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EXPERIMENTER

The Spirit of Homebuilt Aviation / www.eaa.org

Reviewing Engines at AV 2014
Options for homebuilders

Getting Started in Powered Parachutes
Some basic advice

The Aerolite 103
Everything you need!

ADS-B and EAA

BY JACK J. PELTON

WITH THE YEAR 2020 mandate looming ADS-B has moved front and center for every airplane owner, and also here at EAA.

First, it's important to understand that the 2020 deadline applies only to ADS-B "out" equipment. ADS-B "in" equipment that receives subscription-free weather, traffic, and other in-flight information is not required for any airplane in any airspace.

Secondly, the 2020 mandate applies only to flying in airspace where a Mode C transponder is now required. If you are flying where you want now without a Mode C transponder, you can continue to fly in that same airspace without ADS-B "out" after the deadline.

However, the number of airplanes equipped with Mode C transponders is large. According to the most recent FAA activity survey more than 80 percent of the active piston airplane fleet was equipped with Mode C, and another 10 percent had the more advanced Mode S transponder. And 77 percent of homebuilts have Mode C. That adds up to more than 144,000 airplane owners who are now flying with Mode C or better and will need to install ADS-B "out" by 2020 to continue to fly in all of the same airspace they are now eligible to use.

At EAA we understand the superior precision and potential traffic flow improvements and safety of ADS-B in the NextGen air traffic control system. The present radar-based tracking system is stuck in the vacuum tube age and can't go on forever.

But at EAA we are concerned that the ADS-B equipment certification standards and installation approval process that is essential for high-performance airplanes flying in the system in all kinds of weather, and to and from the world's busiest airports, are not entirely necessary for pilots flying personal airplanes outside the IFR system.

For example, we at EAA discovered that experimental airplanes have just been totally left out of the FAA-approved procedures to certify an ADS-B installation. The massive and complex document that describes how airframe manufacturers, or avionics equipment makers, can earn FAA approval for installation of ADS-B "out" equipment simply doesn't mention experimental airplanes.

The entire ADS-B approval pathway revolves around obtaining an amended type certificate or supplemental type certificate (STC) to install the equipment. Experimental airplanes—including amateur-built—by definition don't have a type certificate. At this time experimental airplanes have no clear route to gain the necessary approvals to install ADS-B equipment even though the avionics boxes themselves meet the required standards.

ADS-B is a global standard, and other parts of the world—particularly in Europe—mandate its installation earlier than 2020. Perhaps in the years of complex negotiations that went on to create the international standards the FAA simply forgot about the thousands of homebuilts that fly in regulated airspace.

No matter the reason E-ABs and other experimentals were left out, EAA's advocacy group is working closely with the FAA to resolve the issue. And the FAA is looking to EAA for help in finding a solution.

The other fallout of the complex regulations is what we believe is the unnecessarily high cost for certified ADS-B equipment. Much of the cost is in the two-step process of certifying the equipment, and then gaining approval to install the equipment. At EAA we are convinced the FAA can streamline the approval process for piston airplanes that fly below the Class A airspace that starts at 18,000 feet and cut the cost of ADS-B compliance dramatically.

How important is that to EAA members? I recently heard from a member who took his Cessna 152 to the avionics shop to get an estimate for ADS-B "out" installation. The all-up estimated price was $7,000. The value of the 152 is about $25,000.

If that member wants to fly near a busy airport surrounded by the Class B "veil" he must equip. If he wants to land at one of the only modestly busy Class C airports such as Mid Continent in my hometown of Wichita, the general aviation capital of the world, he must equip. And if he wants to fly a trip along either coast, or passing major inland hub airports, he must equip or will be forced to fly many, many miles out of his way to avoid regulated airspace.

At EAA our mission is not to repeal ADS-B "out" requirements, but it is our absolute objective to make them more logical and affordable for the personal airplane owner. Right now the cost versus benefit of ADS-B just doesn't work for many owners of personal airplanes. EAA

Photography by Jason Toney

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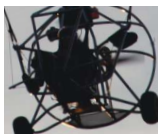
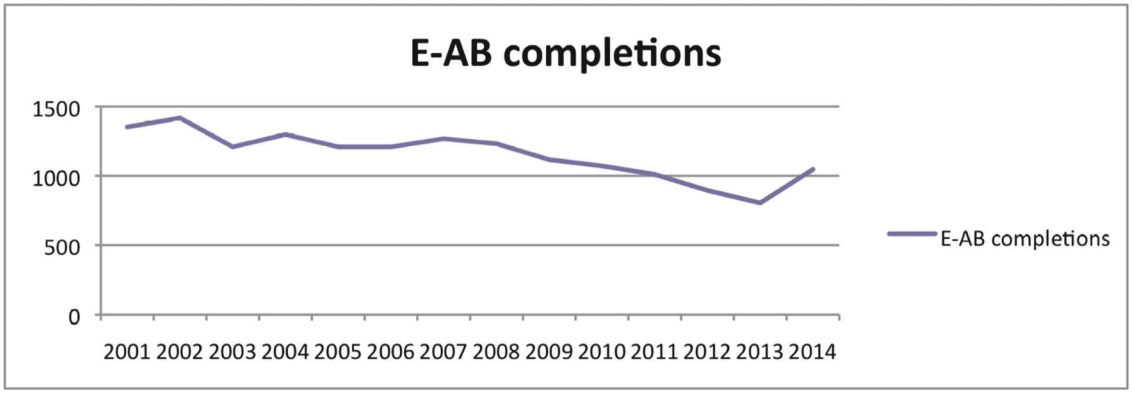


On the cover: Terry Raber flies the Aerolite 103, which he designed. (Photography by Jim Raeder)



New E-AB completed by year.

Keep Those Completions Coming!

And, keep building and flying safely

BY CHARLIE BECKER

WITH THE CLOSE of 2014, I thought it might be interesting to know how many new homebuilts have been completed each year. I get quarterly reports on the fleet size from the FAA, but that data only shows the net increase or decrease. When FAA implemented re-registration from October 2010 to December 31, 2013, that completely messed up the historical data during that time period. Going forward, the numbers should be more accurate as inactive aircraft come off the rolls.

Fortunately for us, EAA member Ron Wanttaja mines the FAA registration database each year and was able to tease out just the new completions going all the way back to 2001 (see graph). Over this 14-year span, in the United States alone, we have added 16,140 new aircraft to the fleet. That is pretty impressive! The average number of new completions each year was 1,153 (for you statistics geeks, the median was 1,209). In fact, every year more than 1,000 homebuilts have been added, except for 2012 and 2013.

Why the dip in 2012/2013? In those years the completions numbered 895 and 805, respectively. Ron's theory on the dip in those years is the delayed economic impact of the Great Recession in the 2007 to 2009 time period. That seems like a reasonable reason because a homebuilt can take two to four years to complete. Because 2014's numbers jumped back up to 1,046 completions, it appears that the economy was driving the dip. I hope we will stay in the 1,000-plus completion range from here on out.

These numbers really don't surprise me much. Homebuilding is where it is at if you want an aircraft, especially a new aircraft. It gives us builders an incredible amount of freedom that simply does not exist anywhere else in the aviation world. (To be fair, ultralighting has it better, but the overall sandbox to play in is too limited by empty weight/stall speed). If you want an affordably priced aircraft, you can scratchbuild and buy a used engine. If you want performance, most homebuilt designs outperform certificated aircraft by wide margins. And if you want a glass panel, the technology available to homebuilders continues to get better and better.

One of the drawbacks of being successful is the added FAA scrutiny that comes along with the increased number of experimental amateur-built aircraft. With a growing number of homebuilt aircraft, it makes it harder to meet the FAA's accident reduction goals. And if there is one thing I've learned from working at EAA, the only thing that could be a real threat to the homebuilt movement is a poor safety record. As builders, we need to safeguard the homebuilt movement by using EAA's Technical Counselor program to make sure our construction practices are satisfactory. And when the time comes for flight testing, take advantage of the EAA Flight Advisor program to avoid an accident during the high-risk flight-testing phase. The extra attention is not always bad as we proved last year by getting the FAA to allow a qualified second pilot onboard during flight testing.

One way to make sure the completion numbers continue to grow is to finish your project! If your project is stalled out or pushed to the back of your workshop gathering dust, take some inspiration from these numbers. Commit to solving whatever issue made you walk away. Call your local EAA technical counselor to come over and devise a solution. Your fellow EAA members are out there and willing to help. EAA

Initial AirVenture 2015 Air Show Performers Confirmed

SOME OF THE WORLD'S top air show performers, including national aerobatic champions, longtime favorites, and some talented Oshkosh first-timers, have made commitments to fly during the afternoon and night air shows at EAA AirVenture Oshkosh 2015, set for July 20 to 26 at Wittman Regional Airport in Oshkosh, Wisconsin.

Afternoon air shows are scheduled to begin at 2:30 p.m. daily, while the Wednesday and Saturday night air shows are scheduled to begin at 8 p.m.

Many more performers will be announced in the weeks leading up to Oshkosh. Schedules and complete daily air show lineups will be announced as they are finalized. Here is the list of confirmed performers:

Sean D. Tucker/Oracle Challenger III biplane
Kyle Franklin/Super Cub
Mike Goulian/Extra 330SC
AeroShell Aerobatic Team/Four North American T-6 Texans
Bob Carlton/SubSonex jet
Joe Shetterly/RV-8
Luca Bertossio/aerobatic glider
Patty Wagstaff/Extra 300
Rex and Melissa Pemberton/Edge 540 and wingsuit
Matt Younkin/twin-engine Beech 18
Rob Holland/MXS-MH
Matt Chapman/Eagle 580
Gene Soucy & Teresa Stokes/Grumman biplane
Bill Stein/Zivko Edge 540
Skip Stewart/modified Pitts S-2S biplane
Jim Peitz/Beechcraft Bonanza F33C
Vicky Benzing/Stearman
Greg Koontz/either Xtreme Decathlon or with the Alabama Boys (TBD)
Jerry Kerby/RV-8 Roger Buis/Otto helicopter

Wipaire to Present Seaplane Rating Scholarship at Oshkosh

SOUTH ST. PAUL, MINNESOTA–based Wipaire Inc. will present the first Ben Wiplinger Memorial Seaplane Rating Scholarship, honoring its founder and celebrating the company's 55th year of continuous aircraft float production. The company plans to award the scholarship, valued at $1,500, at EAA AirVenture Oshkosh 2015.

"As a longtime and active member of the seaplane community, we continually invest in people and products to better serve the industry," said Chuck Wiplinger, Wipaire president, COO, and grandson of the founder. "It only seems natural for us to share the incredible world of seaplane flying with the next generation of seaplane pilots and enthusiasts."

The seaplane rating scholarship will be paid directly to the winner's designated flight school. Applicants must hold a sport pilot certificate or higher, and must submit an application form along with a 500-word essay on why the applicant would like to learn to fly seaplanes, how the scholarship will help in career or aviation industry aspirations, and a statement of financial need. Applicants must also submit a copy of their pilot certificate and a copy of current medical (if applicable).

You must be a legal resident of the United States or Canada (excluding the province of Quebec) to be eligible. Complete the application form available at www.wipaire.com and submit no later than June 30, 2015.

