latch and the striker with a candle.

Rubbing a candle on window slides also makes them move easier without damage to the Plexiglas. Candle wax will reduce wear on your cowl overlaps as well.

A bit of candle wax is also handy in making machine screws go into nut plates. Dragging a wood screw across your candle will make it much easier to install. Because candle wax doesn't attract moisture it helps reduce corrosion of the metal screw in the wood. Plus the wax is easily removed when painting so one doesn't get those nasty "fish eyes" from the silicone lubes.

Lastly, place a colored crayon mark on each of your exhaust stacks if you are trying to find out which of your cylinders is missing or not firing. Briefly run the engine, then look to see which stack has the melted wax. Works every time without burning your fingers.

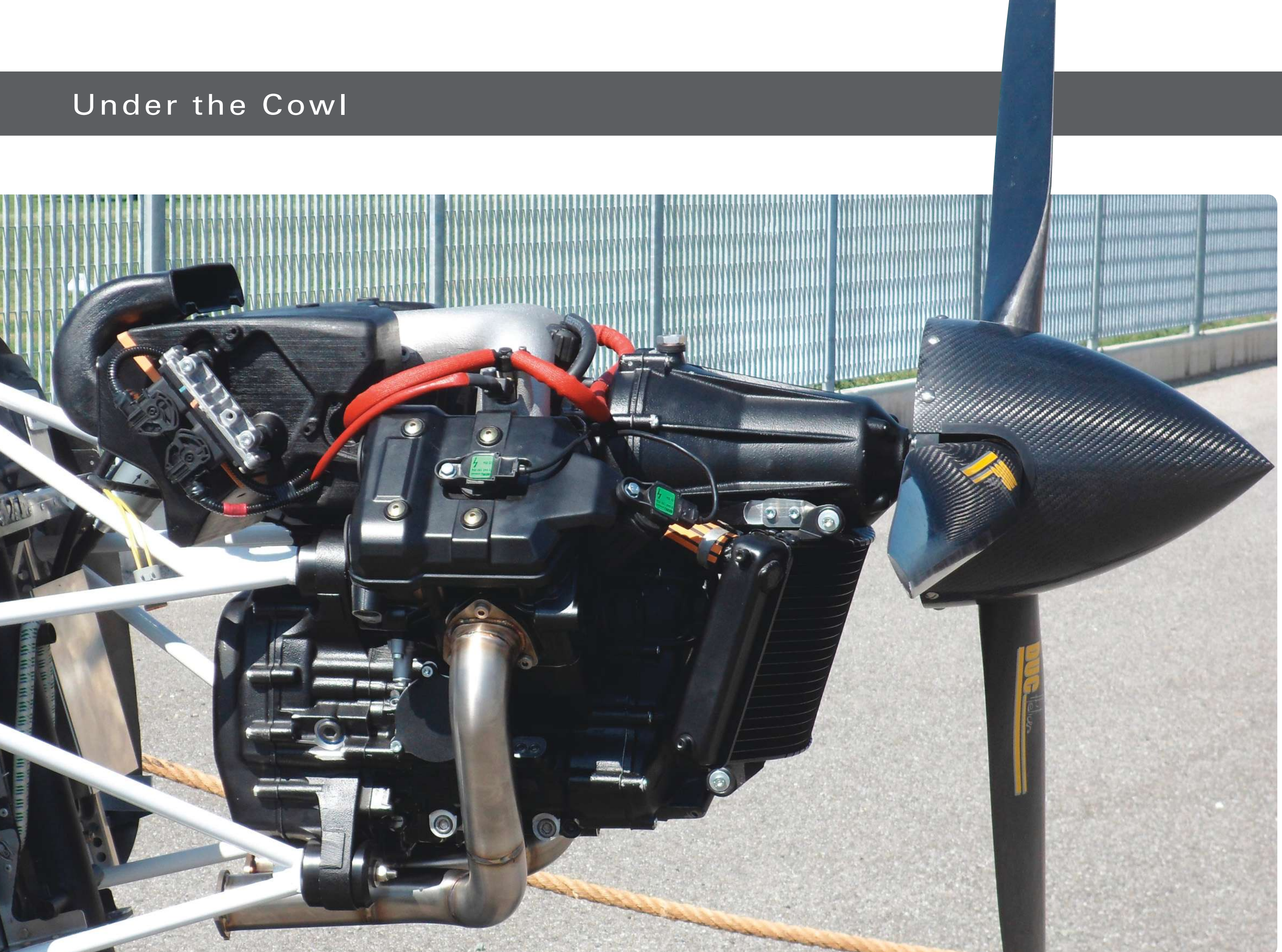
Hints for Homebuilders Videos

Installing Circuit Breakers

In this video, Dick and Bob Koehler show how to install circuit breakers for your panel. Dick and Bob are both Technical Counselors, A&P aircraft mechanics with Inspection Authorization (IA), and SportAir Workshop instructors.

Practical Weight & Balance

Filmed live at AirVenture 2012 in Paul's Vintage Workshop, volunteer Joe Norris discusses the practical aspects of why weight and balance is critical to safe flight. Joe is an FAA CFI, A&P mechanic with IA rating.



I.C.P. from Italy intends to start delivery of this new bolt-on two-cylinder engine by the end of 2013.

I.C.P.'s Bolt-On 80- to 150-hp Engine

New hope for the LSA/experimental market?

By Marino Boric

The major Italian LSA manufacturer I.C.P. will officially introduce a new bolt-on, four-stroke engine with up to 150 hp in the first quarter of 2013. Is this new family of engines going to have a much bigger impact on the engine market than all other newcomers? Probably yes, because the I.C.P. engine has several unique selling propositions. (Some features of the M09 engine, as it is called, are much different than those of all other competitors.)

A few months ahead of the planned official announcement this month, information about a new European engine for the light-sport aircraft leaked. The well-known Italian kit and ready-to-fly aircraft manufacturer I.C.P.

Photography courtesy I.C.P./Italy

intends to present a new engine on a national scale in Italy in February and then again at the upcoming 2013 Aero Friedrichshafen show in April.

I.C.P.'s plan to develop the engine hidden from the eyes of the public worked pretty well for almost 5 years, even if I and a few persons outside I.C.P. were informed, but this was suddenly over when the engine was briefly shown to a "limited" circle of persons during the I.C.P. factory fly-in in mid-September 2012. I.C.P.'s M09 engine is now being extensively tested on the ground, and the timetable for the public presentation in 2013 seems realistic. This new engine will be built to the airplane manufacturer's specification, specifically for the European UL (ultralight) and United States' LSA and experimental airplanes.

The biggest surprise is that this major Italian microlight/ LSA aircraft manufacturer decided to sell its engine on its own. The precise reasons for such an important decision are still unknown, but often in aviation there is a lot of emotion and passion in the game.

I.C.P. primarily developed this new engine to be independent from other engine suppliers. Secondly it was driven by the wish to simplify the airplane manufacturing process. I.C.P. wanted an engine that easily fits in almost any airframe; other engine manufacturers are seemingly not offering this solution. I.C.P. has not just adapted another street engine to light aviation; it developed an absolutely new engine that will be offered as a bolt-on solution to all fixed and rotary wing manufacturers.

