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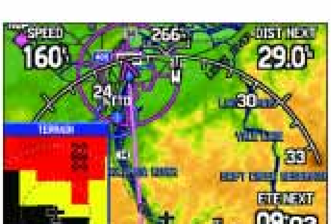

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On the cover: Brian Raeder's dream of building an award-winning Sky Raider became a reality last year when he was honored at Oshkosh AirVenture with the Grand Champion award. Read about his triumph—and what led up to it—on Page 8. Photo by Jim Raeder.

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BY BRIAN E. CLARK

Light-sport aircraft? Not quite yet.

If you've been following the developments in the pending Sport-Planes™/light-sport aircraft (LSA) proposal, you probably know by now that the FAA retracted the rule from the Office of Management and Budget (OMB) in the last week of March. As the 90-day deadline approached for the OMB to approve the rule, questions surfaced regarding the FAA's cost-benefit analysis. Rather than risk an outright rejection, the FAA pulled the rule to address the specific concerns.

In my opinion, there are two ways we can look at this. As an optimist, I'd like to think that the OMB's questions will quickly be answered, and the rule will get back on track for an imminent final approval. But the pessimist in me makes me want to throw my hands in the air, exhale and shout "*Again*!"

The initial notice of proposed rulemaking (NPRM) was unveiled in January 2002—more than two years ago. Initial speculation was that the rule would be announced at Oshkosh 2003, but the FAA was just getting its final rule to the Department of Transportation (DOT), the first of the two organizations to review the proposal, at that point. Next, we thought we'd see a rule by spring 2004. The March delay knocked that out of the picture.

Are these delays unreasonable? Probably not. I understand full well that no governing agency wants to rush into a proposal like this one without the proper amount of preparation and consideration for the consequences that could arise. The point I'd really like to illustrate is—*Stop Waiting*! Why?

First of all, there's no guarantee that the rule will *ever* pass! We certainly expect that it will, but I wouldn't be shocked out of my mind if the news came down that the rule had been abandoned.

Second, we don't know when it will pass, assuming that it does. Currently, the rumor mill has it that a final rule could be issued by summer 2004, but who's to say if that will really happen?

Third, implementation of the rule is going to be a bear, and its ramifications are too numerous to count. KITPLANES® Magazine, EAA, AOPA and other industry groups have already begun preparing for the new rule, and they're all likely to do an admirable job of assisting pilots with the transition. But it won't be seamless.

Finally—there's no reason to wait. We've got two great types of aircraft—ultralight and amateur-built Experimental—that are not going to change an ounce. The list of available 51%-legal aircraft kits grows everyday. If you build one that meets the approximate specifications of light-sport aircraft, then you may be able to fly it under LSA regulations anyway.

And what about ultralights? You don't need *any* license to fly an ultralight, nor is a medical certificate required. I can think of plenty of ultralights that I'd be happy to find parked in my hangar.

I don't intend for this column to be a knock on the light-sport category. It could mean all the things that we hope it does—more people in aviation, easier requirements for licensing and new aircraft available. If all those things prove true, I'll be the first one to take advantage of some of the benefits the rule produces. But I've tried to temper my enthusiasm and maintain a realistic, objective outlook on the pending regulation.

The bottom line? LSA is not here yet. Don't pin all your hopes on a rule that doesn't yet exist. The 20 years this magazine has been around have seen an innumerable list of innovative, exciting, custom-built aircraft take to the skies. You don't have to wait for a new rule to make one of those aircraft yours.

Now get to work on building that Grand Champion.

Speaking of Grand Champions...

"Engine Beat" editor John Larsen recently got the chance to visit with Brian Raeder, builder of the cover-pictured Sky Raider. Larsen's article on Raeder's airplane helps illustrate the time and effort required to build an award-winning aircraft.

Now we know that most homebuilders don't build airplanes solely to win awards—instead, it's the quality of aircraft that matters more. After all, an award doesn't take up too much space above your fireplace; an airplane, on the other hand, requires time, money and space just to maintain, even once it's been built. You've got to really want to build that thing to be successful.

But we thought that some thoughts from a Grand Champion builder might help some of you who are shooting for the stars.

In some cases, it's not the skill level that makes the difference, but the time devoted. Raeder put 2600 hours into his aircraft. You want to follow in his footsteps? Check Larsen's article for some advice.

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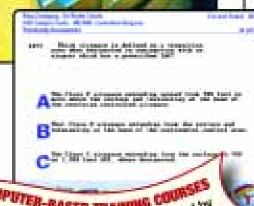

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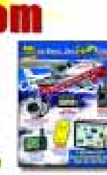

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The Case of the Missing Captions

I really like your magazine and look forward to reading it every month. I always flip to the cartoons first—Robrucha always makes me laugh.

Could you please tell me what the captions would have been on pages 66-77? They didn't print in my magazine.

Leo W. Moritz

Actually, the captions for those cartoons didn't print in any magazines. We managed to crop them off when scanning Robrucha's original cartoons. We realized our mistake quickly. Shortly after publication of the May issue, we received a number of e-mails and phone calls similar to yours.

Apologies to our readers and to Robrucha himself, who was quite surprised. We didn't mean to cause an uproar, but we're certainly glad to see that everyone noticed!

Here are the missing captions:

Page 66: "Smatter? Never seen a rotary engine before?"

Page 75: "Do the words 'stupid' or 'idiotic' resonate with your current get-up?"

Page 76: "It's just the trend. Almost everything in aviation is gradually going digital!"

Page 77: "Wow! I didn't even know there was an Aerocomp 300!" —Ed.

Engine Monitoring Omission?

Just finished reading the April issue and especially enjoyed the article on engine monitors. However, I was disappointed that the article did not include the Stratomaster line of instruments. The Ultra series from Stratomaster appears to be a very capable monitoring product tailored for use in Experimental aircraft and for a tremendous value, especially relative to its competitors. Please explain the omission of Stratomaster from an otherwise thorough article.

Douglas Morton

Actually, the Stratomaster line of monitors is new to us as KITPLANES®. There was no intentional slight of the company's products—we simply were unaware of them until after the article was put together. It was kind of coincidental that Para Aviation, a North American dealer for Stratomaster, contacted our senior advertising manager shortly before publication of the April issue. They placed an ad in the issue, but it was too late at that point to tear up our article layout, research the products and redo the article.

We've researched the company a bit since then, and Stratomaster is a South African company. Now that we're aware that the company offers products for the North American market through Para Aviation, we'll be sure to include them next time we cover engine monitors. —Ed.

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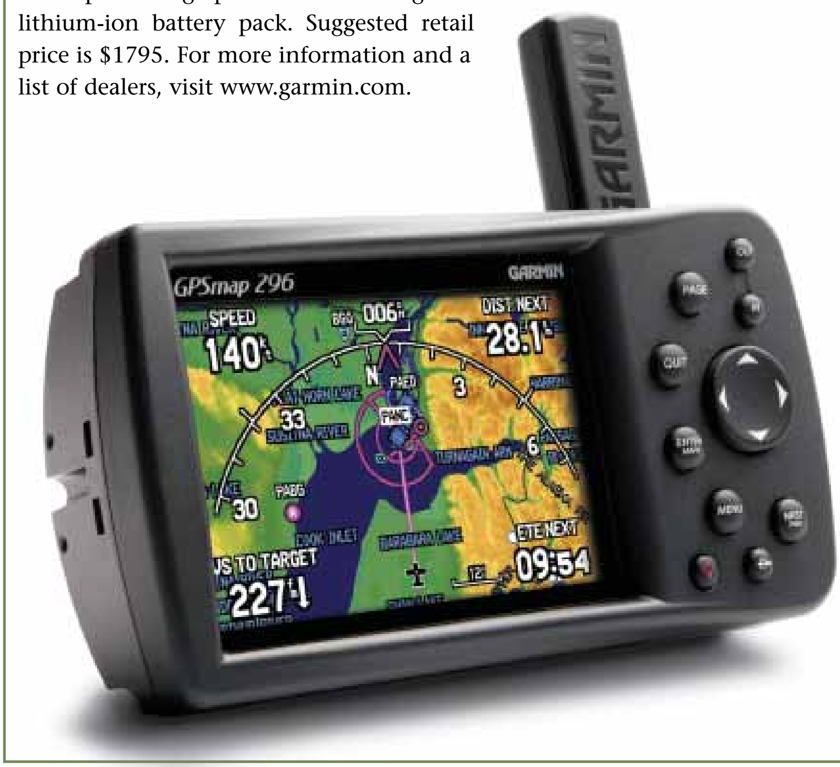
Garmin Unveils Terrain-Capable GPSMAP 296

Garmin International has introduced the latest in its handheld GPS line—the 256-color, high-resolution-display GPSMAP 296, designed to deliver topographic mapping and terrain advisory alerting through its color-coordinated screen.

The 296 blends the capabilities of Garmin's other popular portable GPS systems—the monochromatic GPSMAP 196 and the color GPSMAP 295. It retains the capabilities of those systems but adds a number of new features: terrain cautions and alerts, chart-like topographic data, a database of obstacles and a transparent navigation arc view for course, speed and distance information.

Terrain capabilities are key. Set in terrain mode, the 296 combines inputs from built-in terrain, obstacle and electronic flight databases so that pilots have an accurate, vivid depiction of proximity hazards. To depict terrain as shaded contours in sectional chart-like detail, the device features an extensive Jeppesen database overlaid on the topographic mapping to aid the pilot in viewing his/her flight path in relation to nearby navigation aids, special-use airspace and obstructions.

The unit comes complete with USB data transfer, a faster processing speed and a rechargeable lithium-ion battery pack. Suggested retail price is $1795. For more information and a list of dealers, visit www.garmin.com.



Pressurized ES Kit

Available from Lancair

Lancair International unveiled its latest all-composite kit model—the Lancair ES-P, a pressurized version of the original ES kit. Powered by a Continental 310-hp TSIO-550C, the ES-P cruises at 255 knots at 24,000 feet and retains the 61-knot stall speed of the original ES. The gross weight, however, increases to 3550 pounds. The pressurized version eliminates the 18,000-foot service ceiling of the original ES, and it will allow for cross-country flight in pressurized-cabin comfort.

The ES-P kit is available for $94,900 ($6000 deposit required to order), and an additional $8000 adds an air-conditioning system available through Kit Components, Inc. Builders also have the option of working on the ES-P at Lancair's builder assist facility for $4000 per week.

An additional development at Lancair is the addition of a second door option to the existing fastbuild ES kit. The new second door adds a completely fabricated fiberglass door to the passenger side of the aircraft. All latches, the window and mechanics are preassembled, and only the door frame is left to be installed. Cost is $8900, and Lancair plans to make the option available this July.