Photography by DeKevin Thornton

EAA Making Sure Amateur-Builts Not Forgotten in ADS-B Mandate

EAA IS IN ONGOING discussions with FAA to ensure that experimental amateur-built owners are not forgotten as the FAA looks toward the January 1, 2020, mandate for equipping aircraft with automatic dependent surveillance – broadcast ADS-B avionics.

Historically, builders and owners of experimental aircraft have been able to install avionics that meet the performance standards of certified equipment but are not specifically approved by the FAA. Even in IFR-equipped aircraft, avionics do not have to be approved devices and can be installed by the aircraft builder or by an A&P mechanic. EAA seeks to preserve that historical precedent for ADS-B equipment installation as well.

"The latitude within the amateur-built regulations includes the ability to meet the required performance standards in the ADS-B mandate through means other than certified avionics and professional installers," said Sean Elliott, EAA's vice president of Advocacy and Safety. "EAA wants to maintain the culture of innovation and education that has been a hallmark of our community, and the FAA appears willing to help find a path forward for us."

While the 2020 ADS-B mandate applies to all aircraft that will operate within controlled airspace, there are unique provisions and opportunities within the amateur-built regulations that may allow owners of experimental aircraft to meet the requirements with greater flexibility and potentially lower cost. Specifically that could mean, for instance, the ability for a builder to individually install certified ADS-B systems, or seek out non-certified ADS-B systems that meet the mandate's performance standards.

"Our point to the FAA is that we support the agency's desire for full compliance with the 2020 mandate, provided cost-effective options are available," Elliott said. "The amateur-built regulations allow individuals to fully comply with the requirements in their own way and at a potentially lower price point. There is still work to do, but EAA is committed to preserving the rights and opportunities allowed within amateur-built regulations in all areas, including ADS-B installation."

Win the Perfect Cub

AFTER A LONG AND exhaustive search for "just the right plane," EAA is pleased to announce the 2015 EAA Aircraft Sweepstakes grand prize, and it's familiar: a Piper J-3 Cub, meticulously restored by Ellis Clark, EAA 71644, of Solvang, California. Entries are now being accepted at www.EAA.org/sweepstakes, and entry coupons will be packaged with the February issues of *Sport Aviation*. The lucky winning entry will be selected at 5 p.m. CDT on September 30, 2015.

Looking for an airplane worthy of being the grand prize for the EAA sweepstakes was not an easy task for John Hopkins, EAA's manager of Aircraft Maintenance. However, after answering an ad on eBay for a Cub in Michigan, Hopkins had a pretty good feeling he'd found the one.

"When I called the owner and began talking with him, I knew this would be the one," Hopkins said. "He was very particular, and after I laid my eyes on it, I couldn't blame him—this Cub is perfect! It was everything I was hoping it would be and then some."

Clark said he's proud the airplane was chosen for the sweepstakes. "When I was approached, I almost got cold feet and began to wonder if I should sell it," he said. "But when I found out this Cub would become the 2015 EAA sweepstakes airplane, I realized it would end up in a good home, because I knew there would be an excellent chance that an EAA member would be the lucky winner. I plan on going to Oshkosh to see the airplane in all its glory at AirVenture."

You can read all about this old-school beauty in the January edition of *Sport Aviation*. Second-place sweepstakes prize is an EAA AirVenture Oshkosh 2016 VIP Package valued at more than $3,500.

Cash donations for sweepstakes entries support EAA's education programs. For more information, including full sweepstakes rules, visit www.EAA.org/sweepstakes. EAA

Photography by Jason Toney

Van's RV-12 Is Now Available With Dual Dynon SkyView Touch Screen Displays

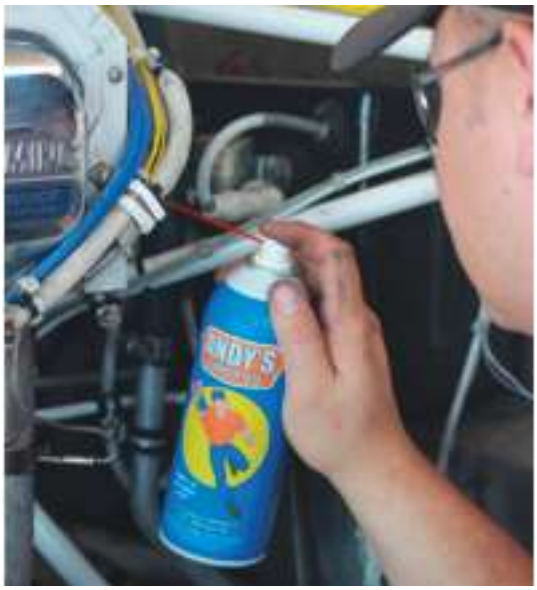
IF ONE OF THE STANDARD Dynon SkyView displays is good, two must be better, so Van's Aircraft and Dynon have worked to create a dual display option for the RV-12.

Both screens are individually configurable. A simple "swap" command will flip the right-side display to the left and vice versa. Perfect for giving instruction or just taking maximum advantage of the large panel, the dual SkyView option adds to the already outstanding value of the RV-12.

The dual touch screen is an option on the RV-12 SkyView avionics order form for experimental light-sport aircraft (E-LSA) builders and is available as an option on special light-sport aircraft (S-LSA) RV-12s. An optional kit that adds a second screen to a flying RV-12 with a single screen is also available.

A POH Tray mounted under the right-side panel is included to replace the mapbox.

For more information on the dual Dynon or the RV-12, call Van's Aircraft or visit www.VansAircraft.com.



Andy's Super Oil—Fastest Growing New Spray Lubricant for Aircraft

ANDREW BARKIN, EAA 210095, of Camarillo, California, is a pilot, engineer, and inventor who studies tribology—the science of lubrication. Several years ago, he became dissatisfied with the sprays that were available on the market and embarked on a personal journey to formulate a new product that would use modern technology and chemistry.

He mixed a high-quality petroleum base with a hand-selected mixture of the finest additives, including PTFE (commonly known by the trademarked name Teflon). PTFE is one of the most lubricious materials known.

The result is a new multipurpose maintenance product called Andy's Super Oil, a totally improved spray lubricant that outperforms the products available in the marketplace today. It's available from Aircraft Spruce & Specialty Co.

A Comprehensive Guide to Composites From ASA

A NEW BOOK, A Comprehensive Guide to Composites: Processes & Procedures From the Professionals, is an insider's viewpoint on the tips and techniques used by the pros to fabricate advanced composite parts. Author Kevin Fochtman's more than 30 years of industry experience provides valuable insight on safety, shop and equipment needs, engineering materials, layup, fabrication, and quality control.

Students and instructors alike will benefit from the coverage of lean manufacturing, science, technology, engineering, and mathematics (STEM), and advanced composites, all in one book. Not only will readers understand the basic skills required by today's composite industry, but also they will gain foundational knowledge to pursue higher-education goals in material science, composite engineering, and composite research and development.

An ideal textbook for science and technology classes for middle school, high school, magnet and STEM programs, as well as vocational and higher-education learning, the book also is available in PDF and e-pub formats, as well as an e-bundle.

Learn more from Aviation Supplies & Academics Inc. by calling 800-426-8338 or visiting www.ASA2Fly.com.

New Rotax Service Instruction

ROTAX HAS ISSUED a revised service instruction (SI) SI-912-020/SI-914-022, Revision 8, Running Modifications on Rotax Engine Type 912/914 (Series).

This revision of the SI has been expanded to include information about the change of CHT measurement (as described in the recent bulletin SB-912-066/914-047) for the new style cylinder heads introduced by Rotax. (See Chapter 72-00-00.)

Chapter 79-00-00 also includes a corrected scope of serial numbers identifying engines that have the new-style oil pressure sensor already installed. (Change in wording/scope: "up to S/N" is now "from S/N.") Get the service instruction.

Changes at CGS Aviation

EFFECTIVE JANUARY 1, 2015, CGS Aviation has been divided into two entities. CGS Aviation will continue to build and sell the ASTM-approved U.S. light-sport aircraft as well as the Canadian advanced ultralight aircraft (AULA) version of the CGS Hawk Arrow 2. All single-seat ultralights and the amateur-built version of the Arrow 2 will be built and supported by Hawk Aircraft.

The factory for the ASTM models will remain at the current location in Alabama for now. The current website, www.CGSaviation.com, will serve the ASTM and AULA models, and a new website and company name, called Hawk Aircraft, will service the single-seat ultralight and amateur-built kit aircraft. The current factory has reorganized to better comply with ASTM standards. No time frame has been given, but the company expects it to be a short period of time. Hawk Aircraft will move to a different facility on the same property.

Contact info for both entities will remain as cgsaviation.danny@gmail.com for e-mail and 251-454-0579 for phone.

A new parts policy for all used aircraft not owned by an original builder will begin, requiring registration with Hawk Aircraft, with details to be announced soon. EAA

The original Aerolite 103 designer, Terry Raber, flies his machine at EAA AirVenture Oshkosh 2011.

Photography by Jim Raeder

The Aerolite 103 Ultralight

Everything you need

BY DAN GRUNLOH

This elegant, 5-gallon, spun-aluminum fuel tank is from a sandrail buggy.

A bare Aerolite 103 fuselage with the control system installed.

A green, Kawasaki 340–powered Aerolite 103 climbing away at AirVenture 2014.

THE AEROLITE 103 STORY is one about a perfect little fixed-wing ultralight that was conceived as a back-to-basics retro design almost 20 years ago. It was designed with just about everything you could want in an ultralight. It flew well and won awards. People wanted to buy them, but within about seven years of its introduction, the manufacturer closed its doors with unfilled orders. This business failure shows that it takes more than an excellent design to make a successful airplane. The company must be able to deliver products on schedule and keep the customers happy.

The Aerolite 103 story has a happy ending, however, with Terry Raber, the original designer putting the ultralight back into limited production in 2010, and finally, like a bird looking for a nest, the Aerolite found a new home in 2013 with a new owner, Dennis Carley of U-Fly-It Light Sport Aircraft in DeLand, Florida.

Terry, a certificated flight instructor and former corporate pilot, got hooked on ultralights when he first flew a Sunburst ultralight in the 1980s. He established a reputation as a CGS Hawk dealer and a prize-winning builder with a Reserve Grand Champion CGS Hawk at the 1995 Sun 'n Fun International Fly-In & Expo. In 1996, he began designing a back-to-basics retro design, saying he thought there was a real need for a modern ultralight-legal machine. Ultralights had evolved in the 15 years since their birth in the early 1980s into full-featured, proper little airplanes, and many exceeded the 254-pound legal weight limit.

EVERYTHING YOU COULD WANT

Terry took the best ideas from existing designs and incorporated just about every feature you could want in an ultralight. The resultant Aerolite 103 was a high-wing pusher with a windscreen, ailerons, flaps, tricycle gear, brakes, and electric starter. It was built with aluminum tubes and Dacron sailcloth for easy repairs. High-wing airplanes make good ultralights because you have a better view of the scenery below, and they may be better for low-time pilots in crosswind landings. Tricycle gear and brakes make a real difference and could lengthen the life of the airframe (besides making it easier to turn around at the end of a runway in a crosswind). Pushers are often preferred in slow flying for a better pilot experience and to get the engine noise behind the cockpit. Add a four-point harness and make it ready to fly (RTF) for a reasonable price, and the Aerolite 103 had everything you could want.