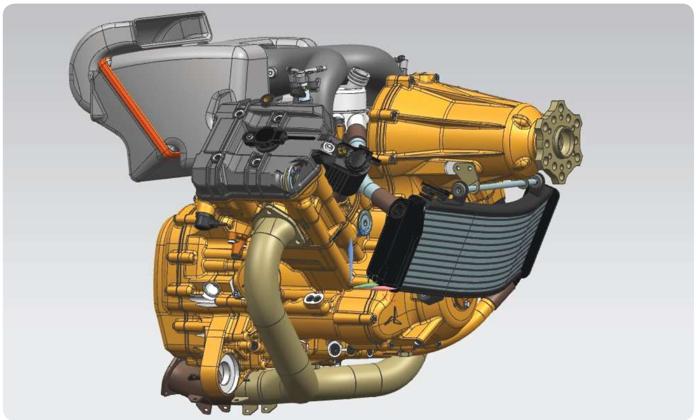
I.C.P. is a producer of several light two-seater airplanes such as the Bingo and Savannah, and it is well aware of the manufacturer requirements on aeronautic engines. In I.C.P.'s opinion, the installation of available engines to a new airframe takes too long, and once the first installation is done the manufacturer still needs up to 50 working hours to install the engine on the airframe. Those are the main reasons why I.C.P. decided to build something absolutely new, a bolt-on solution that could be fixed with a few screws to any firewall and be ready to go.

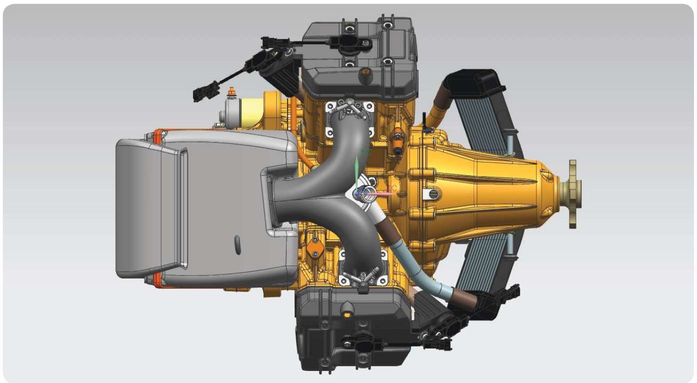
The I.C.P. M09 engine was the idea of I.C.P. owner Edi Razzano, himself a passionate motorcycle rider, who worked with Franco Lambertini to design the engine. Lambertini worked for many Italian engine manufacturers such as Ferrari, Morini and Piaggio. This in part explains the I.C.P. engine architecture; Lambertini has designed and developed many lightweight engines in his working life, and some of us will spot one or another part on this engine that has similarities with recently designed engines.

The M09 is a four-stroke, two-cylinder engine with cylinders in an upright "V" configuration (90-degree "V" angle). The two-cylinder aspirated engine has 1,225-liter displacement and is supposed to to develop from 80 to 130 (150) hp. The I.C.P. engine family will probably consist of up to four different versions; the main difference will be the engine mapping. The atmospheric-aspirated engines should develop 80 to 130 hp, while the most powerful one will reach almost 150 turbocharged horsepower. The all-liquid-cooled engine is fitted with a 2.95-to-1 reduction gear that will deliver the max power at 2400 prop rpm. The liquid/oil cooler is the engine's integral part as it will be the air box, three-phase electric generator, fuel pumps, and the ECU (engine control unit). According to I.C.P., the total weight of this engine, with all liquids, muffler/exhaust, and ready-to-go, is 178 pounds or 81 kilograms! Dry weight of the compact "V" twin with the complete exhaust system is 147 pounds or 67 kilograms. If these numbers prove to be true, the M09 will have one of best weight/power ratios of all modern LSA engines. From the very beginning, a tractor (fixed wing) and pusher version (rotorcraft/autogiro) was considered and developed.

Compactness and the bolt-on feature were primary design goals. The result of this effort can be seen in the engine wiring; it is so short that it is practically nonexistent, or better to say, not visible at all. Everything is already mounted and wired on the engine. This engine is a dual overhead cam (DOHC) design, which means that in each cylinder head, valves are actuated by two cams; the cams are crankshaft driven by a chain. A lot of attention was dedicated to this detail because there is a

Franco Lambertini (left) and Edi Razzano (right) during the Italian fly-in in Ozzano, June 2012 when the I.C.P. engine was still secret.





proprietary chain-tension (length) monitoring system of the DOHC drive chain.

The M09 was developed specifically for aircraft and has redundant (double) electric/electronic systems, twin spark plugs per cylinder, generators, ignitions, and fuel pumps. To achieve good fuel economy, the M09 is using electronic fuel injection like all modern engines. Because the M09 was born as an aircraft engine, in case of the malfunction of the primary engine controller there is another secondary low-pressure backup fuel mixture delivery system. During normal operation a high-pressure electrical pump delivers fuel to the fuel injectors that are ECU driven; if this system fails, the patented secondary low-pressure mixture-creating system (not fuel injected), will keep the engine running. This secondary mechanical "low-tech" system is kept alive by a mechanical fuel pump. The M09 will not stop running even if the engine is completely disconnected from the main electrical system and from the board battery. By the way, the crank-driven generator has a single rotor; but the electric current is induced in a three-phase stator where single coils are physically separated, so we can say it's a single generator body but with multiple independent-current production units. Each generator phase has its own current regulator.

According to Razzano, the first engine tests on a dyno were a big surprise; the engine was expected to deliver 110 hp, but in reality it delivered 135 hp. What an uncommon "problem" for the manufacturer! Now the engine is being tested on the dyno and a fine-tuning process is in development. First flight of the engine is expected in April 2013.

The commercial product name and the price are not yet known, but it is my guess that the price for the 120-hp version will be around U.S. $15,000. First preproduction units are likely to be delivered by the end of 2013. The engine is still in the final development phase, and final data on aspects such as power output, rpm, and consumption are still to be defined.

I.C.P. is one of the major Italian manufacturers of European UL airplanes that are sold around the world. Its portfolio consists of three high-wing aircraft that are Zenith CH 701–like called the Bingo, Savannah (five versions), and Vimana. Recently ICP and Zenair reached an agreement to produce and market the popular CH 650 in Italy for the European market under the name of CH 650Ei. I.C.P. is already present in the United States through I.C.P. Aviation North America LLC which showcased the Savannah high-wing LSA airplane at EAA AirVenture Oshkosh 2012. EAA

Photography by Marino Boric


EAA
THE SPIRIT OF AVIATION
"As a first-time builder, I never would have considered building if it weren't for the EAA Technical Counselor program. There is tons of information online, but having someone inspect your work in person, or demonstrate a technique in front of you, is priceless."
Caleb Ihrig, EAA 1036996
Scratch building a Bearhawk
Bearhawk
To find a Technical Counselor near you, visit EAA.org/techcounselors.
Not an EAA member? Join today by calling 800-564-6322 or visit EAA.org/join.


Overview of the wreckage of an experimental aircraft.

Experimental Aviation
Part 3: Restraints

By Stephen L. Richey

In this article, the third in the series, we continue our discussion of how to improve the crash survivability of experimental aircraft. Given that we have gone over the reasons why we need to pursue such improvements and what we can do to improve the design of the cockpit or cabin, let us move on to the subject of restraints.