For more information on the ES-P or ES door option, visit www.lancair-kits.com or call 541/923-2244.

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FIRST FLIGHT FOR THE FOUR WINDS 210

Sporting patriotic themed paint and piloted by company president Jeff Rahm, the first production-conforming Four Winds 210 flew on February 27, 2004. "So far it's exceeding our expectations," Rahm said after several test flights. "We expect that it's only going to get better."

The model 210 is a 300-hp high-wing kit aircraft designed to fly faster than 200 mph and seat four in comfort. Called the "SUV of the sky" by the company, the FW 210 has a large cockpit, a 1200-pound useful load and a 1200-mile range with 99 gallons of usable fuel in the standard configuration.

"An individual can now own an IFR-equipped four-seater with autopilot and a zero-time 300-hp engine for about $150,000," Rahm said. "And that includes builder assistance."

Conceived by AirBoss Aerospace of Reno, Nevada, the Four Winds 210 uses both carbon-fiber composites and fire-retardant fiberglass in its construction and is rated for up to 800 hp. Various powerplants are available including an Allison turbine with 450 shaft hp. The airframe features a chrome-moly steel cage, a composite fuselage and a high-aspect-ratio wing (10.7) for an efficient cruise. The carbon fiber I-beam wing design does not need struts for support, which translates into less drag and better overall performance, the company says. The optional long-range fuel tanks have an usable capacity of 170 gallons, increasing the range to 2300 miles with a reduced passenger/baggage load.

The 210 has a longer, wider and taller cockpit for more interior comfort compared to the original model 192 prototype. Adding 16 inches to the overall length and creating a 49-inch-wide, 55-inch-tall cabin raised the gross weight to 3400 pounds. A heavier-duty landing gear was designed for the increased weight, and the wing location was relocated aft a few inches to allow a taller windshield with a different slope-angle for better visibility. A composite 760-inch three-blade propeller by Aerocomposites provides thrust and reduces noise.

Red, white and blue paint in a flag motif decorates the tail on N250FW. The outboard areas of the wings proudly display stars and stripes, and even the propeller blades have a custom paint design applied to them. Specialty patterns and custom artwork are available from Four Winds on request.

For more information, contact Four Winds at 386/426-7795 or visit www.fourwindsaircraft.com.

—Bill Grannis

Superior's Camshafts Go Digital

Responding to the aviation industry's need for an improved-performance camshaft, Superior Air Parts announced that it's now shipping 100% computer-optimized camshafts to participating engine overhaul shops and distributors. The company says that utilizing the purest base metals, the camshafts are precision milled using CNC machines, which allow them to achieve the highest quality and tolerance.

According to Keith Blockus of Superior, "The camshaft brain of these engines is designed to provide better cruise economy, lower valve-train loads and smoother operation at idle and high power settings."

Superior has been using these advanced camshafts in its XP-260 engine and its line of Certified Millennium Pre-Owned Engines—both of which are marketed specifically for the Experimental aircraft market. The new computerized camshafts were created exclusively to Superior's specifications by the Thielert Company in Hamburg, Germany.

For more information, contact Superior Air Parts at 972/829-4600 or visit www.superiorairparts.com.

Four-Channel Dimming Control Aids Cockpit Lighting

The LC-40 Lighting Controller, a four-channel light dimming system for Experimental aircraft, is now available from Flight Data Systems.

According to the company, GA airplanes have notoriously poor cockpit lighting, which is partly due to trying to dim all the lights with one control. Most airliners, on the other hand, have more than 20 dimming control knobs to attain proper brightness for each set of lights. On that principle, Flight Data Systems developed the LC-40 to provide separate lighting control for post lights, internally lit instrument lights, map lights and dome lights.

And, according to the company, potentiometers can't handle the current of more than two or three typical panel post lights. The LC-40 can dim up to 18 post lights per channel.

The LC-40 costs $89 and is currently available from Aircraft Spruce and Flight Data Systems. For more information, contact the company at 831/325-3131 or visit www.fdatasystems.com.

Protect From Chemicals with Gloves In A Bottle

Any homebuilder knows the importance of using proper protection while painting, gluing or doing composite work, and here's a solution that helps avoid the constant putting on/taking off gloves dance. According to the manufacturer, Gloves In A Bottle is a lotion that turns your outer layer of skin into an invisible pair of gloves, preventing skin disorders and dry cracking caused by chemicals being absorbed directly into the skin.

Available at pharmacies and art, arts and crafts, and garden centers nationwide, Gloves In A Bottle is undetectable once dry, lasts 4 hours or more and is removed naturally with exfoliated skin cells.

[Don Maxwell, author of our current "Build a SeaRey" series, used Gloves In A Bottle during composite work and recommends the product highly.—Ed.] For more information, call 800/600-1881 or visit www.glovesinabottle.com.

Grand

The result of more than 2600 building hours, Brian Raeder's *Sky Raeder* took home the Light Plane Gold Lindy award at Oshkosh AirVenture 2003.

Sky Raider

Champion

How to build an award-winning show plane.

BY JOHN M. LARSEN

As any aspiring or current builder knows, one of the greatest honors that can be bestowed on a homebuilder is to be awarded the Grand Champion prize at the EAA's Mecca of fly-ins—Oshkosh AirVenture. In 2003, Sky Raider builder Brian Raeder's dream came true as he received that highest compliment, taking home the Light Plane Gold Lindy award in the Ultralight/Light Planes class.

When he came forward to accept the award, Raeder whispered, "Kenny, this one is for you." He recalled the last time he had talked to Kenny Schrader, designer of the Sky Raider. It was the night before Schrader was killed in a fatal crash of one of his designs.

"I made a promise to him that I would do my best to build a show winner," Raeder says. "Now we were holding the Grand Champion Gold Lindy Award, and the promise was fulfilled. Kenny would have been proud."

The Raeder Brothers

Raeder spent his early career as a CAD draftsman but grew unhappy with the profession, and in 1993 he decided to change course and attend A&P School. He wasn't a newbie to the world of homebuilt aviation—he had done drafting for former kit powerhouse Avid Aircraft where his brother Jim was employed as head of research and development. In 1997, Brian joined Jim full-time at Avid, and the two aviation buffs enjoyed working together. In 1998, the brothers formed their own aerial-photography business; in addition, they covered and restored aircraft.

For a couple of years, they worked on the Private Explorer (flying motor home) project; Brian worked on a second airplane while Jim served as chief pilot and flew the airshow circuit with the prototype. Ultimately, the project moved to Canada with a new investor, and the Raeders discontinued their involvement.

Building the *Sky Raeder*

The Sky Raider project began pretty much by accident. "I really never had any intention of building a Sky Raider," Raeder said. "I was a quarter of the way through the process of building an Avid Magnum and had little interest in a smaller plane."

But Schrader, a good friend of the Raeder brothers, had another idea. Schrader, a former employee of both Avid and SkyStar, Avid's major competitor, owned Flying K, the company that manufactured the Sky Raider kit. Flying K was just beginning to take off with the design. When SkyStar, manufacturer of the Kitfox, saw how many planes Schrader was selling, the company had Flying K supply airframes and introduced the Kitfox Lite.

Knowing Raeder's experience with CAD-designed manuals at Avid, he asked Raeder if he'd be willing to take on the project of creating the Sky Raider construction manual. Schrader was low on cash, so he hatched a plan to offer Raeder a kit as payment. At the time, only a few Sky Raiders had been completed and flown. Schrader knew Raeder's work and told him he knew he was a perfectionist. He wanted Raeder to build one of his planes and then show it.

Raeder was hesitant, but he thought Schrader's request was compelling. Eventually, he gave in—he admits that the fact that the two were good friends was a contributing factor in the decision.

However, Raeder had a stipulation: instead of building the kit immediately like Schrader had hoped, he wanted to deviate from that plan. He knew himself too well and feared that if

The diamond-themed painting process proved the most time consuming. With the help of his brother Jim, Raeder spent more than two months working nights in a friend's auto-body shop to complete the job.

PHOTOS: BRIAN AND JIM RAEDER

Schrader delivered the kit now, he would start building it and not get the drawings done. Raeder agreed to do the drawings first and allow Schrader to assemble the kit for him afterward.

Eventually, Raeder completed the construction manual. Then it was time to start the fun stuff. Raeder didn't even have to think about what he would call the plane—*Sky Raeder* was a perfect match.

Features and Modifications

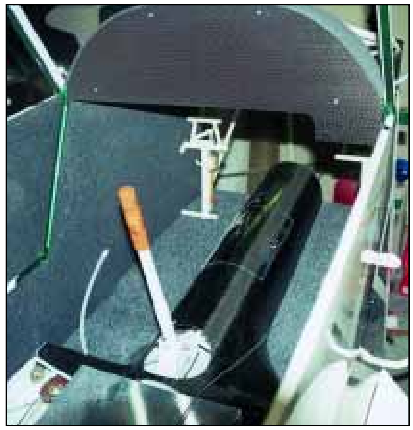
One may get the idea that it is a matter of luck to come home with a Grand Champion trophy. But in reality, luck has little to do with it. A lot of hard work and a keen attention to detail are the major contributors. Raeder completed more than 100 small equipment swaps and modifications during the 2600+ hours he spent in construction.

The aircraft's interior contains a custom upholstery job, complete with the modified Sky Raider logo.

Here are a few of the highlights:

•The wingroot-to-fuselage fairings were borrowed from the design of the Avid Magnum. They proved to be a perfect fit for the Sky Raider wing.

•The wheels on the plane are from the Kitfox. Raeder had quite a time searching for the right brakes for the wheels, but he never considered Cleveland brakes because the Sky Raider is so small. Wandering through an aircraft salvage yard one day, he saw a Cleveland 5.00x5 set that was just what he wanted. "New Clevelands were just a little too spendy," Raeder said, "so I bought a set of 5.00x5 brakes from Robbie Grove of Grove Aircraft."



One of the interesting add-ons Raeder came up with is this center console, ideal for storing charts, eyeglasses or other items that need to remain accessible in flight.

•For the most part, the wings are stock Sky Raider, but Raeder added one additional rib in the flap to allow for slightly heavier loads. The wingtips are Avid Champion design.

•The aircraft has a large baggage compartment, which proved challenging and time consuming to cover. The compartment is covered from the base of the vertical fin to the cockpit area. It was tougher than a standard covering job because Raeder had to shrink the fabric away from the tubing, rather than over it as in a normal covering job. This required many small pieces of fabric.

•He wanted to dress up the interior for it to be a show plane, and he had one idea that would come in handy once he got floats on the aircraft (he's currently scratch-building a pair of aluminum floats, and he plans to incorporate some original ideas for water drag reduction). The feature? A built-in fishing-pole tube perfect for storing a rod or two.