The Aerolite 103's wing and airframe are heavily based on the CGS Hawk and Quad Cities Challenger. The wing is similar to the Challenger wing, but shorter at 26 feet, 10.5 inches. The large tail is similar to a T-Bird or CGS Hawk, and the landing gear struts are fiberglass tubes that have proved successful in countless ultralights, trikes, and powered parachutes. The fuselage is based on a single lower keel, a bit like a weight-shift trike. The airframe is mostly bolted-together 6061-T6 aluminum tube and gussets.

Terry called his ultralight the Aerolite 103 to advertise its compliance with the FAR 103 regulations. It was introduced at EAA Oshkosh 1997 where it won the Grand Champion Ultralight award. He went on to win several more awards at Oshkosh and Sun 'n Fun in the next three years. It had lots of great features

Photography by Dan Grunloh

and excellent craftsmanship, so the demand was high. That's where the problems began.

BUSINESS DIFFICULTIES

Terry loves to build airplanes but prefers a small shop operation. He never wanted to be an aircraft manufacturer; he predicted in 1997 that he would build two airplanes per month. A year later in 1998, Aero Works Inc.—the company doing the production—predicted it could build five per month. Due to strong demand, kits would be offered instead of producing only completed ultralights, as originally planned. The venture didn't work out as hoped, and kit production ceased in 2005 when the company floundered.

Veteran manufacturers in the homebuilt movement understand that airplane kits can be more work and require more support than simply building the airplane as a ready-to-fly aircraft. The precise details here are not important, except to say that late deliveries, incomplete kits, and canceled orders can bring a company to its knees as buyers wait longer and longer for delivery. Because of lost records, no one knows for sure how many Aerolites were built, but 130 or more Aerolites were shipped worldwide. There are at least six listed on the FAA database as N-numbered amateur-built experimental aircraft. Probably more could be found by searching for variations in the name.

U-FLY-IT TO THE RESCUE

Fortunately, Terry resurrected the design in 2010 with a few minor improvements, including a spun-aluminum fuel tank, hardware upgrades, and a new engine. A lightweight 28-hp Hirth F-33 engine allowed additional features to be added to the design, such as a three-blade composite prop, electric flaps, electric start, brakes, wheelpants, streamline strut and gear fairings, and basic instrument package. He flew it at EAA AirVenture Oshkosh that year and again began limited production of the Aerolite 103.

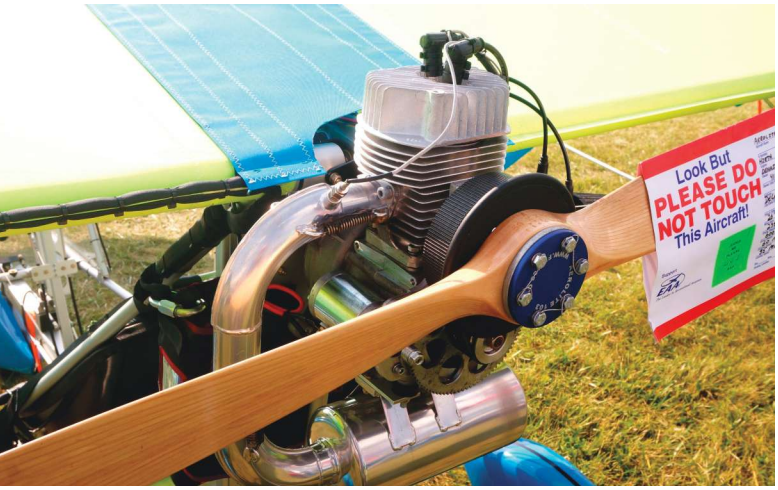
Unfortunately, within two years Terry realized he still didn't want to spend his time manufacturing airplanes. In late 2012, he

SPECIFICATIONS

Empty weight (Hirth F-33): 235 pounds
Gross weight: 600 pounds
Length: 16 feet, 3.25 inches
Wingspan: 26 feet, 10.25 inches
Wing area: 121 square feet
Design limit load: +4/-2*g*
Engine power: 28 to 50 hp
Propeller diameter: 60 inches
Stall speed, flaps extended: 26 mph
Stall speed, clean: 28 mph
Cruise speed: 45 to 63 mph
Top speed: 63 mph
V_{NE} (never exceed): 70 mph
Maximum crosswind: 15 mph
Rate of climb: 600 fpm
Sink rate: 350 to 400 fpm
Roll rate: 45 degrees to 45 degrees per 2.5 seconds
Takeoff and landing: 100 to 200 feet

Dennis Carley is now the proud owner of the Aerolite 103 design.

sold the complete package of design rights, drawings, construction jigs, and remaining parts to Dennis Carley. Everything was packed up and moved from Millersburg, Ohio, to DeLand, Florida, where his company provides sales, service, instruction, assembly, and repair of ultralight and light-sport aircraft (LSA). Dennis has built more than 100 ultralights and experimental aircraft in the last 20 years, including many trophy winners. As a Quicksilver and Challenger dealer with a builder-assist program, and a former designated airworthiness representative (DAR), Dennis inspected and certificated hundreds of LSA and experimental aircraft during the implementation of the LSA rule.



The underwing mount for the Hirth F-33 with a cog belt updrive and electric starter.

Dennis wants to manufacture airplanes, and he has the facility and the staff that can do it. U-Fly-It has a 5,000-square-foot facility at the DeLand Municipal Airport that can build 10 airframes at time. They built 20 Aerolites in 2013 and 40 in 2014, and they expect a maximum output of 50 per year. Perhaps for the first time, the Aerolite 103 will be built using mass-production techniques. The Aerolite 103 is available only as a complete, ready-to-fly ultralight that has been test-flown or as a complete airframe. There are no kits.

Very little has changed on the Aerolite 103 from the version reintroduced by Terry in 2010. It was—and is—a clever design that incorporates components from outside the typical parts stream. The control yoke, familiar to conventional pilots, helps to simplify the control system and allows duplicate push-pull cables to operate the ailerons and elevator, providing a level of redundancy. The yoke, the spun-aluminum fuel tank, and the seat were originally designed for sandrails—a kind of lightweight dune buggy intended for sand dunes. Dennis added a slip indicator and some turnbuckles in the control system. The fiberglass nose cone was originally painted, but the color is now molded into the fiberglass. The Dacron wing and tail coverings seen at AirVenture 2014 and at Sun 'n Fun fit perfectly, and they match the quality of fit that Terry produced in his show planes. Dennis intends to continue that tradition with a sailmaker in Tennessee who has the patterns. The plastic-extruded stream-

A portion of the 5,000-square-foot U-Fly-It shop at the DeLand, Florida, airport.

Photography by Dan Grunloh and courtesy of U-Fly-It

lined strut fairings that Terry sold industrywide for many years are now sold through U-Fly-It.

ENGINE CHOICE MAKES THE ULTRALIGHT

When first introduced in 1997, the Aerolite 103 flew with a 35-hp, two-cycle 2Si 460-F35 engine that weighed 66 pounds. A year later, production shifted to an 85-pound Rotax 447 engine when the 2Si became unavailable. The Rotax 447 was popular, but the weight increase meant that the Aerolite 103 was pushing the ultralight weight limit with minimal options allowed. When Raber returned 13 years later to AirVenture 2010, he had switched to the 28-hp, single-cylinder Hirth F-33 with a displacement of 313 cubic centimeters. It weighs only 55 pounds ready to run and leaves plenty of room for airframe options with weight to spare. A standard Aerolite 103 can be almost 20 pounds under the limit with the Hirth. It's a repudiation to the claim heard in the 1990s that it's too hard to build a legal-weight, fixed-wing ultralight with full three-axis controls.

The German-built Hirth F-33 is still a two-cycle engine and a single cylinder as well, but there is no ignoring the weight-to-power advantage. The engines have gotten better over time, but to be fair, anytime you have two cylinders or less, it's always best to have someplace to go if you lose power. It's not that hard when you can land in 130 feet like the Aerolite 103 will. The engine has dual CDI ignition, a charging system, belt reduction drive, and electric start. It uses premixed fuel at an 80-to-1 ratio and does not have oil injection. The starter is cranked with a lithium battery weighing a mere 1 pound, 5 ounces.

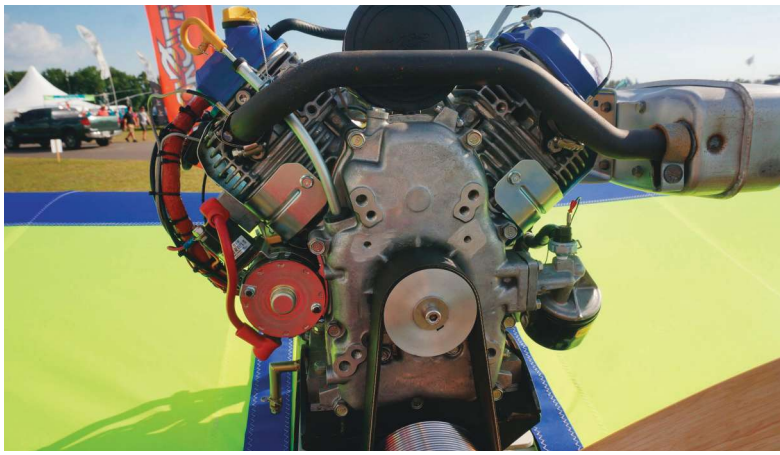
With 25 pounds of torque, the Hirth is also flying powered paragliders, single-seat trikes, and other FAR 103 ultralights. Dennis said they get more than 200 pounds of thrust from the F-33 with a 60-inch prop. The Aerolite 103 will climb 600 feet per minute (fpm) with this engine and cruise at 60 mph on 80-percent power.

This bird is not a slow "floater." It gets up and moves right along. The flaps must be rigged a few degrees downward (even with this small engine) to prevent the ultralight from exceeding the 63-mph speed limit for ultralights. Takeoffs are shortened about 30 feet with 15 degrees of flaps. Dennis (not a little guy) made plenty of takeoffs from the ultralight runway at AirVenture going uphill with this engine, and it flew well. To get a close-up view, please watch the video "Ride along in an Aerolite 103 at AirVenture."

Here is a tip from Dennis about vibration. He frequently equips the single-cylinder Hirth with the simple Balance Masters prop-balancing ring on the prop flange. It sometimes helps tame vibrations, but maybe only by 10 to 15 percent. On a hunch, he installed a similar, specially made offset balancing ring on the magneto end, under the recoil starter cover. He said the second ring dramatically reduced engine vibrations by maybe 50 percent. It was like turning a switch on and off, he said.

If the Hirth F-33 is not to your liking, U-Fly-It also offers the Kawasaki 340 and 440 engines, the Rotax 447 and 503, and other applicable Hirth models. The Aerolite 103 can meet legal ultralight weight with 32-hp twin-cylinder, inline, air-cooled Kawasaki 340, but most of the other engines will put it over the limit. A

The Aerolite 103 features robust aluminum tube-and-gusset construction in the landing gear area.



A four-cycle, V-twin Briggs & Stratton engine on the Aerolite 103, shown here at Sun 'n Fun, is now mounted under the wing, according to reports on the Aerolite Facebook page.

A view of the cockpit, control yoke, and the push-pull control cables.

couple of the N-numbered Aerolites in the U.S. registry are listed as having the 52-hp Rotax 503 engine. Weight is not a problem for them as design gross weight is 600 pounds.