Restraints serve a couple of purposes in an aircraft. The first is to keep the seat occupant from being thrown either completely out of the aircraft or being flailed forward or laterally into the structure of the cockpit. There remain some resistant folks who still think a lap belt without shoulder restraints is sufficient to protect them in a crash. To them I offer the following diagrams taken from a NASA article on human biomechanics. The first (Figure 1) shows the distance an adult man can be thrown about in a crash type deceleration when restrained by just a lap belt. This is known as the "flail envelope" or "strike envelope."

This demonstrates why in aircraft without shoulder restraints, it is not uncommon to find a distinct imprint of the face of the pilot or front seat passenger in the top of the instrument panel. It is an almost certainty that in anything beyond a couple of *g* deceleration that the occupants will be thrown forward and suffer serious facial injuries. While this may seem to be a rather cosmetic concern, one must remember that the face is connected to the skull, and the brain is rather poorly tolerant to abrupt changes in direction or speed. Being slung forward and then bouncing your face off the glare shield is an excellent way to induce serious or fatal head injuries.

Even in the absence of a skull fracture, the differing density of the human brain causes it to slow down at slightly differing rates. A good way to visualize this is to imagine a plastic container of Jell-O with bits of fruit in it. If you grab it and throw it really fast to a friend and then look at the areas around the fruit, you will notice something interesting; the Jell-O around the fruit will often show small tears. This is caused by the denser fruit taking longer to decelerate and pushing and pulling its way through the Jell-O. The same thing happens in the brain in something called a diffuse axonal injury. Those tears cause bleeding and swelling, which is often what causes the coma and sometimes death that we see in folks who initially survive crashes in either aircraft or cars. While you do not have to hit anything to suffer this type of injury, an impact will increase the severity of it as well as add the risk of even more severe injuries. Thus, it is important to avoid gaining any more of an intimate knowledge of your instrument panel than you developed during its construction.

This is where shoulder harnesses come into play. The difference in the strike envelope a shoulder harness makes is quite dramatic (see Figure 2) from what we saw in the lap belt case. This allows us to produce a safer cockpit environment while maintaining the clean and narrower lines that lend to a better performing and more aesthetically pleasing aircraft. Looking at the strike envelope when viewed from the front (the upper right drawing in Figure 2), you see it is easier to envision a fuselage being designed to accommodate the flailing distances so that it minimizes the likelihood of a head impact. That should be a step in the design of any light aircraft if there is any concern for the safety of the occupants.

There is an additional option that is often overlooked outside of aerobatic and military aircraft, and that is the tiedown or "crotch strap." To understand why this is needed in a broader application, one must keep in mind the ways a human body reacts in a crash. There are two predominant "paths" a body can take when restrained. The first is the "up and over" where

The first is to keep the seat occupant from being thrown either completely out of the aircraft or being flailed forward or laterally into the structure of the cockpit.

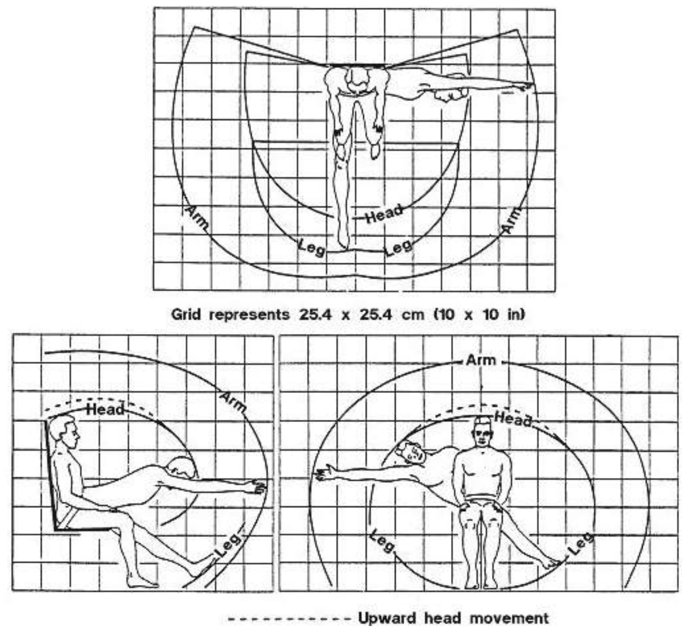


Figure 1. Strike envelope of a 95th percentile adult man restrained by a lap belt during a 4g deceleration.

the body moves upward and toward the front of the aircraft (the direction of travel at the moment of impact). This is the classic flailing impact previously described that results in the face or chest impacting the controls or instrument panel. The second is what is known as "submarining" and happens as the mass of the pelvis and legs pulls the body down and under the lap belt. This is why in some crashes one finds the victim partially in the floorboard of the aircraft. You can also get a combination of the two, especially in cases where the restraints are worn loosely. This is one way you can get injuries to both the upper and lower body.

Submarining often leads to leg injuries along with more serious abdominal injuries. The latter results from the lap belt sliding further up on the abdominal wall. As the body moves forward, the abdomen and its contents (the intestines and the major blood vessels located in front of the spine such as the aorta and inferior vena cava) are compressed, potentially causing serious or life-threatening injuries. It is vital that lap belts be worn low on the bony part of the pelvis (the iliac crests for those of you interested in

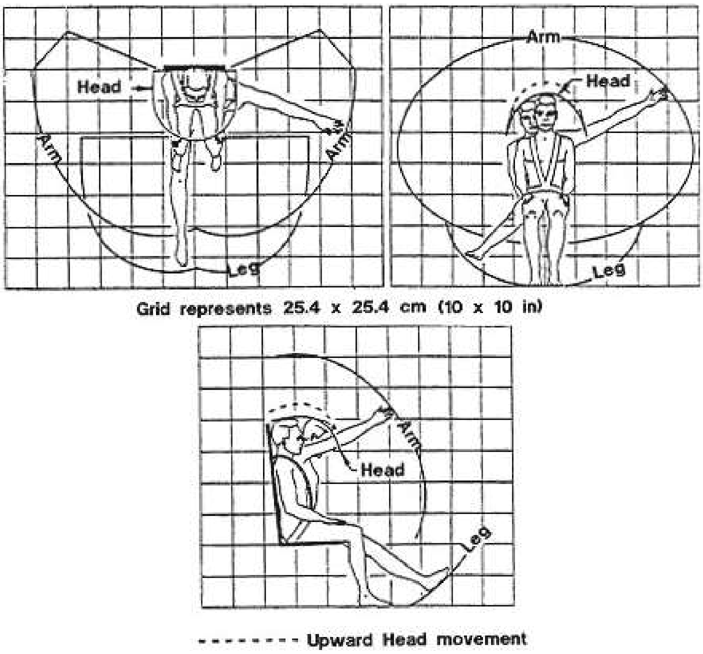


Figure 2. Strike envelope of a 95th percentile adult man restrained by a lap belt during a 4g deceleration.

the anatomical vernacular) and as snugly as possible to minimize the chance of this.

However, the best way to prevent submarining is the use of a tiedown strap. Not only does it provide a direct barrier to the seat occupant sliding down, but also more importantly it keeps the lap belt down where it belongs (hence the name). This minimizes the chance of lower abdominal injuries, especially if used in conjunction with a wider than normal (greater than 2 inches) and padded lap belt. John Paul Stapp, the subject of some of the famous "rocket sled" tests and one of the pioneers in my career field, reported that many subjects found these wider and softer belts to be more comfortable than a simple narrow nylon strap. It is definitely something to consider. Often many homebuilders treat the fabric as the primary part of restraint design, and while it is important, as the saying goes, a chain is only as strong as its weakest link. This is why it is important to have the anchorages for your restraints attached in a way that minimize the chances of a failure. While it may seem that it would take a very devastating crash that would be utterly non-survivable to produce failures of a restraint system, this is not the case despite it being widely repeated when the need to improve restraint design is brought up. In the database that I maintain for my research, there were restraint failures in over a third of all crashes. The NTSB has reported similar findings, even though the actual numbers may be considerably higher due to investigators failing to adequately document the use of restraints or the condition of them after the crash in a significant number of crashes.