•The seats and interior are all custom items created and installed by Dave Fisher of Fisher Upholstery. Raeder made sketches of his ideas, and Fisher built the seats accordingly. Raeder had the pilot-seat cushion built 1 inch higher than standard for extra height.

•One feature that bothered Raeder on the stock airplane design was the lack of a place to put a second set of eyeglasses; he doesn't feel confident with only a single pair accessible. While contemplating how to solve this problem, an idea struck him—a center console. In addition to eyeglasses, the console could provide storage space for charts, flight computers or other things needed in flight. By the time it was done, Raeder had devoted 110 hours to this single part. It took about 1 yard of carbon fiber.

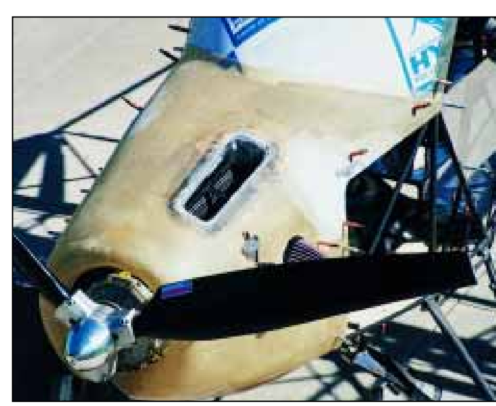
•Another aspect of the kit construction process irked Raeder. When you receive a new powder-coated frame, you need to drill out the bolt holes and round off mounting tabs, which breaks the coating. Instead, he coated the frame after these tasks were done.

•He was determined to avoid another powder-coating problem—the fact that some coating materials are porous. Raeder examined the corrosion ratings of different coating materials and came up with a two-step process for the best finish. He used an epoxy-base powder coat covered with a higher-quality powder topcoat. This should provide a corrosion-free frame coating, but Raeder will be able to tell for sure once the airplane is on floats.

What the Judges Saw

After 2600 hours of construction, the Rotax 503-powered *Sky Raeder* took to the skies for the first time, with Jim Raeder at the controls. As expected, it flew well and no adjustments were required. Soon, it was off to Oshkosh.

Aircraft judging is a science in itself. For light aircraft, the judges examine the subject in these specific categories: (1) General Appearance, (2) Safety, (3) Workmanship, (4) Adherence to Standard Aircraft Mechanical Practices Where Applicable, (5) Compliance with Applicable



Raeder custom-designed a carbon-fiber cooling-air exhaust port.

FAA Regulations, (6) Neatness and Fit, (7) Originality and Innovation. The *Sky Raeder* performed well in all.

•**General Appearance**. Raeder pulled out all the stops and chose a diamond motif where burgundy diamonds are set on a cream background with a forest-green-accented nose and wing leading edges. What's not noticeable at first glance is that both the upper and lower surfaces of the wings have exactly the same pattern. This isn't too common on light aircraft, and it garnered high marks with the judges.

The plane is covered with Stits Poly-Fiber fabric. Raeder used Superflight glue and undercoating material for UV barrier and primer. The entire plane was sanded before spraying the final finish coat, which consisted of Pittsburgh Paint and Glass Concept urethane. The entire finish-coat process including sanding, masking and over-spraying the colors took more than two months, and color

A scratch-built carbon-fiber exhaust cover hides the elbow of the Sky Raider's Rotax 503.

The empennage is of Raeder's own design; he modified the stock design to more closely match that of the Avid Magnum. But for safety, the tail section was welded to the airframe at the Flying K factory.

It may not be noticeable at first, but the burgundy and green diamond pattern extends to the lower surfaces of the wings as well.

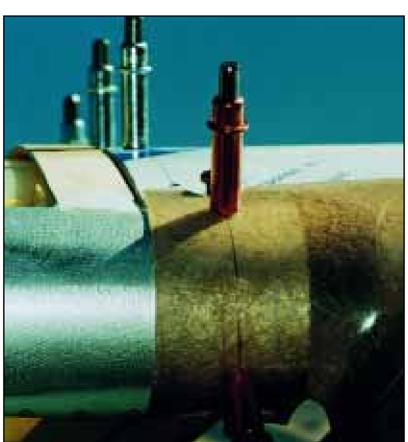
application proved to be the one area in which Raeder needed a large amount of help. Brian took on the job with the help of Jim, and the two spent more time than expected during the process, which was completed at friend Tom Tolsma's auto-body shop. Tolsma's shop is open for business during the day, so the work had to be done between closing (5 p.m.) and opening (8 a.m.).

"For two months, I lost count of the number of times I was getting home as my wife was getting up," Raeder said. "Jim was doing the same."

•**Safety**. This is a category in which some Experimental builders lose points when they get too experimental. There's certainly nothing wrong with getting creative with a design, but any safety question marks result in immediate markdowns on the part of the judges.

Reader knew this in advance and thought about it while building the plane. He incorporated some changes into the empennage design, altering the vertical and horizontal stabilizers to resemble the Avid Magnum's. Size was virtually unchanged, but Raeder knew he had to be careful in modifying any major airframe components. To that end, he decided to capitalize on his relationship with Schrader and have the newly designed parts welded to the frame at the Flying K factory.

•**Workmanship**. In this category, the judges had to be impressed with that 110-hour carbon-fiber center console. To create it, Raeder wrapped the center of the fuselage with plastic bags and filled it up with foam from aerosol cans. When it had cured, he carved and sanded the foam to the desired shape. Next, he skim-coated it with Bondo and painted it with epoxy primer. Following that, he pulled a female mold from the plug. He needed help here, so he called in friend Stan O'Krakel to offer advice. O'Krakel helped lay-up the mold and pulled a fiberglass part from the mold to check the fit; finally, the two created the carbon-fiber console.



Again borrowing from an Avid design, Raeder used Magnum wing fairings for the wing-to-windshield gap.

In addition, Raeder's instrument panel probably helped garner a few votes. It was built from carbon fiber, and each instrument hole was chamfered for a perfect fit.

•**Adherence to Standard Aircraft Mechanical Practices**. Raeder's A&P experience came in handy here, as he'd been formally trained on compliance with standard practices. The easiest way to explain this category is to understand that things that may seem minor to many builders (like the direction that bolts are placed in the airplane) actually make a difference in terms of quality of the build.

•**Compliance With Applicable FAA Regulations**. Raeder built this plane to comply with the FAA regulations covering light Experimental aircraft, as the two-place version of the Sky Raider is out of the jurisdiction for FAR Part 103 ultralight regulations.

•**Neatness and Fit**. In this category, the *Sky Raeder* scored well in many aspects of construction. For example, Raeder (with some factory assistance on this one) moved the flap handle from the left to the right to match the layout in his Magnum. The stock Sky Raider has all the controls exposed, so Raeder made covers for the flap handle.

The cowling was rebuilt so the cooling exhaust air has a one-piece duct to make a clean fit. He bagged and foamed the exhaust area and carved a part so the cowling covers the exhaust elbow. He ran the exhaust out the side of the plane rather than the bottom so should he land in an area where there is dry grass, the plane would not cause a range fire.

Covering the inside of the fuselage, including the fishing-pole tube, and the custom upholstery job helped illustrate a project that was well thought out and well executed.

•**Originality and Innovation**. With all the personalized additions to the airplanes, the *Sky Raeder* had no problem convincing judges of its authority in this category.

Advice from a Winner

So what advice does Raeder have on how to build a Grand Champion?

•Don't put a schedule on the project. If you get behind, you'll try to cut corners to make up for lost time.

•Cost cannot be considered. If you want that trophy, you have to install whatever personal touches you think are necessary, regardless of expense. That doesn't mean that all Grand Champions are $100,000 airplanes. It just means that the builder was willing to spend what it took to do the job right. For example, Raeder used standard instruments in the instrument panel that cost more than the budget gauges but were the right thing to use.

•Along the same lines, count on a large number of unforeseen costs that you don't anticipate.

•Learn all you can about the skills necessary for the type of construction you're about to get into. If your plane is a composite kit, get training in composites.

•Do the same for advice on painting and finishing your plane. Remember, general appearance was one of those categories. Your plane's paint scheme must stand out above all the competitors so people will want to come over and see what you have. It might be just the thing that will catch the judge's eye.

•Build a unique aircraft that will get the judges' attention. With as many RVs as attend every fly-in, it might be difficult to make yours stand out against the competition. But build a less-common design, and it may turn a few more heads and instigate a few more investigations into the type of plane.

•Complete the job. An old home-building adage is still true: The last 10% of the build will take 90% of the time. Anxious to fly, many builders don't complete the details necessary to make a winner.

•Know what you'll be judged on. The Official EAA Judging Standards Manual is available as a 45-page PDF document at www.eaa.org/judging/index.html. Knowing the categories in advance will give you insight as to what judges are on the lookout for.

•Pay attention to detail. Those details make the difference.

Schrader's Spirit Lives On

When Raeder returned from Oshkosh proudly holding his Grand Champion award, I couldn't resist my urge to invite him to my nearby airpark and witness the plane in action. As I watched from below, I noticed that the aircraft cut across the sky as nicely as it appeared on the ground. The *Sky Raeder* swooped and climbed, enjoying the freedom of the wind.

In a way, the plane reminded me of Kenny Schrader, who I'd met when we worked together at SkyStar. For him, heaven on earth was winning a rodeo bull-riding contest or flexing the wings of his latest new design. Perhaps his spirit was winging along with the airplane as Raeder whipped the finest example of Schrader's design around the sky. ✈

FOR MORE INFORMATION on the single- or two-place Sky Raider kit, contact Sky Raider, LLC, at 208/465-7116; web www.skyraiderllc.com.

Naturally, a family that builds together, flies together, too. Klaus Roth's daughter, Sandra, takes the lead (at left) in Roth's fixed-gear RV-4, while he and his wife, Renate, keep a watchful eye in their retractable-gear RV-4.

Even with the help of Renate (center) and Sandra it took Roth more than 3300 hours to construct his RV-4. It wasn't lack of skill or drive that extended Roth's construction period, but his desire not to build an everyday, average airplane.

Imagine this scene: It's a calm morning on a small airstrip in Germany. Parked gliders rest, tipped up on one wingtip and glistening with dew, waiting for soaring conditions to improve. Taking advantage of the quiet time, Klaus Roth taxis out in his new RV-4 for another test flight. He runs through his checklist, pulls onto the runway and advances the throttle. The usual RV takeoff sequence ensues: rapid acceleration, tail up, liftoff, flaps up, gear up and…Wait a minute! *Gear up?* In an RV-4?

Gear Up!

Klaus Roth builds an RV-4 with a difference.

BY ISHMAEL FUENTES

Yes. In this RV-4, at least. Roth's unique airplane features a fully retracting landing gear. As it climbs away, both mainwheels and the tailwheel disappear into the airframe, flush doors close, and suddenly there's a new shape in the sky.