FOUR-CYCLE V-TWIN POSSIBLE

At Sun 'n Fun 2014, Dennis displayed a modified four-cycle V-twin Briggs and Stratton engine, one of two that came with the purchase of the company. The original 22-hp engine is modified to run 4200 rpm and produce 32 hp. A German company has been building this conversion for at least 10 years for powered paragliders and light trikes. The engine is 19 pounds heavier than the Hirth F-33, coming in at 71 pounds with starter and reduction, not including prop and prop flange. Dennis reports the Aerolite 103 flies fine with the Briggs. He gets 190 pounds of thrust swinging a 60-inch prop. To make legal weight with the V-twin, the Aerolite must have nylon wheels, no wheelpants, and a few less options. The four-cycle Briggs engines are now being modified in the United States. An active motorsports community builds these engines for drag-racing garden tractors. The original top-wing engine mount seen at Sun 'n Fun 2014 has been replaced with a below-the-wing mounting with a lighter and more refined reduction drive.

The Aerolite 103 is now available in European Union countries as the Aerolite 120, so named because of the new 120-kilogram (264-pound) empty weight limit proposed in German regulations. Germany and the United Kingdom have implemented measures similar to our FAR 103. The slightly modified Aerolite 120 for the German market was displayed at AERO Friedrichshafen 2014. It will be manufactured here in the United States, with final assembly overseas. More details can be found in an April 12 report from AERO 2014 archived at www.ByDanJohnson.com.

The cost of a ready-to-fly, test-flown Aerolite 103 is $16,790 with electric flaps, electric start, four-point harness, two-blade wood prop, and full instrumentation. For more details about an ultralight that has just about everything you could want, go to www.UFlyIt.com. See Dennis Carley in this YouTube video interview at Sun 'n Fun 2013. The flying footage in that film is with designer Terry Raber flying the Aerolite at AirVenture. Get more Aerolite 103 pictures and the latest news on the Aerolite Facebook page.

Please send your comments and suggestions to dangrunloh2@gmail.com. EAA

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

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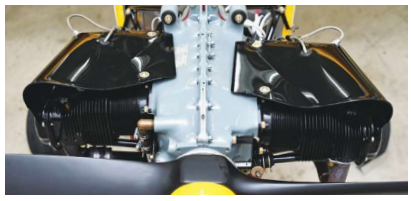

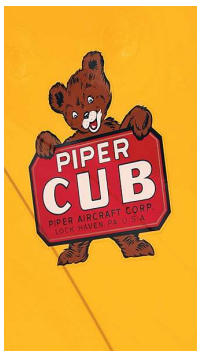

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Engines for Homebuilders on a Budget

A digital catalog

BY MURRY I. ROZANSKY

The 60-hp HKS 700E four-stroke engine has been quietly taking the place of two-strokes for a number of years. Although more expensive to buy, it is less expensive to own and operate.

LET'S LOOK AT THE current status of engines for homebuilders. Unfortunately, the pace of evolution in aircraft engine technology is glacial compared to that of avionics. The power of the tools for producing engines has increased greatly, but the economics of producing engines in small quantities is still much the same. It takes mass production to reduce costs. The entire market for new piston aircraft engines is estimated at about 2,000 or 3,000 a year. By contrast, Ferrari, the "Cadillac of Fiats," makes 7,000 cars and engines a year, and the major automakers make cars in the millions. Manufacturing aircraft engines is such a small and difficult business that we should be thankful there are companies that are willing to take the risks involved.

The freedom of experimenters to legally use just about any powerplant for their experimental aircraft helps to make affordable flying possible. The increasing expense of keeping certificated aircraft in service means that the supply of used Lycoming and Continental engines will remain robust. They are not inexpensive to overhaul and operate, but homebuilders have alternatives. Aviators are typically quite conservative. The majority will stick to Lycoming or Continental engines or the multitude of clones.

Continental Motorsnow has a full line of avgas and jet-fueled piston engines. www.ContinentalMotors.aero

Lycoming has a full line of avgas piston engines, including special engines for light-sport aircraft (LSA) and homebuilts. They are still kind of hiding their jet fuel engines from us. www.Lycoming.com

Superior Air Parts makes almost all kinds of FAA-approved replacement parts, so a Lycoming clone is a short step away. With the freedom of the experimental category, interesting combinations are possible. www.SuperiorAirParts.com

Titan also has gone down the clone road. Its R-Series engines feature a new, one-piece cylinder and head and other improved components to prove there is still life in the old flat engine configuration. www.TitanEngine.com

Somewhat lost but not forgotten are the well-regarded Franklin engines. www.Franklin-Engines.com/en/home, www.FranklinEngines.com

Although Menasco and Ranger engines are long gone, in-line, inverted, direct-drive, air-cooled aircraft engines are still made in the Czech Republic. www.PistoveMotory.cz/en, www.ParmaTechnik.cz/english

A new engine manufacturer will have a marketing advantage if it sticks with the established layout of light airplane engines—direct-drive, air-cooled, horizontally opposed engines.

Rotax's dominance of the 100-hp class came about because it is a better engine for the weight-critical LSA category than engines offered by Lycoming and Continental. Ly-Con was also very late addressing the LSA market. By developing a small, geared, high-speed liquid/air/oil-cooled engine, Rotax was able to reduce engine weight while swinging a large-diameter, efficient propeller, with reliability and a low noise footprint. There are still many pilots who have trouble accepting the Rotax approach even though it has achieved very competitive TBOs. You might recall some years back that Rotax developed and certified a liquid-cooled, geared V-6 of 250 to 300 hp but chose not to put it into production. I believe Rotax could not make a business case for selling a small number of engines at a price point competitive with existing Lycomings and Continentals. Toyota went a similar route with similar results. Porsche, anyone?

Rotax became the biggest piston aircraft engine manufacturer by starting with snowmobiles. It did not take a large investment to modify its snowmobile engines to power ultralights. Because Rotax worked at it, Rotax became the dominant manufacturer of two-stroke engines for ultralights. Rotax recognized the desire for four-stroke engines, and having experience in building four-strokes for other recreational products, it developed the 912/914 series of four-stroke engines that dominate their horsepower class (40,000 built). Being an Austrian manufacturer owned by a Canadian company, it has less liability exposure than an American company.

It is extremely hard to compete with the 90-plus-percent dominant manufacturer, but obviously a few companies are trying.

Jabiru from Australia has a flat-four, direct-drive engine of 85 hp, and a 120-hp flat-six, both air cooled. www.USJabiru.com, www.Jabiru.net.au

Photography courtesy of Green Sky Adventures

ULPower from Belgium also builds engines in a normal aircraft engine configuration but with many modern features as opposed to traditional manufacturers. Its engines range from 97 hp to 200 hp, also in air-cooled, flat-four and -six configurations. www.ULPower.net

We should note that the previous two engine lines get their good power-to-weight ratio in part by rating them at a higher rpm than Lycoming and Continental engines. That means to use that higher horsepower they have to run a smaller-diameter prop and thus lose some low-speed efficiency compared to the Lycoming, Continental, or the geared Rotax engines. You can't fool Mother Nature. The acceptance of the above engines is helped by their adherence to a conventional light plane engine configuration of flat, air cooled, and direct drive.

That statement also holds true for the most common of auto conversions, the VW air-cooled in one-half and four-cylinder versions and the Corvairs in six-cylinder and one-third versions. Another new contender in the cut-down engine arena is Pegasus Power with one-half of an O-200. It is a parts kit of specially made parts such as the crankcase, crankshaft, rods, and piston assemblies, using as many stock O-200 parts as possible to make a flat twin O-100 of between 50 to 60 hp. http://FlyPegasusPower.com/wp

Here's a list of websites featuring VW-based engines:
AeroVee www.AeroConversions.com
Great Plains www.GreatPlainsAS.com/index.html
Hummel Engines (Scott Casler) www.HummelEngines.com
Better Half VW www.BetterHalfVW.com/engine.htm
Revmaster http://RevmasterAviation.com

Motorav Aircraft Engines is a division of a Brazilian company that makes magnesium and bought VW's Brazilian magnesium foundry. It has developed a much-improved version of the VW with models up to 115. www.Motorav.com

Corvair-based options can be found from these sources:
William Wynne www.FlyCorvair.com
1/3 Ultra Vair www.Ultra-Vair.com

There are air-cooled, flat twin engines with propeller reduction units:

HKS from Japan has stopped producing engines for the aviation market, but some are still available. And more importantly, it is still supporting its 80-hp turbocharged flat twin engines. Their well-regarded 60-hp carbureted engine is still available. It is air/oil cooled with a gearbox reduction drive and comes in at about 120 pounds. www.HKS-Power.co.jp/hks_aviation, www.GreenSkyAdventures.com, www.QuickSilverNE.com

Verner Engines from the Czech Republic makes flat twins—air cooled, 80 hp, at only 60 pounds, and a 35-hp liquid-cooled flat twin engine. http://VernerMotor.eu

Flygas has modified what looks like a Citroen flat twin by the addition of a supercharger and a prop gearbox into a 70-hp, 12-pound airplane engine. www.Flygas.info/en/index.html

The Hexadyne P-60 is going to be reintroduced. It is also a 60-hp engine. www.HexatronEngineering.com/prod02.htm

William Wynne has educated people to the fact that they can make an O-200 class engine for a fraction of the cost. William's conversion package is based on the Corvair engine of the 1960s.

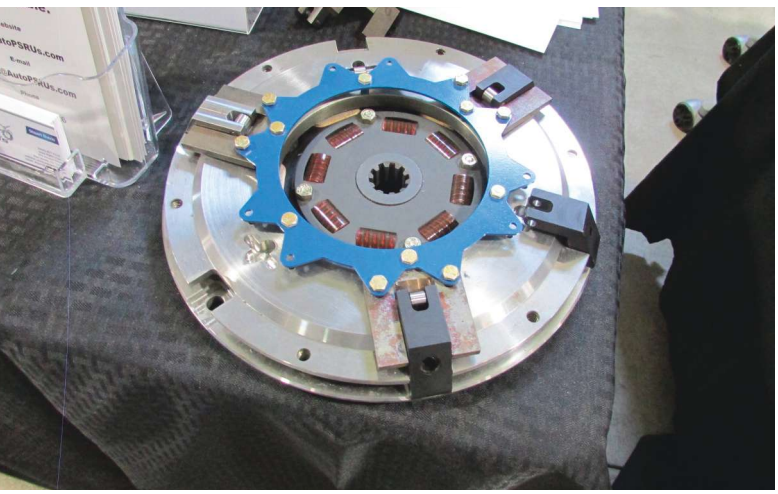
Pegasus Power has a kit of special parts to make a 60-hp, O-100 flat twin engine using O-200 cylinders and components. The custom crankshaft and lightweight rods and pistons make for a smooth-running engine as demonstrated at EAA AirVenture Oshkosh 2014 in the Utralight/Lightplane area.

AutoPSRU's offset up gearbox is quite compact and has a complete oil system, including an optional prop governor.

Photography courtesy of Murry Rozansky

Motorav has beefed up its VW-based engine components. The normal VW heads are considered to be under-finned; Motorav has addressed that as you can see.

Jet Beetle has some grown-up model jet engines, the largest of which can easily launch a sailplane or fly a light, single-seat aircraft. Like all small jet engines, these are fuel-hungry little beasts.



AutoPSRU's centrifugal clutch is a key element in avoiding resonance problems with its gearboxes.