Many survivable crashes are not survived because of something as simple as the failure of a shoulder harness attachment point. Paying attention to what you are attaching your harness to should be taken very seriously.

In fact, even if you are building one of the well-established designs, you should strongly consider "running the numbers" yourself when it comes to design anchorages and consider making them stronger. It is important to remember that many of these designs were done with the FAA design guidelines in mind. These guidelines massively underestimate the ability of a well-restrained and protected pilot or passenger to withstand the deceleration forces involved with real-world crashes. The bar having been set so low by the government probably contributes to as many deaths as it prevents annually; we have the technology, the legal freedom, and know-how to do better. The only thing that seems to be wanting in this matter is the personal motivation. To paraphrase Isaac Newton (or more accurately Bernard of Chartres), if we want to see farther in the name of safety, we need to stand on the shoulders of the giants who have come before us. Assuming that those before us have reached the pinnacle of design and their designs cannot be improved upon is to sell our own abilities short and to abandon the mindset that drove them to improve the designs of those who came before them.

Anchorages for the shoulder harness should be above the level of top of the shoulders. If they are angled downward, you wind up compressing the spine, and this can lead to fractures. (We will get into the subject of spinal compression injury in another part of this series.) The attachment points of the lap belt should be to the frame of the aircraft and not to the seat itself. This provides a more direct energy path and minimizes the number of potential failures. The design specifics of how to define the appropriate angle for the lap belt across the hips are well defined and can be seen in Figure 3.

While anchorages are important, I did not mean to imply that it is not vital to treat the fabric of the restraints as important. The fabric should be inspected and replaced if it shows any signs of wear, fading, or damage. Take a walk around the ramp of any busy general aviation airport and you will find many aircraft with restraints that show these signs of decreased strength.

With the relatively recent introduction of airbags into aircraft, the subject of their use often comes up. The "airbag seatbelt," if put into a crash-resistant structure, might have some benefit if for nothing more than reducing the tendency of the head to swing forward causing the chin to impact the upper torso. This is hazardous for two reasons. The first is that an impact to the chin can transmit forces to the base of the skull via the temporomandibular joint (TMJ), causing a fracture. This is likely how Dale Earnhardt, Sr. suffered his fatal injury. The second is that an impact of the chin against the chest can compress the anterior chest wall, causing compression or rupture-type injuries to the heart and large blood vessels surrounding it in what is called the "chin-sternum-heart syndrome."

Placing airbags into an airframe that will fragment or collapse will probably offer less benefit. Airbags have to be treated as a part of a comprehensive system designed to protect the occupants and not as a Band-Aid for a less-well-thought-out approach. To do so is to possibly impart a false sense of security to pilots and passengers. Probably the best use of airbags is to provide impact-lessening effects on areas of the cockpit or cabin where clearance beyond the strike envelope cannot be provided because of aerodynamic considerations.

Another point one must consider when designing a restraint system is something a lot of us do not consider when you say "restraint." The attachment points of the seats are just as important as any other part of the system. If the seat breaks loose, you will likely overload even an optimally designed harness because the harness is now the only thing trying to hold the seat in place; and the "added" mass of the seat is not normally tolerated in a good way.

I strongly recommend that when doing calculations that you use the biggest, "huskiest" friend you have who could fit into your particular aircraft as the "test case." If you do not want to grab a tape measure and ask your large friend to submit to being measured like a championship bass at a fishing tournament, you can refer to the NASA biomechanics website for measurements. Using a 255- or 260-pound weight will take into account all but the largest folks in our population. If you design your cockpit around a 95th percentile man, it will feel very roomy for those of us who are not quite so large. The only concern with this would be making sure you keep the controls, instruments, and switches within reach for the smaller folks. This is where building a mock-up of the cockpit before finalizing the design can be helpful. The larger mass of the "test subject" will also help to design the restraints to be more resilient when exposed to loads of smaller occupants.

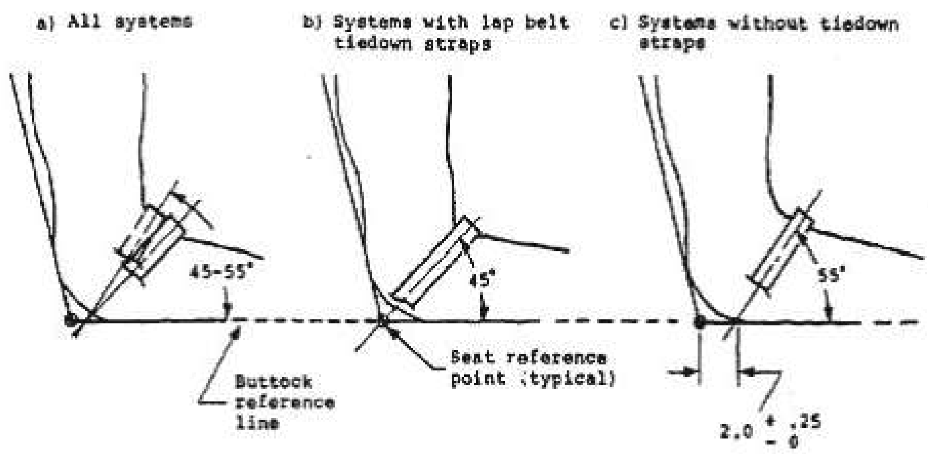


Figure 3. Layout of a well-designed restraint system.

What is a survivable crash also tends to depend upon whom you ask. The issue is extremely complicated and would take more space than I have left this month. The issues of crash loads and energy attenuation will be discussed in the next two installments.

Until next month, fly safely. EAA

Stephen L. Richey is an aviation safety researcher who has been involved with flying for the better part of two-and-a-half decades, starting with his time as a "junior hangar bum" with a local EAA chapter while a child in Indiana in 1988. He has logged about 700 hours thus far, including time in ultralights and as a perennial student pilot in light singles. His current project is the design of a new homebuilt known as the Praetorian.

Aerotique Parasol by Stan Truman at Oshkosh '83 was designed as an ultralight version of the 1926 Heath Parasol.

30 Years Old

Celebrating 'antique' ultralights

By Dan Grunloh

Plans for the ultralight/helicopter village at EAA AirVenture Oshkosh 2013 include special activities and recognition of ultralights and light planes that were introduced 30 years ago, in 1983.

The Quad City Challenger, designed by Chuck Hamilton, appeared at Oshkosh '83, and kit production began in September of that year. It was initially flown with a 294-cc KFM engine. A two-place tandem version followed, and it became one of the most ubiquitous light plane designs, with about 4,000 aircraft completed worldwide. The company recently introduced a light-sport aircraft (LSA) model, which was optimized to meet the sport pilot regulations. The ultralight version is still being built using the Hirth F33 engine. We hope to have a special parking area, forums, and a birthday party for owners of Challengers and other ultralights or light planes introduced in 1983. There will also be a Challenger fly-in later this year in Erie, Illinois. Watch for announcements at www.ErieAirpark.com.