The Builder

Roth was born in Nuremberg, Germany, in 1955 as the country was beginning to pull itself out of the ashes of WW-II. He grew up in his father's joinery, and that mechanical childhood stood him in good stead during his later education. As an adult, he became a master electrician and soon, head of a development workshop. Currently he is head of a department at Siemens Medical, working on magnetic resonance technology.

In 1981, the flying bug bit. Like many Germans, Roth started in gliders and later learned to fly powered airplanes in his glider club's Citabria. This was later replaced with a Christen Husky, so Roth learned glider towing with the Husky, too.

Some years later, Roth was happily married to Renate, raising daughter Sandra, and quite happy with both his job and his flying hobby. But somewhere in there when he wasn't watching, his mechanical inclination and taildragger flying experience met and fell in love. Before he quite knew what was happening, Roth found himself possessed by the determination to build an airplane of his own.

The Build-an-Airplane Bug

The desire was firmly seated by a ride in the back seat of an RV-4 at Oshkosh '93. "I knew immediately I wanted an airplane that flew like this," Roth said. "The controls were very light and sharp like a good high performance glider." He ordered a kit and went to work.

With help from Renate and Sandra, the RV-4 was built between February 1994 and April 1997. With a Lycoming O-360 pumping 180 hp into a three-blade MT constant-speed propeller, the RV-4 proved to be a fine performer. Roth estimates that it took 3300 working hours to complete—quite a few more than the factory estimates.

"Our estimated building times are based on simple airplanes, with middle-of-the-road workmanship and no elaborate custom touches," explains Dick VanGrunsven, president of Van's Aircraft, the company that produces the popular line of RV kit aircraft. "From the photos we've seen, Klaus' airplane was beautifully built and contained a few custom features, so I'm not surprised that it took more time than average." One of the little extras on D-ERKR was a glider towhook, which allowed Roth to use it as a towplane and keep it at his local glider club.

D-ERKR proved to be everything Roth had hoped for in an airplane: fast, a good aerobatic mount and easy to operate out of the glider strip. But after a couple of years flying it, the building urge was on him again. This time, he had something a little different in mind.

"I loved the way the RV-4 flew, but my wife and I talked and we said how beautiful it would be if it were all clean," Roth said. "So I decided to build an RV-4 with a retractable landing gear. Naturally, there were no factory plans for this, so I had to design, find parts and build it, all myself."

Design Considerations

After careful consideration, Roth listed his design goals:

•The gear had to be strong enough to meet the design criteria of JAR (the governing regulations for European certified airplanes). In the case of the RV-4, this meant it must survive an impact of 3.5 G.

•The complete gear cycle should happen with one movement of one switch, so all sequencing of retraction and gear doors closing must be automatic.

•The tailwheel should be retractable, completely covered when retracted, steerable and swivel 360°.

•He would use as many standard kit parts as possible.

•It must be possible to lower the gear even after complete electric or main hydraulic pump failure.

•The wheel axle should be as close to the fixed-gear design position as possible.

•There must be warning lights for all three wheels, both gear up/gear down.

Comparing the two RV-4s

	RV-4RG (D-ESKR)	RV-4 (D-ERKR)
MANIFOLD PRESSURE	20.3	22
RPM	2200	2200
SPEED IN MPH (GPS)	175	175
MANIFOLD PRESSURE	22	22
RPM	2200	2300
SPEED IN MPH (GPS)	185	185
MANIFOLD PRESSURE	18	20
RPM	2250	2200
SPEED IN MPH (GPS)	168	168

Challenges to Conquer

Of course, converting a fixed-gear airplane to a retractable is not a simple task. In fact, it involves a great deal of rearranging. For instance, the only realistic place to put the retracted gear leg in an RV-4 is in the bottom of the wing. There's simply no room in the fuselage.

That's a problem. Obviously the mainspar must stay intact, so the gear must go either in front of or behind it. In the RV-4, the fuel tank is the leading edge of the wing, so in front is not possible. And just aft of the spar is a pushrod and bellcrank running from the bottom of the control stick to the aileron. Moving or changing either one would be a lot of work with a large ripple effect.

In the end, Roth decided he must do both. First, he moved the fuel tanks from the inboard leading edge of the wing to the outboard. Then he steeped himself in landing gear theory.

"I got a detailed understanding and the mathematics out of the book *Landing Gear Design of Light Aircraft* by Ladislao Pazmany," he said. "The gear leg itself was straightforward. I used an oleo design with a 190-mm travel to meet the 3.5-G requirement. The difficult part was understanding the geometry. I wanted the axle as far forward as possible when the gear was extended and as close as possible to the mainspar when it was retracted. And I wanted to do this without changing the basic shape of the wing.

"This proved difficult, but in the end I was able to orient the rotation axis of the retracting gear leg to diverge 13° from the longitudinal axis of the airplane. This placed the extended axle position only slightly aft of where the fixed-gear leg would be."

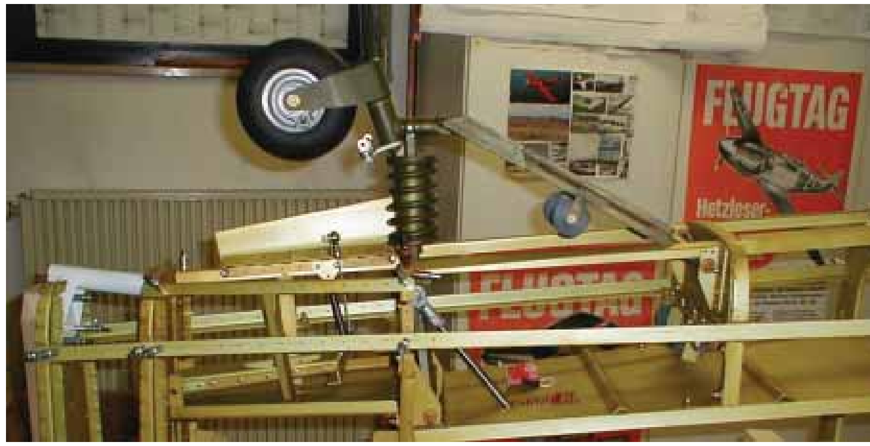
An inboard strake on the wing provided more room for the retracted wheel. The top of the gear leg is mounted to a steel tube running fore and aft through the web of the mainspar. This tube is supported with bearings on both main and rear spars. Retraction is accomplished by pulling a folding link, mounted to the gear leg, inboard with a hydraulic cylinder. Aft of the spar, the upper rotational arm crossed paths with the aileron pushrod, forcing Roth to design and install a segmented pushrod.

For Roth, finding the right parts was a matter of dedicated research. The hydraulic pump, lever and valves are from a German industrial company. Roth thinks that priced differently, these parts are used in some certified airplanes. All necessary bearings and gaskets also came from an industrial source. Roth put the elaborate system of hydraulic controls and plumbing on a plate mounted in the baggage area behind the rear seat, and he can pull the whole system out as a complete unit if necessary.

The tailwheel took as much work as the maingear. Roth bought drawings of the Celerity tailwheel from Mirage Aircraft Inc., which gave him some

PHOTOS: KLAUS ROTH

basic ideas. Other hints came from Canadian RV-4RG builder Bryan Carr [see sidebar]. Although Roth changed almost everything dimensionally, he used the same principles. Eventually he had a fully retracting tailwheel that tucked neatly behind flush doors but still allowed steering on the ground.



Before construction, Roth mapped out his design goals for the RV-4, one of which was a retractable tailwheel (pictured here in his shop) that would be completely covered when retracted, steerable and would swivel 360°.

The electric and hydraulic components of Roth's retraction system are plate-mounted in the plane's baggage area behind the rear seat. If necessary, Roth can conveniently pull the whole system out as a complete unit.

A Glitch

The biggest problem surfaced toward the end of the project. "I already had the wing and the engine bolted on when I noted the lower main wing skins flexing in and out as I tested loads on the landing gear," Roth said. "This problem comes because the movement of the wheel when it touches the ground forces the rear spar down. This forces the almost-flat bottom wingskin to bend in and out.

"It could only get worse with G loads and time. I didn't want to accept this, so I disassembled everything and reinforced the skin with aluminum angles between the ribs. Unfortunately, I had to use blind rivets, which I normally try to avoid. If I had foreseen this during wing construction, it would have been easy to add some ribs for a cleaner solution."

The Result

A simple RV-4 could weigh somewhere in the low 900-pound range, but most weigh around 975. Roth's fixed-gear RV-4 (with its 180-hp engine and three-blade MT prop) weighs about 1022 pounds. The new RV-4RG with the same power package but with retractable gear and a Christen inverted oil system, weighed 1132 pounds, a gain of 110 pounds. A maximum gross weight of 1650 pounds gives the airplane a reasonable useful load, but the published aerobatic gross weight of 1375 pounds does impose limitations. Roth is fully aware of the compromises: "I can only fly aerobatics by myself, and light on fuel. And I don't plan on

Unusual, Yes—But Not Quite Unique

As unusual as it is, Klaus Roth's retractable-gear RV-4 is not unique; at least two other retractable RV-4s have been built. Probably the first was N8DU, built by Dave Lewis, Sr., and his son, David Jr., in Hillsboro, Oregon. Lewis Sr. has thousands of hours in his logbooks including a stint as a North American test pilot flying just-finished P-51s off the end of the production line in Dallas. In the 1980s, still an active and skilled pilot, he joined his sons in building several RVs. They hatched the idea of a retractable version, no doubt influenced by Mustang memories, and modified the RV-4 to accept a retractable maingear, modeled on the gear used in Mirage Aircraft's Celerity. Finished in the late 1980s, this airplane was somewhat simpler than Roth's with no wheel covers and a fixed tailwheel.

Another airplane closer in concept was built by Canadian Bryan Carr. Carr, who has also built several RVs, is a master craftsman. In this airplane, he incorporated many changes. Besides the fully retractable landing gear, Carr built a sliding canopy and installed a quite different cowling.

The airplane is now owned by Paul Best of Seattle, Washington. According to Best: "N66PB flies like a 'normal' RV-4 except for the speed. The only thing that holds me back is the redline on the airspeed indicator. I have owned it for five years now, and even though there is a little more maintenance required for a retractable airplane, it is a fun airplane to fly. I do a gear retraction/extension test every six months or when I have done any work on the gear. Bryan [Carr] included a system for lowering the gear in the event that the normal extension system has a problem. My empty weight is 1108 pounds, which, of course, is higher than most RV-4s, but the plane stalls and spins in a conventional manner, and it is an aerobatic delight. I can get my fuel burn down to between 7.5 and 8 gph depending on power settings and cruise altitudes."