As we look at engines somewhat more outside the conventional realm, the D-motor will be our first step on the wild side. It is a flat four from Belgium with the seemingly retrograde use of the flat head configuration that is no longer used even for lawnmower engines. Flat heads are more compact and lighter than the now universal overhead valve (OHV) heads, so more displacement can be put into a compact, lightweight, direct-drive package. They are also liquid cooled. A six-cylinder version is in the works. This one has potential, but being made in small numbers, is not inexpensive. www.D-motor.eu/nl/home-1.htm

Also harkening back to an earlier age are a number of radial engines:

The M14 series radials from Romania and Russia of 360 to 400 hp are available, although not likely at the bargain prices of the past. http://MotorstarNA.com, www.SteenAero.com/Products/engine_m14p.cfm, www.Yak-Aviation.com/index.php/engine

The Rotec radials of 110 and 150 hp come from Australia. It also makes liquid-cooled heads for the Jabiru engines. www.RotecRadialEngines.com/index.htm

Verner Engines from the Czech Republic also is making a line of radials from 25 to 150 hp. http://VernerMotor.eu

MWfly's engines from Italy start at 95 hp in direct-drive versions and higher in geared versions. They are flat four-cylinder engines with liquid cooling and SOHC heads. Some unique features are roller bearing cranks and a low-speed decompression device to eliminate gear rattle. MWfly is hunting for some of Rotax's market share. www.MWfly.it/index_file/homemwfy.htm

Another Rotax competitor on display, in mockup form, at EAA AirVenture Oshkosh 2014 was the Sodemo V-2, a motorcyclelike, liquid-cooled engine from France with all the modern bells and whistles. Whether it will have enough weight and/or cost advantage to compete remains to be seen. Availability is expected in the spring of 2016. www.Sodemo.com

DIESELS AND JETS

Before we search for more affordable engines for homebuilders, let's take a look at engines at the expensive end of the spectrum—diesels and jets. What they have in common is the ability to run on jet or diesel fuel. Hopefully the panic over the loss of 100LL has passed. A 100 NL is within sight in the United States. In other parts of the world, avgas is very expensive or not available, so turbines or diesels are needed. We all know of P&W Canada, Rolls-Royce, Walter-GE, and Williams engines. Even if found surplus at a reasonable price, their fuel burns are not affordable by most homebuilders.

There were two exhibitors of small turbine engines at EAA AirVenture Oshkosh 2014—PBS from the Czech Republic and JetBeetle from Taiwan. They both have 250-pound-thrust engines that weigh under 50 pounds, but they are fuel hogs; figure about 40 gallons/hour for takeoff power. The PBS TJ 100 is more than $50,000 and powers the SubSonex and some self-launching sailplanes. The JetBeetle H250 is about half the price. Both companies' engines would be great for launching sailplanes, where

Photography courtesy of Murry Rozansky

the engines are used for a short time each day. PBS also makes a 240-hp turboprop version of its engine that is flying in an RV-10—interesting. If you have to ask, you can't afford it. PBS—www.PBSVB.com/aircraft-engines, www.TurbineSolutionGroup.com; JetBeetle—http://JetBeetle.com, http://JetBeetleUSA.com

Here's a bit of Oshkosh lore. The seeds of the small aircraft diesel engine revolution were planted many years ago by Michael Zoche and family of Munich, Germany, by displaying its ever-evolving X-4 and eight-cylinder, air-cooled, two-stroke radials. The Zoches woke people up to the possibilities of aircraft diesels, which led to the GAP engine from Continental and indirectly to the Delta Hawk project. www.Zoche.de

Delta Hawk is a liquid-cooled V-4, direct-drive, two-stroke diesel of 180 hp and up. From Wisconsin, it is currently being test flown in Cirrus, and STCs are planned. Certification is expected in 2015. www.DeltaHawkEngines.com

Engineered Propulsion Systems, also from Wisconsin, has an engine being flight tested in a Cirrus, too. Starting at 350 hp, it is called a flat V-8 engine. It is liquid-cooled, geared, turbocharged, and four-stroke. www.EPS.aero

Safran SMA makes the very aircraftlike 230-hp, flat-four, air-cooled, four-stroke, turbo diesel and is testing a flat six of 350 to 400 hp. www.SMAengines.com/?lang=en

Continental, now Chinese owned, is covering its diesel bets by buying early SMA technology for a four-cylinder, air-cooled diesel and the Thielert/Centurion line of I-4, V-6, and V-8 cylinder, Mercedes-based, liquid-cooled diesels.

FlyEco has "Smart" diesel and gas engine conversions. www.FlyEco.net

In general, aircraft diesel engines are a bit heavier and more expensive than the gas engines they are intended to replace but with much lower fuel consumption of less expensive, more widely available fuels. Is diesel the future? For homebuilders, as more diesel cars become available in the United States, the choice of organ donors for auto engine conversions increases. It has already been done in Europe with great success.

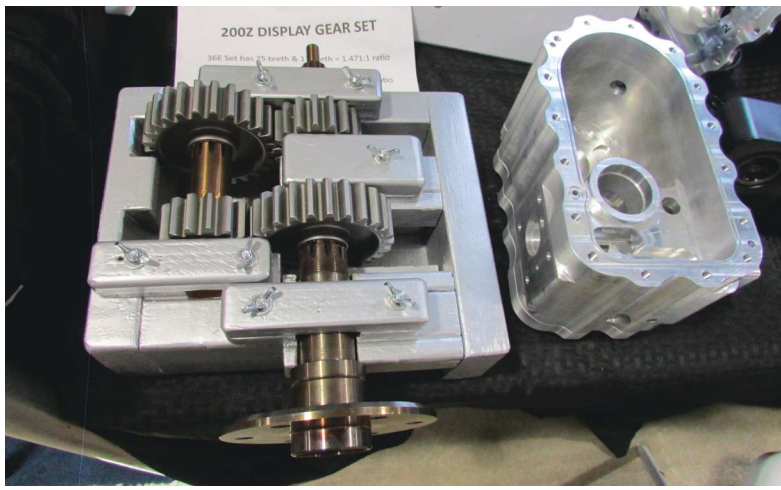
AUTO ENGINE CONVERSIONS

Engines based on high-volume production auto engines are less expensive than specially made aircraft engines. Let's look at some of the less aircraft-like engine conversions.

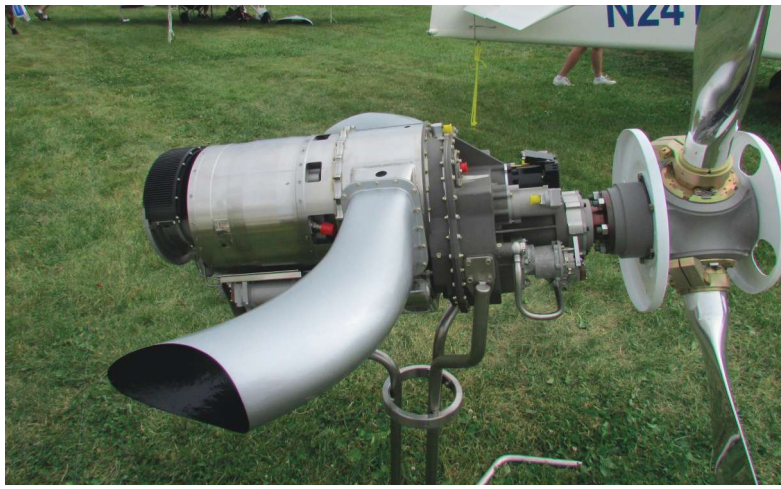
The Subaru flat fours and sixes are still popular choices for conversion, though I did not see any vendors at Oshkosh this past year.

There have been auto engine conversion vendors that have sold underdeveloped and undertested products. Two or more of the Subaru developers fall in that category. One of them has moved on to a Honda Fit conversion. Viking Engines is marketing an engine based on a Honda Fit engine turned on its side to better fit a normal flat engine cowl. www.VikingAircraftEngines.com

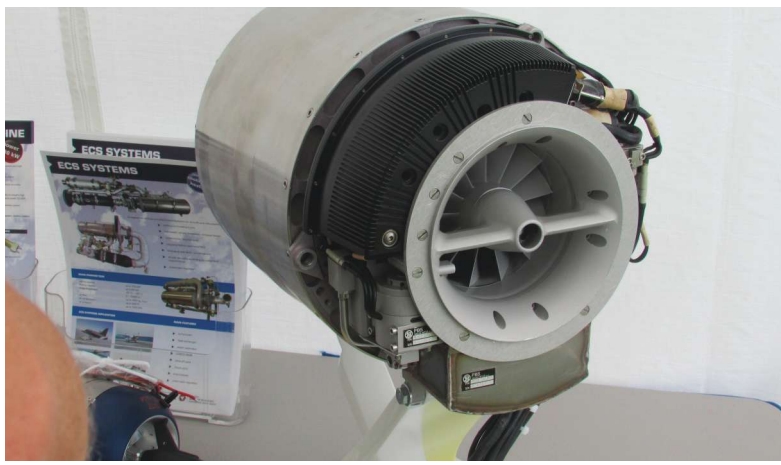
Raven Rotorcraft & Redrives has a 19-year history of three- and four-cylinder Suzuki engine conversions and is now developing an upright Honda Fit engine addition to its line. Raven successfully converted a four-cylinder Suzuki to a sidewinder, but it does not think it is a cost-effective choice for the Fit engine. Raven uses a



AutoPSRU's inline gearbox was developed to replace a troublesome unit from a defunct Subaru converter. It would also be useful for Mazda rotary engines and others that need a co-axle shaft, with non-reversing output.



This tiny, 240-hp turboprop from PBS is being tested in the RV-10 shown behind it. If you have the money for the engine and fuel, go for it.



The compact and lightweight PBS 240-pound thrust turbojet powers the Sonex Jet and some self-launching sailplanes. Homebuilt jets are not just for air show performers now that engines like this are available.

The Verner JCV 360 is a compact, liquid-cooled flat twin four-stroke engine of 35 hp and 60 pounds. It is successfully flying some single-place light aircraft such as powered parachutes.

UL Power has added modern features to its conventional light aircraft engine configuration, which will aid its acceptance as the engine proves its airworthiness.

toothed belt reduction with a proprietary "soft" coupling in the prop sprocket. Jeron Smith, Raven's principal, expressed a desire at AirVenture to find a buyer or partner to take over the engine part of his business so he can get back to working on his aircraft project, which is what got him into the engine business to begin with. www.Raven-Rotor.com

Aeromomentum Aircraft Engines is a new source for Suzuki engine conversions. It has a source for new engines that it has used for quite a while in the marine part of its business. The four-cylinder engines are available in upright and 70-degree slanted versions. Aeromomentum has its own custom gear reduction unit and a reflashed electronic fuel injection (EFI) computer. These engines are slightly heavier than the EFI 100-hp Rotax but at less than half the price. www.Aeromomentum.com/

Air Trikes supplies gearboxes and other components for Suzuki, Fit, BMW, and other engine conversions. www.AirTrikes.net/engines.shtml

Autoflight is a New Zealand company that makes gearboxes for Subaru and other engines. www.Autoflight.co.nz/reduction

Cam Drive auto engine conversions have been around for a while. http://Firewall.ca/index.html

Airflow Performance has been making mechanical fuel injection systems for experimental aircraft for a number of years. www.AirflowPerformance.com/html/site_html.html

Simple Digital System makes electronic fuel injection/ignition systems that are well suited to and used on experimental aircraft. Ross Farnam, the owner, thinks enough of his product to fly the SDS-equipped Subaru-powered RV that he built. There is much useful info on the website. www.SDSefi.com

Rotax, Hirth, Compact Radial, and Simonini gearboxes have also been adapted to other engines.