1983 was a pivotal year in the evolution of light-sport aviation with the introduction of a mixture of old and new technologies. A survey of faded 30-year-old magazines reveals the Avid Flyer, Rans Coyote, Aerotique Parasol, Buccaneer amphibian, Zenair Zipper, Paraplane, and the Sky Pup, which were all introduced in 1983. The Avid Flyer by Dean Wilson won best new design at Oshkosh '83 and spawned about 2,000 copies. At least three more designs were inspired directly by partners or associates; the Kitfox (4,500 planes), Sky Raider, and Ridge

Runner were all derived or evolved from the first Avid Flyer introduced in 1983.

The plans-built Sky Pup was my favorite of that time because of its low cost. Around 500 were completed and flown, and there is still an active builder community at groups.Yahoo.com/group/Skypup-club. If you've never seen a Sky Pup in flight, watch this YouTube video of my own Sky Pup flying at Oshkosh a few years later. It's a real hoot to fly.

The diminutive Paraplane powered parachute by inventor Steve Snyder created a sensation when it was flown at Lakeland and Oshkosh in 1983. Reaction from the aviation community was mixed as spectators marveled at the novel sight of parachute climbing under power, and experts openly doubted the claim that it could not stall. The critics could not have imagined that eventually 10,000 or more powered parachutes would be built including the latest 100-hp special light-sport aircraft (S-LSA) factory-built versions. The sport of powered parachuting was born 30 years ago. A few of the original Paraplanes are still flying, and we invite enthusiasts to bring them and any of the other designs turning 30 years old this year to our birthday party at AirVenture 2013.

The Great Ultralight Weigh-In

June 9, 1983 – The FAA sent a letter to field officials outlining increased enforcement procedures for the ultralight regulations established just 10 months earlier. It recommended the establishment of technical standards committees that could verify compliance with FAR 103 using charts and tables, and to clarify the details about the parachute allowance, wide seats, and other details. This information was later published as Advisory Circular 103.17. However, the letter also included guidance to FAA inspectors as to when and where to inspect ultralights. The document recommended the inspectors conduct such investigations in conjunction with other activities, such as monitoring air shows and fly-ins.

Within three weeks, then EAA Ultralight Association President Bob Ring announced that all ultralights would be weighed at Oshkosh '83 before they could be flown. It was an unusual move and sure to be unpopular, but the threat of FAA enforcement at the convention may have been a factor. Tents were set up and teams of volunteers established. I worked on one of those teams and can confirm that more than 100 ultralights did indeed weigh less than the 254-pound weight limit (though some did so with help of a chute allowance). Weigh-

The original Challenger ultralight on display at Oshkosh '83 was powered by a 25-hp KFM engine.

ing revealed the truth behind manufacturers' claims, as some came back repeatedly with smaller wheels, thinner seat cushions, and fewer instruments until they could make weight. I still have a copy of the published weights from that event 30 years ago. The lightest was the Paraplane at 171 pounds, and a few weight-shift fixed wings were less than 200 pounds. But most pushed the upper limit. Some could only make the weight limit with clean tires and dry sails. A weigh-in was conducted at one other fly-in, but the idea was quickly abandoned. It was unpopular, fraught with technical challenges, and took a lot of volunteer manpower. The great ultralight weigh-in of 1983 was a turning point because it marked the beginning of a new era of N-numbered experimental light planes such as the Challenger and Avid types.

Cantilevered wing of the plans-built Sky Pup viewed from below.

Trike Accident Not Remembered

Jeff Edwards, a 38-year-old pilot certificated in airplanes, was seriously injured August 31, 2011, in a crash during his first solo flight in a single-seat ultralight weight-shift trike at the Washington Court House (Ohio) airport. He contacted the EAA and wants to share his story in hopes others will learn from his experience. The precise details of the accident are sketchy because he suffered amnesia from a head injury and cannot remember the accident or any of the events leading up to it.

Jeff is a recreational pilot and a member of the Air Force Reserve, and his dad holds a private pilot rating.

The Zenair Zipper by Chris Heinz had no ribs, and its wings could be folded in under two minutes.

Lon Pinaire's Ultra-Aire was beautifully built and flew well, but by 1983 standards it was already behind the technology curve.

They both love aviation, and both also fly foot-launched powered paragliders. However, it was becoming hard for his dad to foot-launch, so they wanted to get into trikes. The pair purchased a maroon Sky Cycle trike manufactured by Fly Hard Trikes in Wildwood, Georgia that was displayed at the 2011 Sun 'n Fun International Fly-In & Expo at Lakeland, Florida. Later they traveled to Tennessee to train in a two-seat trike with designer and manufacturer Michael Theeke. Each pilot received several hours of dual instruction over a weekend, but they didn't solo. The plan was to return later for more instruction, but they never managed to do it.

Jeff said he doesn't remember how it happened, but apparently he and his dad decided to take the Sky Cycle to the airport and try some low hops down the long 5,200-foot runway. His dad tried it first and got airborne briefly; the single-place trike handled quite a bit differently than the two-place trainer. He pulled back on the control bar too much after the initial liftoff, and the trike descended sharply and landed hard enough that he felt a bit shaken up.

Dad brought the trike back to the start of the runway, and Jeff took his turn. According to witnesses, Jeff made a full takeoff and climbed away from the runway. He flew around the pattern and appeared to make a landing approach but was not aligned with the runway. He angled away from the runway as if to go around for another try when suddenly the trike descended wings level as if in a stall, from an altitude of about 100 to 150 feet. The engine was still making power. Just before it

The Sky Cycle trike involved in the Edwards accident when it was on display at Sun 'n Fun 2011, where it won the Best Type Trike award.

A trip through the weigh-in tent at Oshkosh '83 yielded an empty weight of 205 pounds for the prototype Sky Pup.

impacted a cornfield, one wing dropped and the trike cart wheeled into the tall corn.

Fortunately, sheriff's deputies were at the airport with a helicopter conducting an exercise for drug eradication. It was used to find the accident site, which could not be located at first because of the tall corn. A fire truck arrived and knocked down the corn so Jeff could be rescued. Jeff was still in the cockpit and wearing a full shoulder harness and helmet, but he was temporarily knocked unconscious by the accident. He had an open fracture of the right leg and a shear fracture of his sacrum and pelvis. He also had damage to an artery and said if the sheriff's helicopter had not been present to expedite the rescue, he might not have survived due to uncontrolled bleeding. Seven months after the accident he was walking again, but he has four plates and 16 screws in the leg and pelvis along with nerve damage in the leg.

The damaged trike wing was sent out for repairs, and nothing was found that might have caused the crash. It's possible the pilot simply failed to maintain sufficient airspeed; however, trikes are generally hard to stall accidentally in normal flight modes because the control bar must be deliberately pushed well forward with both arms. The accident occurred at 9:40 a.m. When asked, Michael Theeke said he would never send a beginning student out to fly that late on a summer morning because of thermal turbulence. You can't learn to fly a trike when there is turbulence, and he felt it quite likely the pilot reacted too slowly, or perhaps had a momentary control reversal when the trike departed from normal level flight. Michael emphasized he had told the pair they should not attempt to fly until they received additional training. Ideally the instructor should be present at the day of the solo to test-fly the aircraft to ensure it is assembled properly. And finally, the instructor should be on the ground in radio contact with the pilot during the first solo flight. EAA

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

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

Photography by Dan Grunloh

Angle of Attack
That single number that works for you

By Ed Kolano

Last month we finished explaining how to calibrate your airplane's airspeed indicator. We laid the foundation with a little theory, explained the test procedures, and finished with the data reduction that created plots (or charts) of observed airspeed (what you read on your airspeed indicator) versus calibrated airspeed.