—Ishmael Fuentes

Retraction is accomplished by pulling a folding link, which is mounted to the gear leg, inboard with a hydraulic cylinder. During flight tests, Roth discovered that the system needed a mechanical uplock. He therefore designed a pilot-actuated cable, which inserts a pin so the gear would not "droop" during aerobatics.

An inboard strake on the wing provided more room to install the retracted wheel. Roth mounted the top of the gear leg to a steel tube running fore and aft through the web of the mainspar.

While Roth met all of his goals when installing the retractable gear on his RV-4, he admits the process wasn't easy. Even before construction, he spent much time finding the right parts, which was a matter of dedicated research.

doing spins with much fuel in those outboard tanks!"

An Analysis

Following construction, Roth made these discoveries:

•Strength: Tests proved that the long-throw oleo strut design met the JAR standards, standing up to a load of 3.5 G.

•One switch: This was partly achieved. There is one switch for normal flying. The gear retracts and extends smoothly when the switch is moved. Sequencing the gear and gear doors is handled automatically by a set of switches activating hydraulic valves. But in flight test, Roth found that aerobatic G loads pull the wheels about ½ inch out of their wells. He added a manual gear-up locking system, using two lever-controlled Bowden cables that push pins through holes.

•Electric failure: If there is no electricity, every valve goes to the gear-out position. A manually activated valve and a hand pump on the left side of the pilot's seat lowers and locks the gear. Naturally, the pilot has to remember to retract the locking pins if the electric failure occurs during an aerobatic flight.

•Wheel axle position: The geometry of this was difficult, but the axle ended up just slightly aft of the standard fixed-pitch position.

•Retractable, steerable tailwheel: All goals were met. But it wasn't easy.

•Warning lights: There are lights indicating the position of all three wheels.

•Using parts from the kit: Roth was able to use the mainwheels, tires, tailwheel, brakes, leading edge and fuel tank components provided in the kit. Wheel forks came from a Glasair, and the hydraulic parts from a German company. Additional parts were purchased from Aircraft Spruce.

How Does It Fly?

Of course, everyone wants to know how the RV-4RG compares with the straight-leg version. In other words, how fast is it?

According to Roth, "I don't have complete performance data, but here are some impressions and simple comparisons: My feeling is that the speed is increased 5-8 knots at my normal cruising power setting of 22 inches and 2200 rpm. This is not a great difference, but I didn't build the retractable because I wanted any great increase in speed.

"My daughter, Sandra, got her pilot's license in 1999 and her aerobatic license in 2002," Roth said. "Today she flew the regular RV-4 and I flew the RG. We flew side by side at 3500 feet MSL. Temperature on the ground (1600 feet MSL) was 31°C. Wind was calm. We recorded the speed with a GPS. We filled the tanks on both airplanes. The pilot's weight was 85 kg for me and 50 kg for Sandra. Both airplanes are equipped with an O-360-A1A and an MT constant-speed, three-blade prop. We did not ballast the fixed-gear airplane to match."

See **Table 1** for a side-by-side comparison. "You can see that the power difference to maintain the same speed is not too much. This means that the fixed gear does not cause much drag. Also, the heavier RV-4RG must have more induced drag. The glide ratio for the RG is slightly better. In all handling aspects, the airplanes are the same."

The Bottom Line

Many homebuilders have made extensive modifications to existing designs expecting large gains in performance and have been disappointed by the result. Roth is not one of them. He realized before he started that Dick VanGrunsven had designed an excellent airplane and had already done the easy stuff. He knew that performance gains would be modest and partially offset by increased weight and complication. His satisfaction has come from the fun of designing, problem-solving and building a unique airplane.

And there are other satisfactions as well. When he goes to the airport, Roth has a choice: Which beautiful hand-crafted airplane does he take today? Either way, his wife will join him, and together they can look out and see their daughter tucked in tight on their wing.

Who wouldn't be satisfied with that? +

FOR MORE INFORMATION on the fixed-gear RV-4 kit, contact Van's Aircraft at 503/675-6545 or visit www.vansaircraft.com.

Ladies and Gentlemen, Please Be Seated.

How Oregon Aero's Mike Dennis "un-engineered" a safe seat for the RV-10.

BY DAVE MARTIN

Oregon Aero, the small company in Scappoose, Oregon, with a reputation for innovative products, has a new aircraft seat that just might revolutionize the way all aircraft seats are built. For now, it's revolutionizing the standard front seats of the new four-seat Van's Aircraft RV-10 (see the November '03 KITPLANES® cover story).

The RV-10 seat is also the story of how Oregon Aero owner Mike Dennis thinks and works in unconventional ways. His inventions led him and his wife, Jude (now the company general manager), to found Oregon Aero in 1989. The company's first product was an aviation headset cushion to eliminate the headaches that Jude experienced while flying with Mike. It's now one of 500 products that Oregon Aero makes for safety and comfort in a wide variety of environments.

The Seat Problem

Comfort and safety in aircraft seats—military, airline and general aviation—have been a problem forever. Knowing Oregon Aero's reputation for solving problems, Van's Aircraft owner and RV-10 designer Dick VanGrunsven collaborated with Oregon Aero early in the airplane design process.

Did Mike Dennis consider the RV-10 cockpit design as he designed the seat? He says no. "Dick did a very wise thing. He came here and got the new seat frame and then built his wood cockpit mockup around the seat. That is the smartest thing anybody has ever done," Dennis said. "Most aircraft manufacturers do it backward because they think the seat is simple and is mostly to keep the pilot from landing on the floor with his knees bent.

"Late in the certification process," Dennis said, "manufacturers want to get by as cheap as they can. And the vertical-load seat test [for certified-aircraft FAA approval] is highly resistant to anybody's concern about money. In fact, it's a vacuum cleaner for money. You have to get this right early in the game, and that's what Dick did. It was a pleasure working with him."

The New Design

The RV-10 seat is designed in modules. One of the major components is the adjustment block that holds the seatback. Van's Aircraft wanted some seatback forward and rear recline for its four-seater, and the CNC-milled solid aluminum adjustment block parts make that happen.

"The block is roughly analogous to the case of a watch," Dennis said. "It holds the gears for the operating mechanism. It's CNC-machined here because we can make machine parts in minutes rather than making molds for cast parts." The time and money to cast

Oregon Aero founder Mike Dennis designed a revolutionary seat for the new Van's Aircraft RV-10.

PHOTOS: COURTESY OREGON AERO, INC. AND DAVE MARTIN

The Oregon Aero High-G Safety Seat is standard equipment for the RV-10's two front seats.

Seats

CONTINUED

parts would have to be amortized over hundreds of parts. Machined parts are also stronger than cast or forged parts.

I looked at a list of 34 operations the CNC machine performs to turn out a seat block. The machine changes its own tools for the required milling or boring operation.

"We designed a lot of extrusions for the seat," Dennis said. There is a bulky custom-made aluminum extrusion for the rail that can be machined into whatever type rail is needed, such as for Oregon Aero's military version of the seat.

In the RV-10, the front seats travel up as they move forward on rails for short-legged people. A major contributor to the seat's operation and safety is a solid UHMW (ultra-high molecular-weight polyethylene) self-lubricating cast slider located between the fixed and moving parts of the seat rail. (UHMW is like Dupont Teflon except it won't abrade in the presence of grit or dirt.) The objective is to avoid bowing the seat rail under high stress or impact, which would occur if the rail were supported by wheels at each end of the movable rail.

A pair of crosstubes supports the patented seat pan, which is a 9-ounce, non-springy high-tech fabric. The crosstubes are beefy extrusions with a built-in web that is oriented to absorb survivable crash loads without bending. (Three quarters of the weight of the original crosstube was removed by adopting the web design.)

A seat pan is usually made of sheet metal or plastic that, Dennis said, acts

Elizabeth, who works in Oregon Aero's Fabric and Finishing Department, operates one of the company's computer-driven cutting tables.

David (right) in the Seat Department does final trimming on a bottom cushion as Seat Department coordinator Tony stacks cushions en route to the next process.

like a drum head; it deflects and springs back. Years of Oregon Aero experiments—including many runs on calibrated test sleds—revealed that in a crash, it's the springiness of seat parts feeding energy back to the occupant's spine during a crash that is often fatal. Everything that bends and returns to its original position is a spring, and it tends to amplify the effect of the crash.

The Crash Event

A typical potentially survivable crash in a light aircraft, Dennis said, is at about 70 mph and 30° nose-down contact with the ground. Horizontal deceleration (lasting for only about the first 6 milliseconds of the crash event) is survivable because the seatbelt and shoulder harness do their jobs well.

But the fuselage then slams to the surface, creating a massive vertical spike of energy that tries to compress the spine of the occupant. In a typical GA fatal crash, Dennis said, the aircraft fuselage is relatively intact, but the occupants are killed by crushing of the spine.

To assure best crash protection in its seats, Oregon Aero contracted with

Hand cutting of some seat-cushion fabric assures a proper fit.

Seats

CONTINUED

MGA Research Labs, a testing facility in Burlington, Wisconsin, that Dennis says has the best test sled setup in the country. The sled is used to test seats for new cars, trucks and military vehicles for crashworthiness. And it is used by aircraft manufacturers to certify crashworthiness of seats to FAA standards. Often, Dennis said, FAA seat certification of a new aircraft comes near the end of the process when time and money are running out for the manufacturer. The seat tests often fail as test dummies record more than the allowed 1500-psi pressure at the lumbar area of the spine. This is the vertical test, also known as the 19-G test.

After thinking about the difficult problem posed by the FAA requirement, Dennis designed a baseline test (he's not aware of anyone else doing this before) to determine the lumbar loads without a seat or its structure; the test dummy sits on a rigid metal plate on the sled.

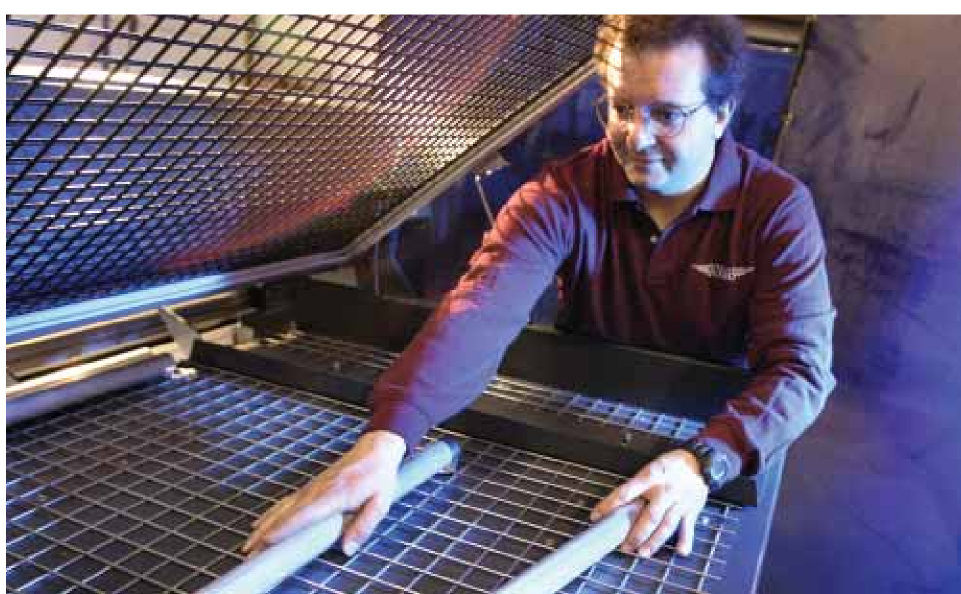
To many people's surprise, the baseline test found that *without a seat*, typical crash loads were survivable. Lumbar loads were about 1350 psi—well under the 1500-psi limit.