Where are the Wankel rotary engines? They are out flying and more are being built. Thanks to Mazda, there are rebuildable cores available, and they are some of the easiest, least expensive engines to rebuild. It is very much an experimenter's engine. The best single source of information is Paul Lamar's website. www.RotaryEng.net

Some of the aforementioned gearbox suppliers have reduction units for the Mazda Wankels. One of the pioneers of rotary conversions was Lou Ross. He developed a propeller speed reduction unit (PSRU) based on a planetary gear set from a Ford automatic transmission. After Lou passed away, it was improved and a new version was available from Tracy Crook, who has retired, again making the lightweight PSRU unavailable. Patrick Panzera, the former editor of *Experimenter* and publisher and editor of *Contact!* magazine, has stepped up to make the planetary PSRU available once more. If you have any interest in alternative aircraft engines, the best source of information is Pat's *Contact!* magazine. You can catch up with back issues and there are four volumes available of the best articles. www.ContactMagazine.com

Other rotary engines include:

Rotron, a small Wankel. www.RotronAero.com

Woelfle Rotary, a small Wankel derived from a kart racing engine. www.Woelfle-Engineering.com

Photography courtesy of Murry Rozansky

Dave Atkins may have more hours flying behind a rotary engine than anyone else. His company does not make PSRUs, but just about everything else rotary is available. www.AtkinsRotary.com

TWO-STROKE ENGINES

While we may go far afield, we should remind you that two-stroke engines are still available. In fact, a used two-stroke can be the least expensive power to fly. It is not possible to match a two-stroke engine's power-to-weight ratio at a reasonable cost, especially at the lower power end. The smaller Wankels can match the power-to-weight ratio but are pricey.

Polini makes some interesting two-stroke, single-cylinder engines. James Wiebe of Belite Aircraft had good things to say about this not-inexpensive Italian engine. www.Polini.com/en/page_719.html

Simonini, also from Italy, makes a line of two-stroke engines frequently used by powered paragliders. www.SimoniniUSA.com/?page=HomePage

Hirth from Germany makes a full line of two-strokes. www.Hirth-Motoren.de/en/home.html

Compact Radial Engine, based in British Columbia, is one of the few North American manufacturers of engines for light aircraft. Leon has a very interesting flat twin in the works. www.CompactRadialEngines.com/index.html

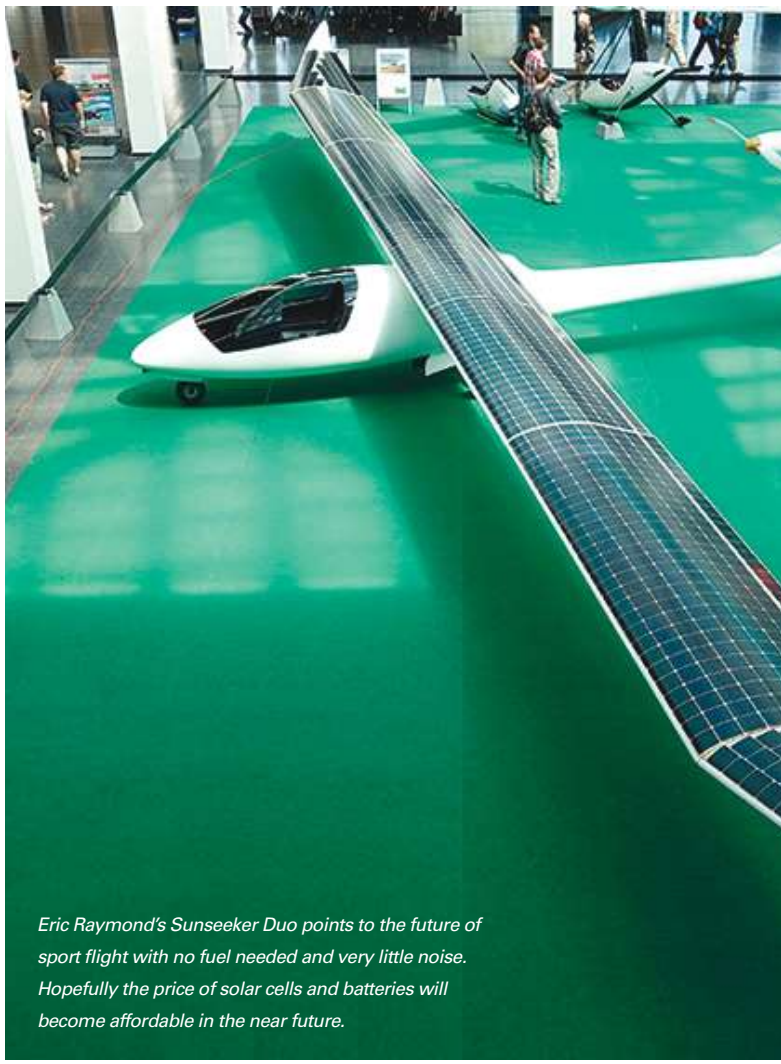
Rotax still makes the 582 two-stroke. I wonder if Rotax has tried direct fuel injection on the 582. www.FlyRotax.com/enginesImpressum/product-range.aspx

While it would be a hard sell to conservative aviators, a modern two-stroke engine is, I feel, the best technical choice for light planes needing 100 hp and below. The key features necessary would be computer-controlled, direct-in-cylinder fuel injection, and liquid cooling. These technologies are used on two-stroke engines for snowmobiles and outboards. They are also used for some unmanned aerial vehicle (UAV) engines, in part to enable them to use heavy fuels, but have not appeared on any two-strokes for sport aviation use. Rotax and Hirth have the technology, but as of yet, have not made it available for us.

Hirth has almost the perfect engines for direct fuel injection. Their 80- and 100-hp, liquid-cooled, in-line three-cylinder engines would be ideal for conversion to direct injection. The three-cylinder, two-stroke engine can produce good power with a more compact exhaust system than other two-stroke engine configurations. Such engines would be lighter than the Rotax four-strokes, more compact, less expensive, and potentially, with lower fuel consumption. Lycoming has a similar heavy-fuel two-stroke for UAV use. You'd have to ask Lycoming if a gasoline version could be sold at a reasonable price.

At the low end of the power spectrum are engines designed for the backpack-mounted power packages for paragliders. From about 15 hp, they can range to more than 30 hp and have to be lightweight and compact, so they are normally single-cylinder, air-cooled two-strokes. There are a few liquid-cooled flat twins or four-strokes. There are some very nice single-seat aircraft from Europe that will fly quite well on about 25 to 35 hp.

The 350- to 400-hp plus EPS Diesel is the wave of the future for the heavier end of light planes. It is only a bit heavier and more expensive than a gas engine, but it has a much lower fuel burn of a less expensive fuel. Comparable turboprops are lighter, much more expensive, and use twice the fuel.



Eric Raymond's Sunseeker Duo points to the future of sport flight with no fuel needed and very little noise. Hopefully the price of solar cells and batteries will become affordable in the near future.

Some people will not fly with a two-stroke engine because it is not felt to be as reliable as a four-stroke, and/or they do not like how it sounds. The half VW and 1/3 Corvair engines mentioned earlier are established choices. There has been work done, mostly by the floppy wing fliers and some fixed-wing designers such as Leeon Davis for his DA-11, to convert industrial engines to power their flying machines. The websites www.SDplanes.com/new and http://Luciole.co.uk/index.html have some "real" aircraft examples. The goal is to have enough power to fly well with an engine that burns less than 2 gallons an hour, weighs less than 100 pounds, and costs well under $5,000 ready to fly. This is a development that deserves more attention.

Valley Engineering is one example. www.CulverProps.com/Engines.html

Solo Flight's package is based on a 627-cc Briggs & Stratton engine. www.SoloFlightLtd.com/SOLO%20ENGINE.html

Leeon Davis' "Mower Power to the People" DA-11 is shown at this link. www.YouTube.com/watch?v=HpDgeNcQWh0

ELECTRIC AND HYBRID POWER

There are interesting developments happening with electric and hybrid electric power. One company to watch is Pipistrel. www.Pipistrel-USA.com/index.html, www.Pipistrel.si

We will have more to report after the Electric Aircraft Symposium IX this coming spring. http://CafeFoundation.org/v2/ea_eas_2014_main.php

V-6S AND MORE

At the opposite end of the homebuilding spectrum are the bigger automotive-based conversions. Many V-6 engines are more than 300 hp, but the engines with real star potential are the LS series from GM. The LS 3 is available as a crate engine of 430 hp for $6,500. It is not quite ready to run as it needs an ECU and some accessories, and to turn a prop, a reduction unit of some kind. The volume of such conversions is so small that they are virtually custom built.

Jack Kane's website is a great place to start if you are interested in high-power auto conversions as there is a wealth of information there. www.EPI-Eng.com

Stewart Davis is carrying on Bud Warren's gear drive development. He has an in-line compound reduction box for Subaru and others and an offset up gearbox for V-8s. They feature a centrifugal clutch to avoid torsional resonance. www.AutoPSRUs.com

Robinson made quite a splash at Oshkosh a few years back with a polished, air-conditioned Seabee with LS V-8 power. Its PSRU is the only one I know that is currently available using Morse Hy-Vo internal-toothed chain pioneered by the late Fred Geschwender. Robinson offers complete engine packages. www.V8Seabee.com

Guy Marcotte has developed gearboxes similar to that used on the early Allison V-1710. They have a pinion meshing with an internally toothed ring gear. That makes for a compact, lightweight gearbox with only two gears, and it has the engine and prop turning in the same direction. The small offset between the input and prop shafts make it especially suitable for rotary and Subaru conversions. www.GlasairProject.com/Marcotte/Page2.html

Ben Haas has a successful Zenair 801 conversion and will help others interested in doing auto conversions. www.HaasPowerAir.com/Home.html

Jess Myers is one of the pioneers of toothed belt drives. www.BeltedAir.com

Richard Finch's book on auto engine conversions, *Converting AutoEngines for Experimental Aircraft*, is out of print but is available. It is worth having. Used copies are available on Amazon.com.

Toothed belt drives have proven to work well, although they get quite large when used on higher horsepower applications. Poly-V belts are used at the lower end of the horsepower spectrum and are even more suitable for an amateur to construct.

Aircraft engines have gotten too expensive for airboat use, and auto engine conversions have taken over. An example is found at www.CenturyDriveSystemsInc.com. Airboat drives may be on the heavy side for aircraft use. http://WhirlwindPropellers.com/airboats

This is just a taste of the fascinating subject of aircraft engine options. Auto engine conversions display the "time versus money trade-off." If you expect someone to provide a developed package, it is likely to cost as much as a "real" aircraft engine. If you know or are willing to learn about engines, low-cost powerplants can be made by taking advantage of mass-produced core engines.