No doubt about it, airspeed is important. The Federal Aviation Regulations (FARs) define more than two dozen "V speeds," and aviation texts define dozens more. These include stall speed, maneuvering speed, maximum range speed, best glide speed, and on and on. All are handy numbers for pilots, but they all depend on your airplane's weight or altitude or flight condition.

What if you had a single number you could fly that would guarantee maximum range regardless of your airplane's weight? Or a single number to replace stall speed that would be correct whether you're straight and level or in a hard turn? This number exists, and it's called angle of attack.

Angle of attack (AOA) is the angle formed by the wind and the wing. Specifically, it's the angle between the relative wind and the wing's chord line, the imaginary line between the wing's leading and trailing edges, as shown in Figure 1.

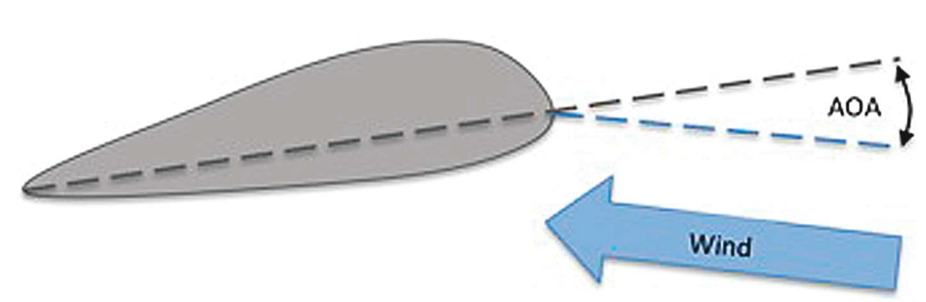


Figure 1

Stall AOA

All pilots know that a wing stalls when it exceeds its critical angle of attack. And as the *Airplane Flying Handbook* (FAA-H-8083-3A) says, this can happen at any airspeed, at any attitude, and at any power setting. Regardless of the airplane's flight condition, the wing always stalls at the same AOA.

If a wing stalls at the same AOA, why does your airplane stall at a faster speed when it's heavier than when it's lighter, or at a faster speed when turning than when flying straight? Your airplane stalls at different speeds precisely because the stall AOA does not change. Let's look at the lift equation to see why.

$$L = \frac{1}{2} \times \rho \times V^2 \times S \times C_L$$

L is lift. ρ (the Greek letter *rho*) is air density. V is true airspeed. S is wing area. C_L is the wing's coefficient of lift. If we limit our discussion to one altitude, the air density doesn't change. Wing area certainly doesn't change, and neither does the number 1/2. That means true airspeed and lift coefficient determine lift.

Lift coefficient is a convenience term aerodynamicists use. The value of C_L depends on the AOA as shown in Figure 2. You can see how higher AOAs produce larger C_L values up to a point where the C_L drops off—sometimes dramatically—if the AOA increases any further. On the C_L versus AOA curve, the AOA corresponding to the highest point (CL_{max}) is the stall or critical AOA.

This plot is valid for all flight conditions—climbing, descending, turning, or level. No matter what airspeed you fly, your airplane will always stall at the same AOA. Because there's only one C_L that corresponds to the stall AOA, your airplane will always stall at the same C_L.

During 1*g* flight, lift equals weight. When you slow down, V (true airspeed) decreases, so C_L must increase to maintain enough lift to support the airplane's weight. You've done this many times during slow flight. To compensate for the decreasing air-

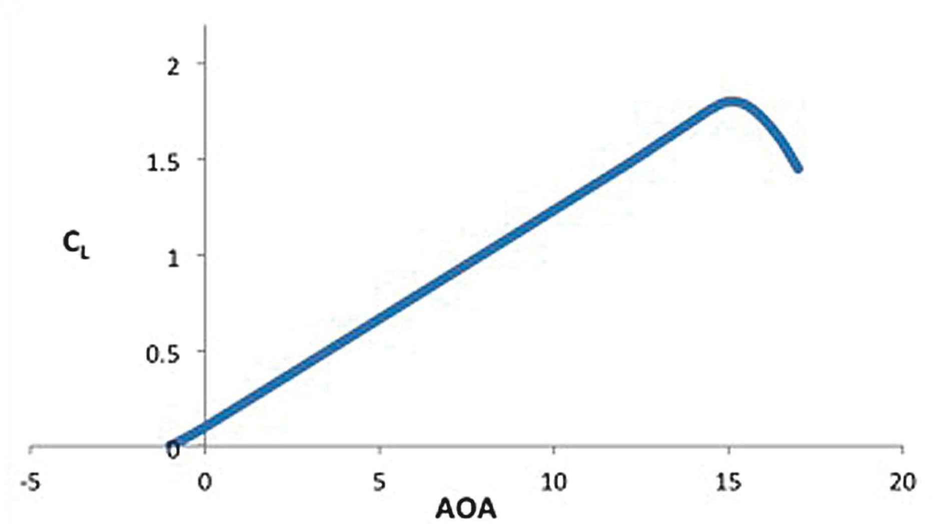


Figure 2

This plot is valid for all flight conditions—climbing, descending, turning, or level. No matter what airspeed you fly, your airplane will always stall at the same AOA.

speed, you apply even more back stick to increase the AOA. When you reach CL_{max}, increasing the AOA any further results in a lower C_L and a loss of lift, and the wing stalls.

Final Approach

Let's put some real-world numbers into the lift equation. Let's say our airplane weighs 1,000 pounds and has a wing area of 100 square feet. We're flying the traffic landing pattern at 1,000 feet pressure altitude, where the air density is 0.0023 slugs per cubic foot. Our airplane's CL_{max} is 1.8.

Plugging these values into the lift equation and solving for V, we get a 1*g* stall speed of 69.5 feet per second or approximately 41 knots. A typical landing approach speed is 1.3 times the stall speed, or 53 knots in this case.

If we add a passenger, some luggage, and top off the fuel tanks, our airplane would weigh 1,400 pounds. At this weight the stall speed would be about 49 knots. If we used our landing approach speed based on the lighter-weight airplane, we'd be flying just 4 knots faster than stall speed. In this case a 5-knot wind gust could be trouble.

With the heavier loading, the recommended approach speed would be 64 knots (1.3 x 49 = 64). If we flew this speed in the lighter airplane, assuming we'd touch down just as the plane reached its stall speed, we'd float a long way down the runway while dissipating that extra 23 knots (64 – 41 = 23).

If our airplane had an AOA indicator, we could have flown the same landing approach AOA at both weights. The airspeeds still would have been 53 knots with the lighter loading and 64 knots with the heavier loading, but we'd have had the same stall protection in both cases. Pretty handy, huh?

Turning Stalls

In a turn, the wing produces more lift than the airplane weighs, and the effect on the stall speed is identical to loading the airplane to a heavier weight. The effect on stall AOA is also identical—the stall AOA stays the same.