Rather than improving survivability by slowing the crash event (by crushing or bending or compressing something), the conventional aircraft seat—because of its springy components—was amplifying the loads.

Using heavier seat components such as a thicker seat pan only makes things worse, Dennis said, because the *amplitude* of the springiness increases. And it is the amplitude of the seat oscillation that kills. On the test sled, Dennis found that adding a regular seat cushion raised the lumbar load to about 2000 psi. And after adding an ordinary seat structure, lumbar loads rose to 3000-3500 psi—well into the fatal range.

Oregon Aero's high-quality, adjustable test fixture allows checking components (seats and mounting hardware) under high hydraulic load for failure and springiness.

Leslie in the Shipping and Receiving Department prepares one of Oregon Aero's portable universal SoftSeat cushions for shipping. The cushion—one of the company's most popular products—is claimed to be painless and reliable without compromising headroom.



Oregon Aero's response was to undo the damage that seats cause by removing things and using lighter materials and components that will not spring at survivable crash loads. Examples are the fabric seat pan and the webbed rigid crosstubes.

The inclined rail raises the seat as it is moved forward, which means that short pilots can see over the nose. This feature was VanGrunsven's design, Dennis noted.

Design and Testing Modes

Dennis said that often when he has approached general aviation manufacturers about dynamic seat requirements, they will say something like, "Go talk with Harriet. She's in charge of interiors." He noted that he is usually invited to participate in a project at the point that the seat is failing to meet certification standards.

Sled runs at MGA generally cost $2000-$5000 each depending on the complexity of the setup, which takes from hours to days. For doing basic research and testing specific seats and components, Dennis proposed something different: buying a full week's sled testing.

MGA saw the value of a collaborative effort, which continues. By now, Dennis has supervised more than 300 sled runs. MGA works two shifts, and on test days Dennis is there for more than 16 hours.

Part of the problem with aircraft seat certification testing has been a lack of planning by aircraft manufacturers. Dennis quotes the director of the MGA lab saying that automotive and bus and even train people come to the lab with a test plan, but airplane people arrive with high hopes and wishful thinking.

All of this had led Dennis to "un-engineer" the conventional seat to result in the least possible seat structure. The modular RV-10 seat—on which other Oregon Aero aircraft seats are based—is the result. "Our seat is mostly aluminum and air with some interesting fabric,"

◊ **David, an Oregon Aero research and development machinist, loads aluminum bars into a lathe feeder. The CNC system makes parts for RV-10 and other seats.**

Seats
CONTINUED

Dennis said.

It resulted from placing a conventional seat in a special test rig built by Oregon Aero and stressing it with hydraulics. Dial indicators showed that it was flexing everywhere. And when pressure was released, the dial indicators returned to zero. "This meant we had 'springs' everywhere," Dennis said. At this point he began the un-engineering process.

"Safety Seats"

Dennis notes that he has given the same speech for years on the unsatisfactory crash performance of seats designed to slow the impact over time. A significant problem is that the mass (weight of the seat and its occupant) needs to be known to design properly. If the seat is designed for a 170-pound person and someone weighing 120 pounds crashes in it, the components designed to bend or crush won't deflect enough to slow the acceleration—causing death.

And if the occupant weighs 240 pounds, he/she may bottom out before the crash event is over. "If you bottom out during the acceleration, the game is over," Dennis said. The G force spikes and the occupant dies. The band of protection of the safety seat is really narrow unless it is adjustable. And then you have the added weight, complexity and expense...plus the need for each occupant to set the proper number before flying. The problem is too complex.

"Our seat is not doing something spectacular," Dennis said. "It is simply not doing something negative."

Test Results

Oregon Aero's new aircraft seat passed its initial seat test at the lab, and the same seat was used for six more test runs, passing each time. Nothing failed. The lab director said these tests made history. Dennis quoted him as saying, "But don't expect any ticker tape parades...because there are only six people in the world who understand what we are doing, and three of us are here."

With the Oregon Aero seats standard in the front RV-10 kits, the company's cushions for the rear seats (which are actually a fixed part of the airplane structure) may be ordered through Van's Aircraft.

The special seats may also be ordered from Oregon Aero by companies or individuals for other homebuilts. The price will vary from a minimum of $3000-$4000 each.

While that might seem like a lot of money for a homebuilder to spend on seats, Dennis points out that the same seat is being modified for military aircraft including the H-53 and CH-47 helicopters. In these cases, the Oregon Aero special seats come with armrests, headrests and other features that cost the military up to $8000. But they are replacing seats that originally cost up to $64,000, Dennis says. Taxpayers should be happy about the change, he thinks. And the seats are lighter, too, weighing 25-35 pounds as opposed to the original 50-75 pounds.

Other Products and New Stuff

A new Oregon Aero program involves seats to protect high-speed military patrol boat personnel in high sea states—an exceptionally severe environment. "In sea state 3 at 60 knots, Dennis said, it's the equivalent of minor airplane crashes every second for hours." But that's another story.

Dennis revealed new patents on several unusual products: bulletproof foam ("armor that floats," he calls it) and a soft helmet that protects against extremely high noise, such as on an aircraft carrier flight deck.

Dennis also shared a recent e-mail from a U.S. Army sergeant who was wearing his Oregon Aero helmet liner in Iraq when his group was attacked with a rocket-propelled grenade. The soldier says the blast went off a few feet from his head, and he's convinced that he could have been seriously injured—or worse—without the helmet liner.

There's always something interesting going on at Oregon Aero. ✢

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Fly-by-Wire—

On the Horizon?

Fly-by-wire systems for homebuilt aircraft could become a reality sooner than you think.

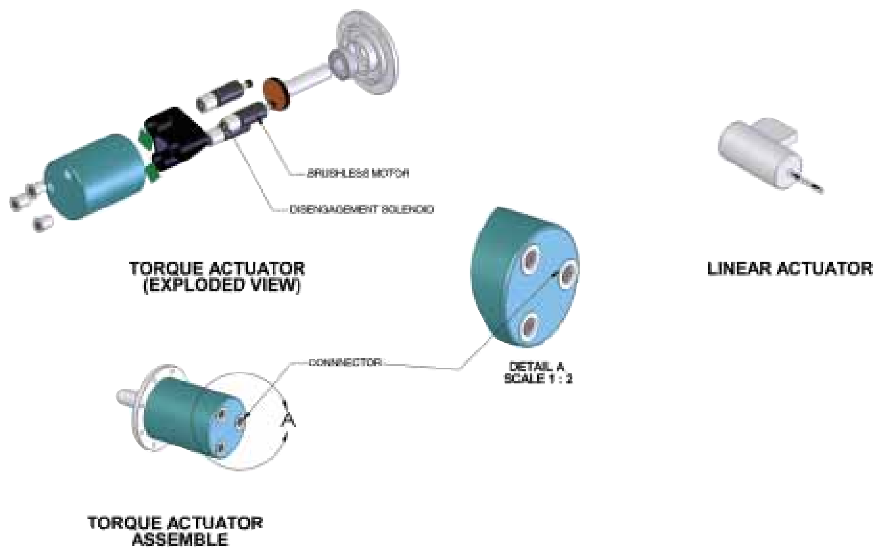
BY MIKE PERKINS

I guarantee that full fly-by-wire systems for Experimental aircraft will be a controversial subject. However, some believe fly-by-wire (FBW) systems are a natural step in the evolution of Experimental aircraft, and perhaps the day is close at hand where increased reliability of electronics and electromechanical actuators make them ready to meet flight control surfaces without a mechanical back-up.

NASA has successfully used fly-by-wire systems since the mid 50s, beginning with the X-15. All other spacecraft have used them out of pure necessity, as have numerous commercial aircraft, but out of expediency as well. These systems have certainly not been without their failures, but redundancy has taken up the slack for the most part. By now you've probably sat in an airliner that had either partial or full fly-by-wire systems, and chances are that your car has an electronic engine control system without mechanical backup. And many piston aircraft engines can now be upgraded by aftermarket Full-Authority Digital Electronic Control (FADEC) systems, boasting improved economy and higher reliability.

Others have previously suggested concepts such as aircraft with car-like steering, using highly integrated and automated systems to fly the highway in the sky. Although that concept is quite valid, there are many interim, progressive steps that might be taken towards that goal. These interim steps are not without their own risk but are necessary to ensure the success of farther-reaching concepts.

When it comes to subsonic aircraft, not much has been learned about aerodynamics since the 1930s. Without a doubt, some of the biggest performance improvements in small aircraft have had more to do with engine design. It may not be possible to make many more large strides in aircraft design improvements without considering fly-by-wire systems.



The triple-redundant electric servo represents a critical path in the development process of FBW systems. The author and his associates are working on this rotational servo with redundant motor drive circuits as well as a linear version.

The final recipe for an FBW system could take shape as many different forms, and there is a lot of room for experimentation—but not a lot of leeway for error. Before we can even get to that point, there is an entire stigma to be overcome, born out of natural mistrust for anything for primary flight controls other than solid control cables, pulleys and push-pull tubes.

A Checkered Past

The electronics required for FBW systems have earned their bad reputation honestly, beginning with vacuum tubes, hand-wired radios, transient susceptibility and the utter lack of automatic backup systems. Even modern avionics technology has added to that reputation by also being troublesome. Adding fuel to the same fire is the mistrust of inexpensive, throw-away electronic consumer products along with consumer-grade PCs with their crash-prone operating systems.

If one can step away from those issues for a moment, FBW systems have numerous advantages. But until recently, the disadvantages, both actual and perceived, have heavily outweighed them. It's my belief that we won't know all the advantages of FBW until we've flown some experimental versions successfully. Naturally, there is a lot of work to be done. And along the way, there are a number of truths to find among the various possible FBW recipes.