After many years of reporting on this subject, I tell people this: "If you want to fly, put in the aircraft engine that the designer intended for your airplane. If you are still interested in an alternative engine, make a test stand and develop your new engine, and when the weather permits, go fly your airplane with that engine. When you are happy after running the hell out of your new engine on the ground, you can sell your old aircraft engine and recover a good portion of your costs. Then put your new engine on your aircraft. Developing an engine conversion is a big project; ask Jeron Smith and the other developers. Building an aircraft is a big project. Do you have time for two?" If you really want to, go for it. You will learn a lot. That is what experimental is about.

Because of EAA, I was able to meet William Besler at Oshkosh. Bill, a longtime EAAer, had designed, built, and had flown the only documented successful steam-powered, man-carrying airplane in 1933. I told him that someday I would like to build the second successful steam-powered airplane. He replied, "Well, good for you." That is a challenge. That is the Experimental Aircraft Association. www.YouTube.com/watch?v=yvQsvfa2N_c

In 2015, the homebuilder has more choices of powerplants than ever: from ones you can strap to your back, up to fire-breathing turbo V-8s for Sport Class racers to outrun Unlimiteds; jets; and almost silent electrics. If you can't find an engine you like, you can always fly gliders. www.SSA.org, www.ESoaring.com EAA

Murry I. Rozansky, EAA 48039 Lifetime, is president of the Experimental Soaring Association.

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Fuel Drains

Keeping your fuel lines clean

BY RICHARD KOEHLER

FUEL DRAIN VALVES ARE essential to your fuel system to remove debris and water from the low point(s) in your fuel system. There are many different types of drain valves you can install, but most of the different brands have equivalent types made by the Curtis Superior Valve Company. Perhaps the most common is the Curtis CCA-1550 valve, which is used in most gascolators and the wing tanks on many Piper aircraft. The valve is made from brass and has a 1/8-inch new pipe thread (NPT), which is a tapered thread designed to jam for a tight, leakless seal. The valve is opened by pushing up and gently rotating the crossbar. It can be locked open with a quarter turn. The internal seal looks like an O-ring but actually has a P shape. In the past, mechanics would substitute a small O-ring (AN6227B-1), but that is not good maintenance.

If the valve is leaking, it is most likely due to a bit of debris stuck in the seal. A piece of grass, metal filing, or even a human hair can allow the valve to seep fuel. One approach that sometimes works is to open the valve wide open and drain a lot of fuel, such as a pint or more, and hope the debris will be flushed out. A variation on this step is to open the valve and put a blast of air from your compressor inside the valve, momentarily reversing the direction of flow and hopefully dislodging the debris. Be sure to remove your fuel cap to allow the pressure surge to escape easily. Fuel tanks can be burst with a relatively low pressure increase of only a few pounds per square inch (psi). If the debris is in the drain in a gascolator, disassemble the gascolator and get to the valve from the inside.

If all attempts to clear a leaking valve fail, today you only have one option—replace the valve. An FAA ruling a

HINTS FOR HOMEBUILDERS VIDEOS

HERE ARE SOME OF THE LATEST HINTS FOR HOMEBUILDERS ADDED TO THE MORE THAN 450 HINTS CURRENTLY AVAILABLE HERE:

Removing Damaged Fuel Drains
Dick Koehler demonstrates a simple method to remove damaged fuel drain valves.

Carburetor Heat Operation
Dick Koehler describes how traditional carburetor heat valve systems work, including maintenance and repairs.

Knife Trimming Composites
EAA Technical Counselor Mike Busch demonstrates how to trim a layup while in the green state not fully cured.

Removal of Stainless Steel Pulled Rivet
Brian Carpenter from Rainbow Aviation Services demonstrates a technique to remove a stainless steel pulled rivet

Photography courtesy of Richard Koehler

few years ago determined that the valves cannot be overhauled, meaning that you cannot replace the seal in the field. In fact, you cannot legally use the O-ring, and the original seals are no longer sold on the open market. You may find one at a fly market, but again, per the FAA it is not legal to install it. Your only option is to replace the entire valve. The good news is that the valves are relatively inexpensive and readily available from most aviation supply houses. The most recent Aircraft Spruce & Specialty price on the above-mentioned CCA-1550 is $12.50, so just buy a new one.

Another reason you may want to replace the valve is due to age. A 10-year limit on the seal is established by the manufacturer.

The biggest problem you will probably have is removal of the old valve. Remember that the valve was screwed in to a jam condition using the NPT tapered threads. It should have been put in with a thread sealant, preferably Teflon based, but it probably wasn't; and now you have to break it loose. Also remember that the body is soft brass. If you simply use an open-end wrench, or worse yet, an adjustable wrench, the chances are that the flats on the brass body of the valve will give way prior to the valve rotating. You then are faced with using channel-locks or vise grips and pretty much destroying the valve to get it out.

A much easier approach is to cut off the protruding crossbar ears and use a deep socket or slip on a box-end wrench. (See photo.) The best removal tool is a deep six-point socket. It will easily remove the valve. The crossbar ears can be cut off easily with a fine hacksaw, razor saw (available at hobby shops), or (carefully) with a cutting wheel on a Dremel-type tool.

Install the new valve with appropriate thread sealant and do not overtorque. A good technique is to lightly torque the valve in place and then put in fuel. If there is a leak around the threads, continue torquing just until the leak stops. Do not overtorque. Fittings can be cracked, which leads to a much more complicated repair.

If you fly a plane that has this type of valve, you may want to keep a spare in stock, just in case. It is cheap insurance against losing a tank of avgas at today's prices.

I hope this discussion helps you with building and maintaining your bird. EAA

Richard "Dick" Koehler, EAA 161427, is an active pilot, A&P mechanic with inspection authorization (IA), an instructor for the EAA SportAir Workshops, and EAA technical counselor for EAA Chapter 186.

Getting Started in the Sport of Powered Parachuting

Approaching with due diligence

BY DOUG MAAS

SO YOU HAVE BEEN bit by the flying bug! Flying may have been a lifelong dream or a midlife goal. Or you may have had a past flying experience and now decided that flying low and slow in a powered parachute is exactly what you need.

You may have taken some preliminary steps to investigate what it takes to get seriously involved in the sport. You have found that manufacturers seem more than anxious to sell you an aircraft. You may have scanned the Internet and found dozens of seemingly great deals on used aircraft. And you may have been told by somebody that learning to fly a powered parachute is a piece of cake. Now what?

I can tell you from my experience of observing many prospective powered parachute pilots that some jump right in and live to regret their impulsive decision for a variety of reasons. I also know dozens of would-be pilots who spent years overanalyzing and never made the decision to take a step forward. We offer this simple checklist of issues as a way of prompting you to investigate with due diligence and then get on with fulfilling your dream. Here is a summary of the primary questions you should ask before you make an investment of time, money, and other resources:

- What type of flying are you most interested in?
- Would you prefer to fly a simple, single-seat aircraft, or do you envision carrying passengers?
- What is involved in learning to fly?
- Do you want to purchase a new aircraft or a used aircraft?
- Are you a builder, or do you mainly want to just fly?
- What other expenses are involved in owning a powered parachute?
- Do you have support available, including instructors, flight examiners, qualified maintenance personnel, and factory resources?
- Do you have places to fly and people to fly with?

Let's take these issues one at a time.

WHAT TYPE OF FLYING ARE YOU MOST INTERESTED IN?

We'll stay focused on light-sport aviation and ultralights, assuming you may have already checked out the costs and requirements to fly a general aviation (GA) aircraft and earn a private pilot rating or higher. But within the light-sport world, there is a variety of great ways to fly. These include powered parachutes, airplanes, weight shift trikes, gyrocopters, and even balloons. The powered parachute is a good choice for those who don't mind traveling at only 30 mph and wandering not more than about 75 miles on a typical local flight. And the powered parachute remains one of the safer ways to fly since it is not a three-axis aircraft and therefore is resistant to stalls, rolls, loops, and other maneuvers that might be possible in an airplane. The powered parachute is easier to learn to fly because of these characteristics. The powered parachute is a fair weather aircraft, and we generally don't fly in winds greater than 15 mph. If you want to fly farther, faster, or in a wider

range of weather conditions and don't mind the additional hours required to train, then the powered parachute might not be for you.

WOULD YOU PREFER TO FLY A SIMPLE, SINGLE-SEAT AIRCRAFT, OR DO YOU ENVISION CARRYING PASSENGERS?

Answering this question is not as easy as it seems. Nearly all prospective powered parachute pilots that I meet are convinced that they need a two-seat aircraft because they will certainly be flying their spouses, children, and friends. And nearly all powered parachute pilots learn that not everyone is quite as enthusiastic as they are to launch into the atmosphere and indeed spend 90 percent of their flight time alone in their two-seaters.

The real decision here has more to do with costs and training. If you purchase what is termed a true FAR 103 ultralight powered parachute, you avoid a good deal of the complications. FAR 103 refers to the federal aviation regulation (FAR) that defines an ultralight powered parachute as a vehicle weighing no more than 254 pounds without pilot, having only one seat and having no more than 5 gallons of gas capacity. If the powered parachute you purchase meets these criteria, then the FAA says that there are no age requirements, no training requirements, and no medical, and the operating rules and regulations are quite simple. We'll talk more later in this article about training. Nonetheless the ultralight is cheaper to purchase, cheaper to learn to fly, and cheaper to maintain.

If you decide to purchase a two-seat powered parachute, then you need to learn the legal requirements for aircraft certification with the FAA (not required with ultralights) and the training certification requirements for earning a sport pilot certificate.

WHAT IS INVOLVED IN LEARNING TO FLY?

As previously reported, legally there is *no* training requirement whatsoever if you purchase a legal FAR 103 ultralight powered parachute. And you will find manufacturers and individuals who will sell you one without being a bit more truthful. While there are many who have taught themselves and lived to talk about it, these are often the folks who indeed end up crashing early and often. If you connect with a reputable, experienced powered parachute flight instructor, you will always learn that you should enroll in at least an abbreviated training course. The Western Sport Pilot Association, as an example, offers a seven-lesson ultralight-pilot course at a reasonable cost. This course is often covered over a three-day period, and at the end of the course, you will be competent and feel proficient—and be able to fly safely for a lifetime!

If you have headed down the path to a two-seat powered parachute, then you may start with the solo course that leads to a student pilot certificate. That will allow you to fly your two-seater legally until you complete the requirements for the sport pilot certificate. That certificate requires a minimum of 12 hours of flying, two solo flights, and 10 hours dual flight instruction (in the air with the instructor in a powered parachute equipped with fully functioning dual controls). All of this training must be accomplished by an FAA certificated flight instructor who is rated in powered parachutes.

Once you complete the flight time requirements, you will be required to take an FAA written examination, followed by an FAA Practical Test that consists of oral questioning and an in-flight examination conducted by an FAA designated pilot examiner. This may sound daunting, but if you connect with the right organization and instructors, you will find the experience more painless than it initially sounds and totally satisfying in the end with the earning of an FAA sport pilot certificate.

Cost needs to be a part of your decision here, too. Solo training courses in an ultralight usually range from $750 to nearly $2,000, depending on many factors, including whose aircraft you train in, the speed of training, and the method of ground school. Achieving a sport pilot certificate is an investment ranging from $1,500 to over $4,000, again dependent on many factors. Some manufacturers package sales of their aircraft with sizable discounts on the training program that goes with it.

DO YOU WANT TO PURCHASE A NEW AIRCRAFT OR A USED AIRCRAFT?