Pilots know that a level-flight, 60-degree bank turn generates 2*g*. This means the wing is generating an amount of lift that's twice the airplane's weight or two times what it is during straight-and-level flight. This is true for any 2*g* maneuver, whether the airplane is in a turn or inverted at the top of a loop.

$$L = 2 \times W = \frac{1}{2} \times \rho \times V^2 \times S \times C_L$$

If you let the airplane slow down while maintaining your 2*g* pull during this turn, the wing still stalls when its AOA exceeds its critical value. Because CL_{max} doesn't change, the only other variable that can change is the airspeed at which CL_{max} occurs, i.e., the stall speed. In this example, the stall speed is 1.4 times faster than during 1*g* flight.

It doesn't matter what the airplane's weight is, what the 1*g* stall speed is, or what the altitude is (altitude determines ρ) to know how maneuvering the airplane affects stall speed. Because the stall AOA stays the same, the only thing that affects stall speed in our example is how much lift the wing is producing or, said another way, how hard you're maneuvering.

In the steep turn, we increased the lift by a factor of 2, which means the stall speed squared (V2) increased by a factor of 2, and the square root of 2 is approximately 1.4. In a 3*g* maneuver, the stall speed would be the square root of 3 (approximately 1.7) times the 1*g* stall speed and so on. As Figure 3 shows, a level, 60-degree bank angle turn would generate 2*g* (blue arrows), and the airplane

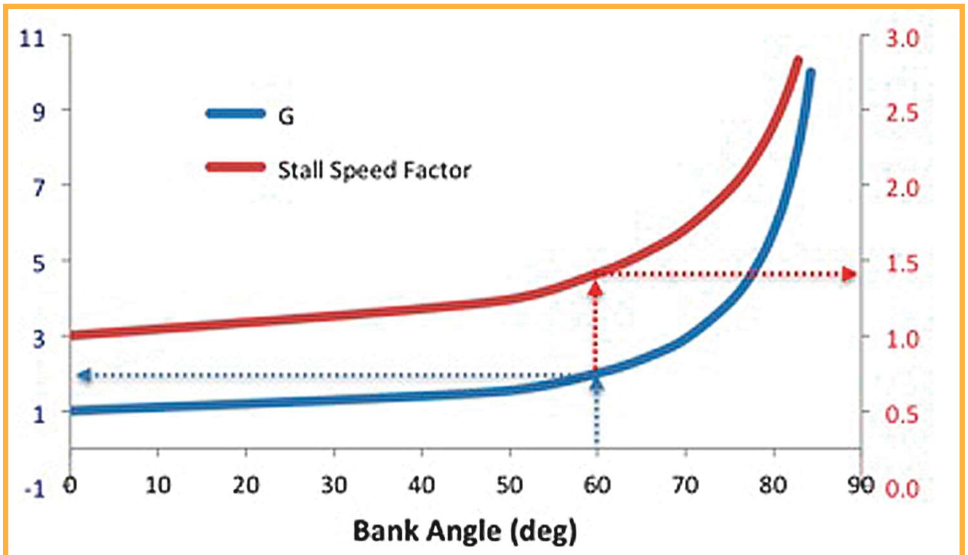


Figure 3

If we used our landing approach speed based on the lighter-weight airplane, we'd be flying just 4 knots faster than stall speed. In this case a 5-knot wind gust could be trouble.

will stall at 1.4 times its wings-level, 1*g* stall speed (red arrows). This chart is valid for every airplane.

This relationship holds true for any airplane at any weight at any altitude. We used a level turn in our example, but the argument is just as valid for any 2*g* maneuver. The wing doesn't care about its orientation to the ground. The stall speed is the same during a 2*g* pull-up, a 2*g* level turn, or a 2*g* pull-down during inverted flight at the top of a loop.

Changing your airplane's configuration can change its stall AOA, and flaps are the perfect example. You know that lowering the flaps lets you fly slower. What the flaps really do is enable the wing to generate more C_L, usually at a lower AOA (Figure 4). With the higher C_L capability, the wing can fly slower and still produce enough lift.

Changing configurations changes the stall AOA and CL_{max} from the previous configuration, but the stall AOA and CL_{max} for the new configuration don't change. In other words, a 2*g* stall with the flaps down will occur at 1.4 times the 1*g* stall speed with the flaps down. The bottom line is, for every configuration there is only one stall AOA. Figure 3 applies whether flaps are up or down and at any weight.

If your airplane has an AOA indicator, you would know how close you are to stalling under all flight conditions. A red mark on your indicator for the cruise configuration stall AOA and a different mark for the landing configuration AOA would keep you better informed than applying the same airspeed for all airplane weights and configurations. Another mark on the indicator for your airplane's proper landing approach AOA can be a lifesaving cross-check of your final approach airspeed.

There's one more mark you might want to have on your AOA indicator. That's for the AOA that results in both your maximum range cruise speed and your maximum range engine-out glide speed. Now that's a useful number, and we'll explain why next month. EAA

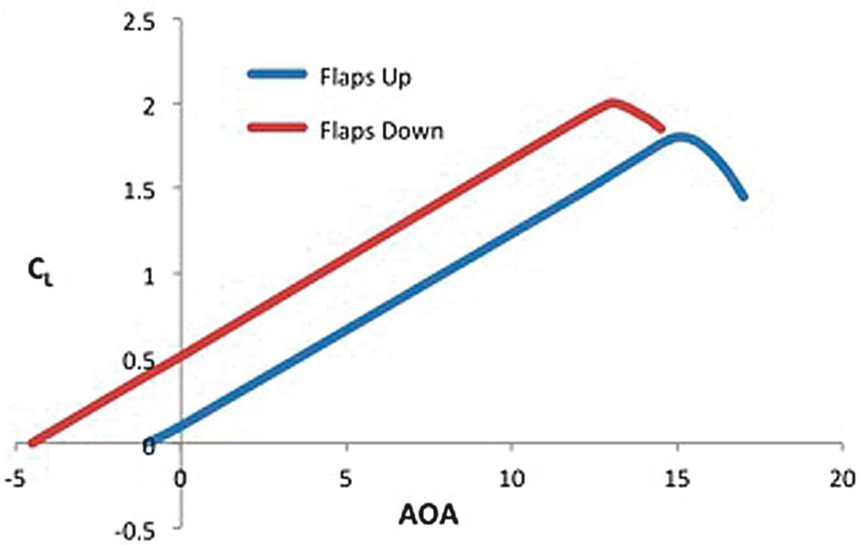
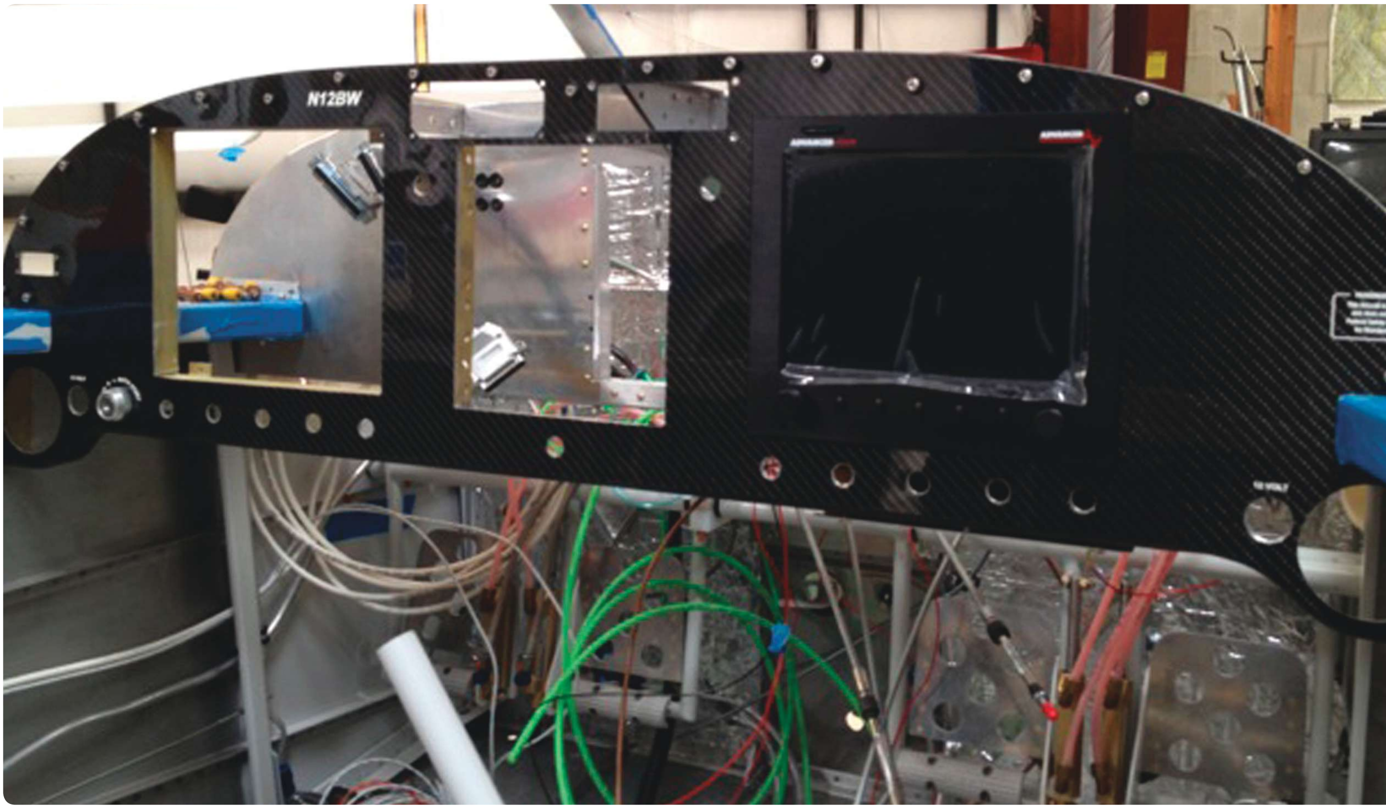