Control Unit Options

In the middle of any FBW system, between the pilot-operated controls and the control surface actuators, is a control unit. Inputs from the pilot are translated by the control unit into control surface movement. We have four possible classifications of control units:

1. Pure analog

2. Hardware-only digital (digital, but no software whatsoever) with analog input/output

3. Personal computer

4. Embedded, special-purpose computer

Any FBW system will contain by necessity, at least some analog circuits, if to do nothing more than act as an interface to the control unit. But a pure *analog* system by definition contains no digital components and certainly contains nothing resembling software. Such an analog system is merely a joystick-to-control-surface translator, much like most autopilots in use for small aircraft. They are not unlike a larger version of a model airplane control, minus of course the radio transmitter and receiver. There are few features that can be added to an analog control system, but only at great cost and a possible sacrifice of reliability.

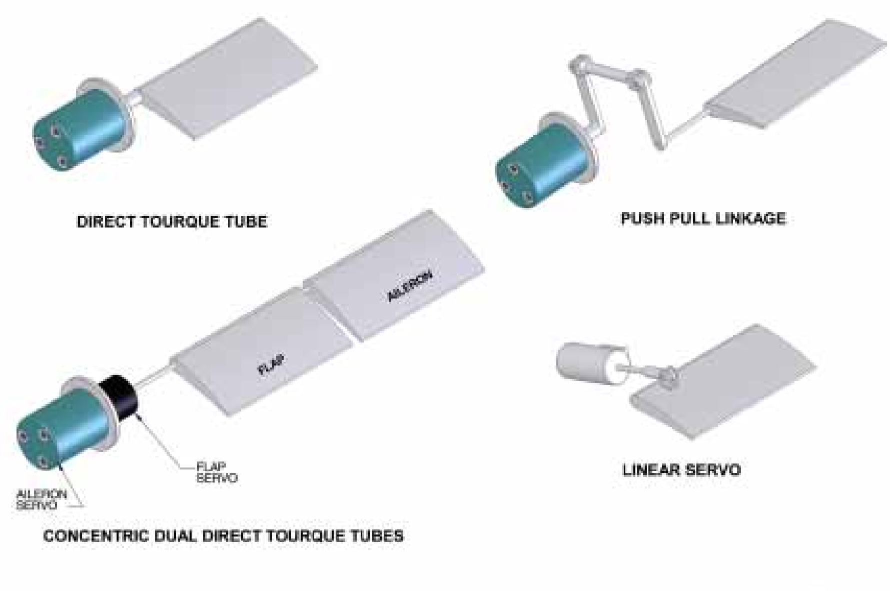
A *digital* system is similar to an analog system, but with dedicated digital hardware to accomplish certain computations—for example, a digital adder circuit for trim-plus-joystick mixing instead of an analog summing circuit. However, there is not a lot of justification these days to use a hardware-based digital system, which has a lot of complexity with little flexibility (much like the full analog system), and adding modest control system laws to either one can only be had with an exponential increase in complexity. (Control system laws are the core of an FBW system, similar to the many possible equations in an Excel spreadsheet.)

The third approach is a *PC-based system*. Although good enough for desk-mounted simulators, its choice in FBW systems is universally rejected by design engineers. This is due to the PC being an incredibly error-prone, complex collection of hardware and non-deterministic software. A modern PC, although quite capable of handling the actual complexities of FBW systems, has a rate of soft failures that is many thousands of times too great to be used in any flight control system, even with redundancies. Just think of the number of reboots required of a typical PC over a week's worth of use. Any FBW system must ultimately be as dependable as control cables, pulleys and push-pull tubes.

An *embedded computer system* is not unlike an aircraft engine's FADEC or your car's engine control system. An aircraft engine's FADEC has built-in redundancies as you would expect, but when your car's engine control goes out of whack, so does your car's engine. An FBW embedded computer system is not only redundant like a FADEC, but also has very *deterministic* software in it like a FADEC, meaning that for every input condition, there's not a chance of an unexpected output. An embedded computer is not your PC on a diet—the software is tightly-coded and carefully crafted for reliability and predictability, as is the hardware.

There are four such embedded computer systems aboard the U.S. space shuttle, all identical and interconnected in such a way that disagreements—if any—are solved immediately and invisibly by a voting system before any action is taken. However a fifth computer, with software created by an entirely different company, serves as a total backup flight system in case of a generic software problem in the other four. Quadruple redundancy with a backup fifth sounds good, but it may or may not be required for a terrestrial aircraft operating VFR with a full-aircraft parachute recovery system. However, redundancy is required.

One can't help but notice that there are several new integrated glass cockpit systems on the market for Experimental aircraft for navigation, terrain-avoidance and engine monitoring. They are based partly on (1) state-of-the-art laser-ring gyros, (2) accelerometers and (3) GPS. Recent advances in these three technologies have made this type of glass-cockpit system possible at a small fraction of the cost of what was possible just a few years ago. In fact, these GA systems, which are unburdened by regulatory requirements, are much easier to use than those found in modern airliners. Many of the same basic technologies used in small glass cockpits can be used in an FBW system with the same cost benefit.



Future aircraft can be designed specifically for FBW systems, which will minimize moving parts by using direct drive, thus eliminating the need for push-pull tubes, bell-cranks, cables and pulleys. Current aircraft designs can be mechanically adapted.

Control Surface Actuators

Control surface actuators (CSAs) are a key subject, and I would not be writing about FBW systems if not for

ILLUSTRATIONS: MIKE PERKINS

recent reliability improvements and downward costs along with significant force-actuation improvements. For many years they've been used successfully for primary flight surface controls of military and air-transport aircraft, but their cost and weight have been prohibitive for small aircraft. However, proper CSAs have yet to be designed specifically for small aircraft. At this point, ganging several actuators for redundancy purposes might be preferable to total reliance on one actuator per surface.

One additional feature an FBW system can have is automatic compensation for a disabled actuator. An example would be a malfunctioning left aileron compensated for by the right aileron and rudder. Almost all man-rated FBW systems built to date have a form of built-in compensation that accounts for this kind of degraded operation.

The types of actuators that currently exist are hydraulic, electro-hydraulic and electrically driven. Either type of hydraulic system offers the advantage of tremendous power possibility from light and compact actuators, but hydraulics require pumps, heavy fluids, plumbing and reservoirs, and must be controlled by electrically operated, proportional valves. In the overall weight-to-performance graph, I think most analyses would find that the hydraulic curve does not favor small aircraft. Pneumatic control systems are dismissed for the same reason, but with the additional factor that because the pressures are usually much less than hydraulic, they are even larger. Regardless, any actuator must have environmental conditions taken into account: rain, snow, ice, temperature, sunlight and humidity. The development of properly designed actuators is a key element, and proper aircraft design can contribute to helping with the weathering they see.

Here again, enter recent advancements in a technology; in this case, significant advances in motor-driven, position-feedback servo actuators. These types of servos often operate very fast numerically controlled machines. Other examples include the control of giant-scale model aircraft. Response times and efficiency have been improved by microprocessors running modern DC motor-control algorithms, which have been invented only within the last few years. This kind of servo becomes a servo-on-steroids, with the only adverse side effects being a slight increase in power consumption and a bit more cost. At the same time, the dead band (the range of control-system inputs where the actuator does not make any positional change even though there are commands to move it slightly) is significantly reduced, increasing the precision that an actuator servo can be repeatedly positioned. The overall positional response time improvements are shown in **Figure 1**.

Servo actuators designed specifically for small aircraft would certainly have failsafe requirements; a servo detecting a problem within itself might take itself off-line. But because an actuator might also fail as a result of disconnect from the FBW system, an autonomous failsafe design might be required. That is, when something goes amiss, it might self-center and lock in a flight-control-neutral position. Or it might free-wheel or float, accomplished by an internal, autonomously operated disconnect clutch, perhaps a requirement where several servos are ganged together to control one surface.

It should be noted that the principle of using multiple actuators per control surface has other advantages. For instance, if three actuators were linked to a single control surface but each actuator were connected to a separate FBW system, this would create a natural redundancy should an entire FBW system fail.

On the horizon are *smart materials*—structural solids that literally change their shape based on some kind of input such as heat or electrical stimulus. Though somewhat of a far reach at present, these materials offer much hope for becoming aerodynamic control surfaces—perhaps we will see the day once again when wing-warping is the preferred method of control.

Another interesting side benefit of an FBW system is that aerodynamic trim in all three axis can be controlled without having physical aerodynamic trim surfaces. This would simplify aircraft aeromechanical design. Instead of a trim surface, input from the pilot via traditional trim controls would be

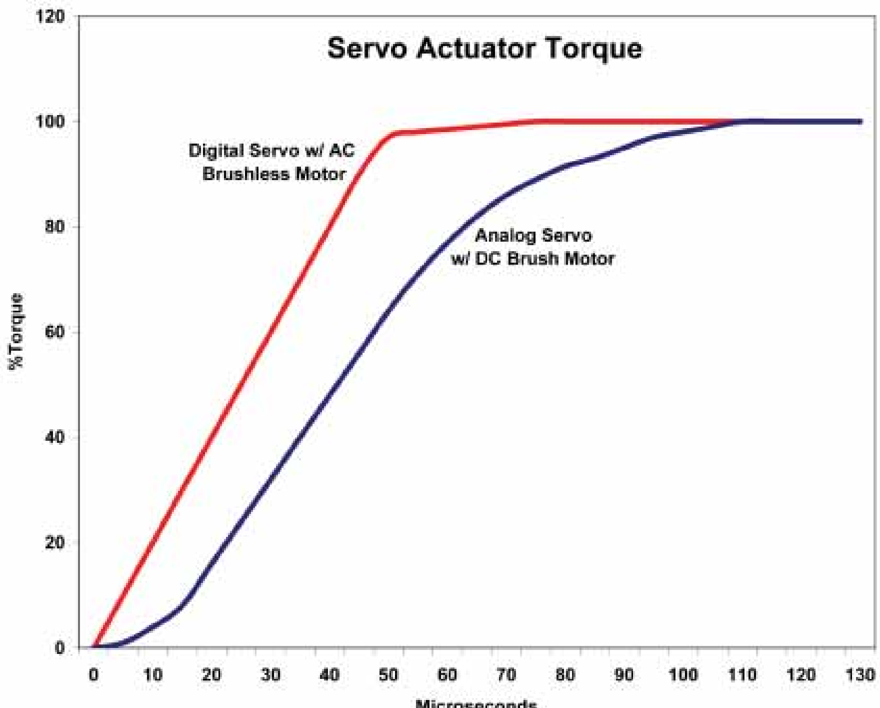
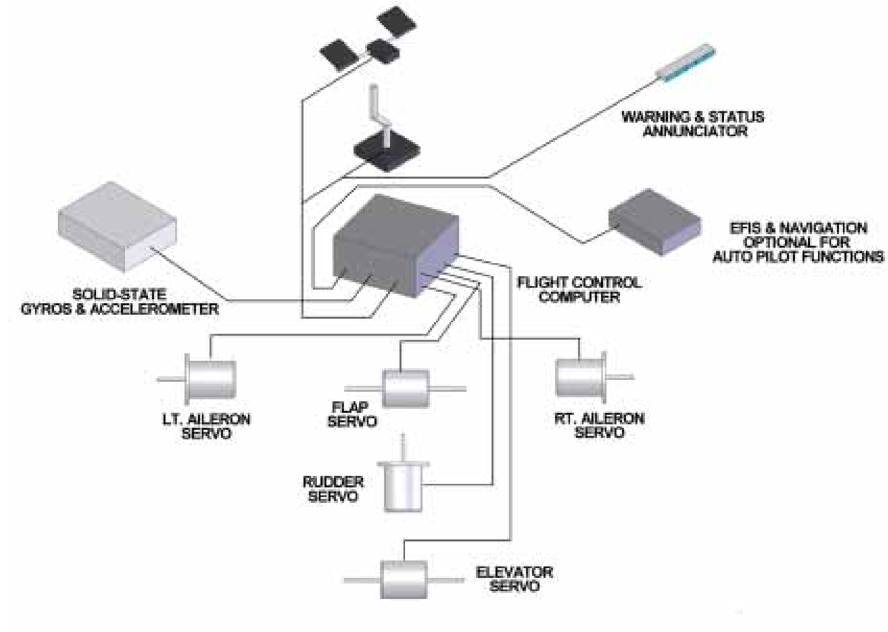