The first step in this decision is to make sure that you are purchasing a *legal* aircraft! There are some manufacturers and a lot of individuals who will sell you an aircraft without explaining the legal requirements. One set of requirements is the previously mentioned specifications to meet FAR 103's definition of an ultralight. It is not difficult to find what appear to be some great deals on single-seat powered parachutes that, in fact, do not meet the specifications and are therefore not legal unless issued an airworthiness certificate and registered with an N-number issued by the FAA. And these single-seat aircraft would then require the pilot to have an FAA or sport pilot certificate to operate them legally.

The next step of legal requirements relates to two-seaters. These are considered light-sport aircraft, must be issued an N-number by the FAA, and must have a valid airworthiness certificate in addition to a few other registration and paperwork requirements. Again, if you are searching the Internet or, sadly, even talking with some manufacturers, you may never hear a discussion about these certification requirements.

Once you have focused on acquisition of a legal powered parachute, then the new or used question can be considered. There are a lot of very good deals on the used market for legal single- and two-seat aircraft. We would always recommend that you purchase a used aircraft only when you are dealing with a reputable organization or seller, when the history of the aircraft is known, and when the maintenance and condition of the aircraft can be proven. Even with all of these issues satisfied, you know that you will be investing in an aircraft that likely has no warranty remaining. The other issue is to consider whether the original manufacturer of the aircraft is still in business and there-

fore able to provide ongoing parts and other support. You will learn that there are very few powered parachute manufacturers still open for business.

A new powered parachute, while carrying a healthy price tag, will usually come with warranties on all components, including the airframe, the engine, electronics, and the canopy. You will learn in your investigation that new aircraft that are being sold by reputable manufacturers are all usually in about the same price range. All powered parachute manufacturers that sell legal light-sport powered parachutes use the same engines, the same electronics, and the same canopies. The differences are usually found in design differences of the airframe.

Purchasing new should only be done when you know that the manufacturer is approved by the FAA to build and distribute legal light-sport aircraft. While years ago there were nearly 40 powered parachute manufacturers, today there are only about half a dozen that have invested in and earned the approval of the FAA.

Another slightly more complex decision is to purchase an experimental light-sport aircraft (E-LSA) or a special light-sport aircraft (S-LSA). Essentially the aircraft are the same, and this is a question of FAA certification method. The primary difference in these categories is that the S-LSA is fully assembled, prepared, test flown, and certificated by the FAA before it leaves the factory. That typically comes with a higher cost associated with it due to assembly and paperwork required by the FAA. S-LSA are required to conduct sport pilot training, so if you are an instructor or have any intention of instructing, this is the direction you need to go. If you are an individual owner, you can legally be trained in your E-LSA, if it is equipped with fully functioning dual controls. If you own an S-LSA, the maintenance requirements are more stringent and expensive as all repairs and serious maintenance must be done by a certificated repairman. If you own an E-LSA powered parachute, you the owner are allowed to do all maintenance and even repairs.

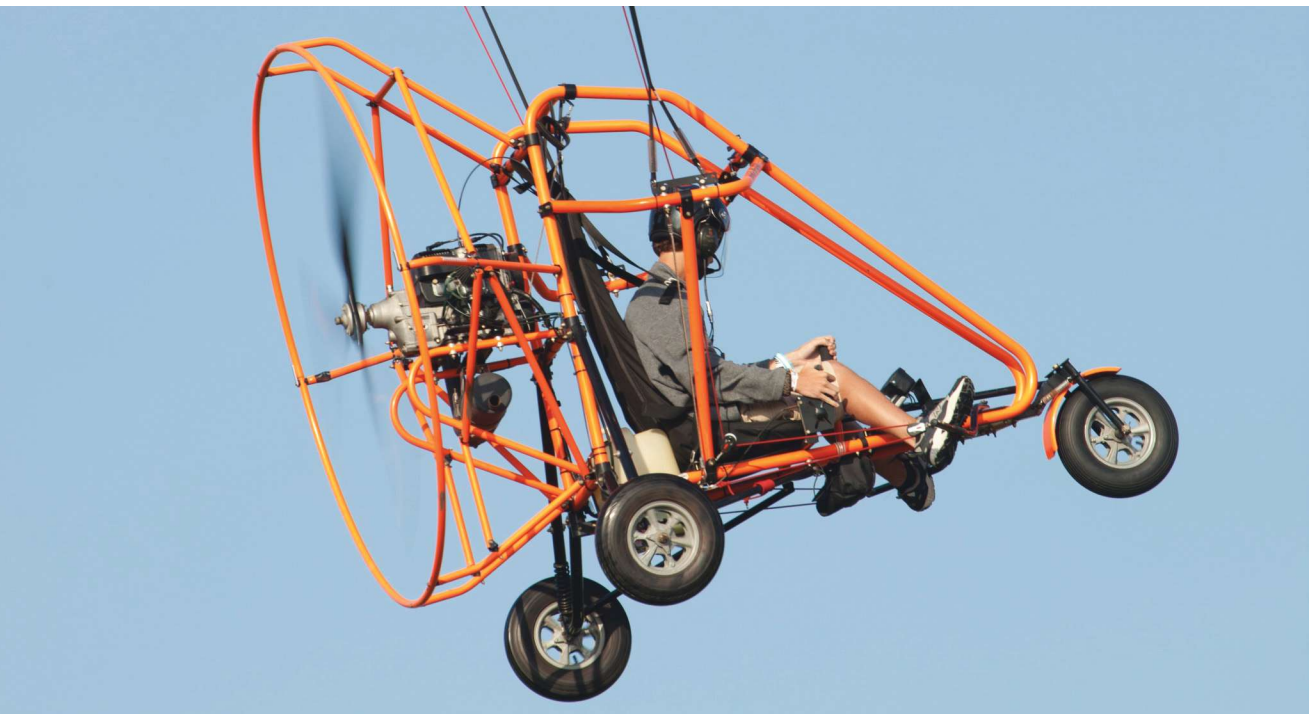
ARE YOU A BUILDER, OR DO YOU MAINLY JUST WANT TO FLY?

If you enjoy the prospect of building your own powered parachute from an FAA-approved kit, you can save thousands of dollars. But if you decide to build from a kit, you need to find out from the manufacturer how complicated it will be, what skills and what tools are required, and what the average build time is. Then you need to be realistic about your ability and patience to build from a kit.

There is quite a variety in the kits offered by various manufacturers. These “kits” can range from nearly fully assembled E-LSA kits to nothing assembled amateur-built eligible kits. If you lean toward building from a kit, be sure that you spend considerable time researching this option and asking the right questions of the company you are looking to purchase from.

WHAT OTHER EXPENSES ARE INVOLVED IN OWNING A POWERED PARACHUTE?

There are a lot of very cool products out there to supplement your flying experience, and many owners spend literally thousands, customizing and equipping their aircraft and themselves. But there are a few basics that are definite considerations. These include:



Transport. Most powered parachute pilots trailer their aircraft from field to field much like trailering a boat to various lakes. Basic transport can be with a simple utility trailer; however, you need to be careful to learn the footprint of the aircraft you will buy. Most require slightly oversized, non-standard trailers. If you envision traveling far to attend events or just to enjoy flying in various areas of the country, then a covered trailer is nearly mandatory. A covered trailer protects your investment and becomes your portable hangar. Again, be careful to consider the size of the trailer required for your particular aircraft.

Training. This was discussed earlier, so be sure and consider this as a primary cost of acquiring an aircraft. If you fly a two-seat powered parachute, you will also need to anticipate a flight review every two years with a certificated flight instructor. Flight reviews usually range from $150 to $400 and require a minimum of one hour of ground and one hour of flight training. The flight review is designed to keep you safe, legal, and proficient.

Helmets and intercom. Some pilots fly without helmets, but you will find that our pilot culture encourages helmets as basic safety equipment. The helmets and intercom systems used for light sport are really quite specialized and available from only a couple of reputable vendors.

Radio. If you will always fly alone and never with another powered parachute in the sky with you, and in remote areas away from airports and more complicated airspace, you might not need a radio. Most of the powered parachute pilots we equip and train purchase a simple handheld VHF aviation radio that is compatible with the helmet and intercom system.

Maintenance. The typical powered parachute pilot carries a nice small set of personal tools so that he can conduct routine in-the-field maintenance. There is also an annual inspection of condition required for FAA-certificated light-sport aircraft. If this inspection is completed by a qualified repairman, expect to pay an average of $400 a year. An owner also can take a 16-hour repairman course that earns him a certificate and privilege to conduct his own annual inspection. The cost of that course is about the same as an annual inspection and thus a very good investment of time and effort.

Registration and taxes. This is a final area that you need to investigate and is specific to your state requirements. There is a cost associated with the first-time inspection and issuance of an airworthiness certificate, but this is quite often included in the pricing of new aircraft or already done if you purchase used. The FAA now requires re-registration every few years, but that is only a $5 process. States vary, but most require that FAA-certificated aircraft be registered with the state aviation authority, and thus another fee. And this registration is usually shared with the state department of revenue, thus the need to check on sales tax requirements.

DO YOU HAVE SUPPORT AVAILABLE, INCLUDING INSTRUCTORS, FLIGHT EXAMINERS, QUALIFIED MAINTENANCE PERSONNEL, AND FACTORY RESOURCES?

As you conduct your due diligence in the areas detailed above, you will soon discover whether or not the support resources are available. Unfortunately there are many areas of the country where these are far and few between. If you will be earning a sport pilot certificate and your nearest instructor is a thousand miles away, you need to anticipate the logistics and costs

involved, not only in the training but also the travel to get there. The same issue needs to be considered in each of the other areas. Who will be available to conduct your flight test? Where will you be able to take your aircraft for maintenance and service? And if you need parts and factory support, how available is that?

DO YOU HAVE PLACES TO FLY AND PEOPLE TO FLY WITH?

Some could get through this entire list of issues and satisfy them all but discover in the end that there really isn't a practical place to fly your powered parachute. And if you are a social person at all, you may discover that you are indeed all by yourself in a wilderness with no other participants to share the sport with.

If you are in an urban area with only general aviation airports available, you will need to learn from an instructor and perhaps the airport managers whether you will be able to operate safely from the airport and within the more complicated airspace that surrounds many cities. Most powered parachute pilots operate either from smaller, more rural airports or from open private fields.

EAA has a network of clubs called chapters across the United States. Many of these chapters are focused on ultralights or light-sport. And this may be a great place to start by meeting others and learning about where they fly locally. Of course, if you are located in the more rural areas that comprise most of America, you are likely to find more flying locations than you will be able to explore in a lifetime!

THE END OR THE BEGINNING?

This article can make entry into the sport seem daunting. But the other perspective is to understand that any of life's great adventures worth the undertaking require time, resources, and learning as suggested above. It doesn't matter whether it is rock climbing, water skiing, or recreational flying. All come with requirements and effort. The real question is how badly you desire the achievement.

This article has been offered to help you move forward toward the achievement of becoming a powered parachute pilot with a full understanding of what is involved. Taking the time to conduct the level of due diligence suggested in this article will help to save you money, save you time, and most of all, give you some level of guarantee of success and enjoyment. EAA

Doug Maas is an FAA flight instructor and designated flight examiner. He is also president of the Western Sport Pilot Association LLC (*www.wppa.org*), co-owner of Six Chuter International LLC Powered Parachutes, and an executive board member of EAA Ultralight Chapter 127.

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