Figure 4



Working on the panel of his RV-7 caused Rick to reminisce about the development of various avionics.

Persevering on Our Projects

And reminiscing about GA advances

By Rick Weiss

The weather for the past week has been more like spring than winter here in Central Florida, so I have not been suffering from the "dark ages," that period of time when winter weather keeps me from working on my aircraft projects. It's been warm and beautiful, so it was out to the hangar to continue working on my RV.

For me, the instrument panel is one of the more exciting parts of the building process. It's an opportunity to be creative, and it brings the experimental part of building more into play. My panel design is set in aluminum, but where in the fuselage do you place all those boxes that make the magic work? That part is easy if you don't care about having access to them later when the fuselage skin is on and you can't reach in to repair something. I spent a large amount of time trying to figure out where to place the XM weather box. So much time, in fact, that my mind started wandering to the past.

Let's go back to the early 1980s. Imagine, if you will, having a weather radar picture in front of you in your small GA airplane. Most of us remember when that would have required an onboard weather radar system, which would have cost more than our entire homebuilt aircraft. In the early 1980s, I was working in the cockpit technology office of the FAA when a MITRE Corporation engineer designed a system that took the WSR-57 (Weather Surveillance Radar-1957) weather data, digitized it, and delivered the data to the VOR. The data was then transmitted as "background noise" on the VOR voice channel. (Back then almost everyone had a VOR receiver.) The information was received via a "black box" under the pilot's seat, decoded, and sent to a small dot matrix printer (small digital displays hadn't been invented yet and PCs were just born) where a printout of the weather was available to the pilot. Just reach down and tear off the printout, orient it to your direction of flight, and presto, situational awareness of the weather and your aircraft.

We took this invention to Ohio University (OU) for flight testing by Dr. Richard McFarland's flight department. Doc was one of the most brilliant scientists in the aviation world and a big proponent of general aviation. The device was installed in an OU Bonanza and DC-3. Then Administrator J. Lynn Helms came to OU, flew the system, declared it worked, and then soon left the FAA. We tried to get this invention to the attention of senior FAA management heads, but they weren't interested in reprogramming money for GA. They said if pilots had this information, they would just get themselves in trouble. We were incensed and became committed to changing this absurd attitude.

Fast-forward to the 1990s. NASA (Dr. Bruce Holmes) and now the FAA (myself with Administrator Joe Del Balzo's full support) joined forces to reinvent GA. AGATE, the Advanced GA Transport Experiments program, was created jointly with industry as a full partner. One of the goals was to fast-track technology into GA aircraft. Of interest, of course, was getting weather and other vital information to the in-flight pilot. We decided to bring AGATE to the attention of the GA community by going to EAA Oshkosh and telling our story. We did this during the early 1990s.

One of our partners was ARNAV, an avionics manufacturer owned by Frank Williams, a great person, brilliant engineer, and someone who was not just involved in GA but committed to making it better and safer. Frank had developed a system that could track a vehicle and have two-way communications with it. Some of you old-timers may remember a brightly painted ARNAV VW Beetle equipped with all sorts of electronics and antennae, driving around the convention grounds back then. This vehicle was equipped with a GPS and data link that transmitted position, speed, and more to a ground station in one of the convention buildings at the ARNAV booth where received messages were displayed and sent to the Beetle.

The technology went from Beetle to aircraft in less than two years. The development path included installation in emergency medical service helicopters for use in GPS approaches to hospital heliports and for ATC to track helicopter operations to oil platforms in the Gulf.

In 1996 we took this technology, enhanced it to the greatest extent possible, and installed it on the 100 aircraft that were permitted to fly over the 1996 Olympic Games in Atlanta, Georgia. Here's an interesting side note: For security purposes this data link equipment was required for any and all vehicles flying at low altitude over Atlanta during the games. The project focused primarily on helicopters and photoships and included GA aircraft as well as the Goodyear and Bud One blimps. During Oshkosh 1996, we had the Olympic airspace system on display in the FAA building. This effort was the first real test of a GA data link and the birth of what is now automatic dependent surveillance-broadcast (ADS-B).

The technology went from Beetle to aircraft in less than two years. The development path included installation in emergency medical service helicopters for use in GPS approaches to hospital heliports and for ATC to track helicopter operations to oil platforms in the Gulf.

The FAA has progressed, and thanks to Dr. George Donohue, then associate administrator of engineering, and David Hinson, the FAA administrator during this period, this GA project was fully funded and became mainstream within the FAA. From Oshkosh to Atlanta to Alaska (Capstone project) and now almost nationwide, ADS-B is providing vital flight information to the GA community.

While ADS-B brings great information to the aircraft, the XM system brings other features that the government system doesn't. Which brings me back to where I am now, trying to figure out the placement of all these marvelous inventions in my RV-7. The journey that is the building process is awesome. I wonder what great new product will be introduced at EAA AirVenture Oshkosh this year, and where will it fit in my airplane? EAA