Figure 1.

electronically mixed by the FBW and fed directly to the main flight-control servo actuators. This has been done for decades in radio-control aircraft—trim acts as an "offset" to a control system rather than balancing aerodynamic forces.

Going a step further, an FBW aircraft could be made to actually maintain a given airspeed, climb rate, altitude or any combination of these without the pilot learning to control a complex autopilot. Functions like *airspeed hold*, *altitude hold* and *climb hold to xxxx feet* could be accessed by simple buttons on the instrument panel with the functions being integrated seamlessly throughout the entire FBW system, similar to automotive cruise control.

Some of the additional possibilities are having a stick-shaker, or audio, voice and/or annunciator panel warnings for various flight regimes, including stall or gear-up with ground-proximity detectors. All these things become inexpensive additions once an FBW system is installed.



The flight control computer is at the center of the FBW system, but like the servos and because there is no mechanical backup, it is required to be triple-redundant. Stick and rudder pedals have redundant force-position sensors as well as force-feedback. Solid-state gyros and accelerometers provide full 3-D situational "awareness" for the flight control computer—sensing motion with six degrees of freedom is essential.

Keeping the Look and Feel

An FBW system does not mean having to give up a traditional center stick or yoke in favor of a side-mounted, PC-simulator-style force-feedback joystick. In fact, the primary pilot flight controls can be any of the types presently found on aircraft. The FBW designer can choose from traditional pedals, yokes and sticks, side-mounted controllers, dual or single—all with the same look and feel as mechanically-linked flight controls.

Aircraft designed optimally for FBW systems can also someday take advantage of having less inherent aerodynamic stability, which translates to a more agile aircraft. This inherent instability is how some modern-day fighter aircraft achieve their incredible G-rates used in air combat maneuvering (ACM). In fact, aircraft in ACM are often inherently unstable. Furthermore, maximum G-rates in numerous flight regimes are limited by the FBW computer so as to keep the aircraft intact or the pilot from blacking- or redding-out.

For our less-extreme purposes, we might artificially (and reliably) alter the FBW outputs in various fight regimes to prevent conditions such as whipstalls and over-rotation tendencies, or to correct control stick pressures that are too light or too heavy. Often, a new aircraft design suffers from mismatched pitch and roll input forces, this being correctable by software rather than complex and time-consuming aeromechanical changes. Furthermore, rather than just the simpler force-feedback joystick, all the input controls could (and perhaps should) include a traditional combination of force feedback *and* distance displacement. This would provide a more natural feel to pilots who are transitioning from mechanical controls to FBW systems.

The flight characteristics of any FBW aircraft are computed within the FBW computer by numerous translation tables or translation equations called *functions*. These functions imply translated control input force and displacement into accelerometer-measured rate changes and control surface displacements. For example, automatic compensation for adverse yaw would be easy, thus providing feet-flat-on-the-floor flying by a specific programmed function. Naturally, the rudder pedals could be made to override the automatic yaw compensation system at any time for slips and other rudder-based maneuvers.

It's Still Your Choice

These functions could potentially be changed by pilot choices. Therefore it is a distinct possibility that the FBW pilot could choose from one of several operating modes such as stall-prevention mode or feet-on-the-floor mode. How these choices would be made, whether in-flight or pre-flight, and what actual flight characteristics might be customized gives rise to many philosophical and practical questions.

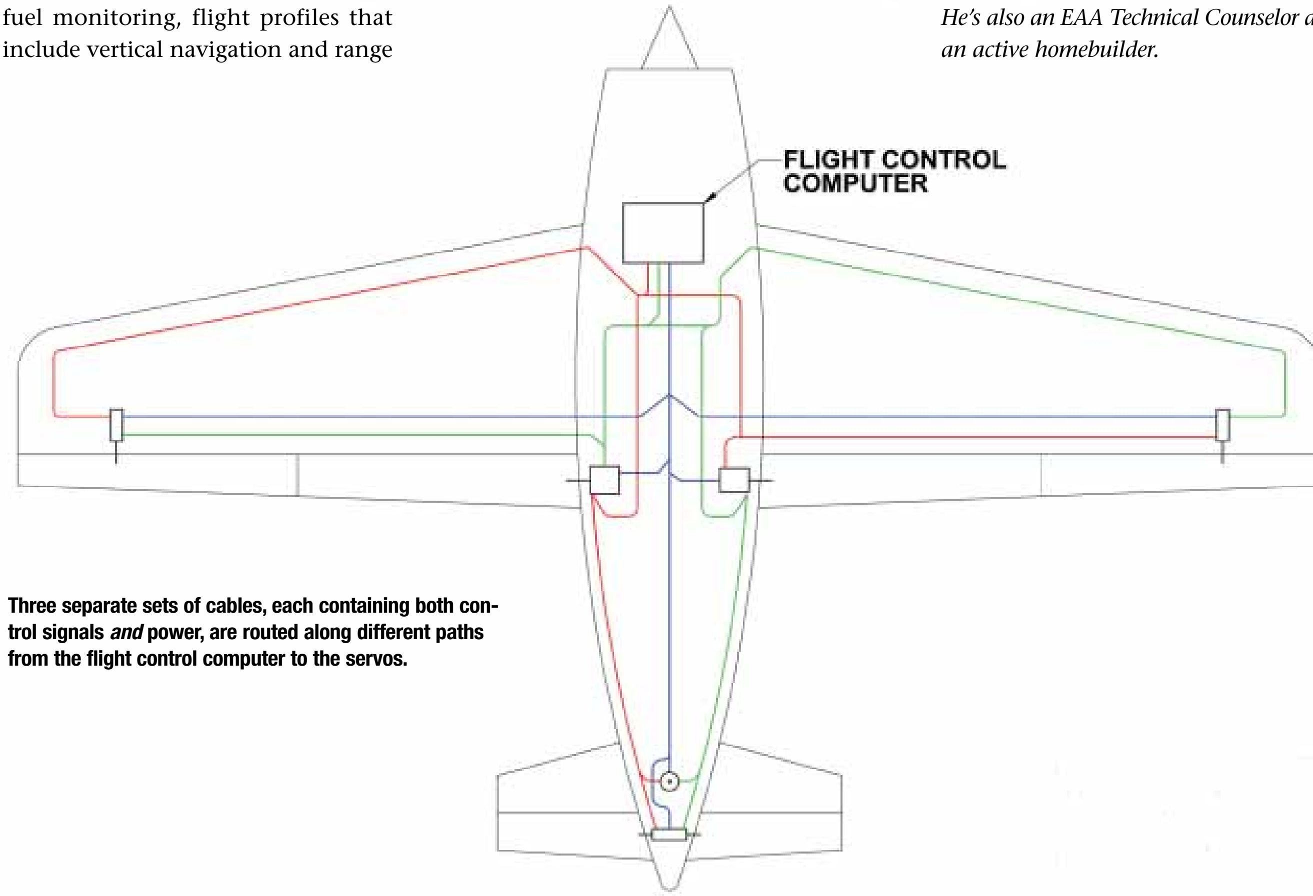
There are numerous considerations and problems to be solved that are not normally considered in traditional small aircraft, such as non-susceptibility to single-point failures, voting systems, redundant power sources, "battle-damage" wire routing, extreme-temperature circuits or temperature-controlled electronic housings, and transient protection from lightning and electrostatic discharge. And of course, the nature of a pre-flight inspection would have to change for an FBW aircraft, but the design of such a system would entail such considerations. Naturally, if traditional aircraft control systems are 99.9% reliable, then an FBW system must also be 99.9% reliable.

In the end, some of the additional benefits of a more automated, FBW aircraft are quite subtle. For example, such things give rise to automatic fuel management as opposed to fuel monitoring, flight profiles that include vertical navigation and range extension through efficiency. Better displays are also possible, such as delta-predictive displays and heads-out-of-lap navigation and systems monitoring. Once envisioned, there are many natural extensions of an FBW system.

An FBW aircraft is not meant to be a crutch for poor pilots. Instead, it stands to solve some of the age-old, traditional compromises between flight characteristics, aircraft feel, efficiency, simplified cockpit design and safety.

Stay tuned.

Mike Perkins has worked as a hardware and software engineering design manager for 28 years, the last 19 years designing life-safety communications systems for Rauland-Borg Corporation. Currently, he's exploring the possibility of converting a light aircraft to an FBW control system. He's also an EAA Technical Counselor and an active homebuilder.



Three separate sets of cables, each containing both control signals *and* power, are routed along different paths from the flight control computer to the servos.

With nearly 700 kits and complete aircraft in the market, Italian manufacturer Tecnam Spa can feel understandably proud. The company's core product is a high-wing, metal airframe, side-by-side two-seat aircraft in fixed tricycle-gear configuration. Called the Tecnam Echo, it's nearly a Cessna 150 clone—a safe, reliable and efficient design.

The Echo is a product of the Italian commercial aircraft industry. The first flight of the prototype P92 Echo occurred in Naples in 1993. Now built in Italy by Costruzioni Aeronautiche, the company's sales figures in 10+ years of production are testimony to its foresight.

Distributorships for Tecnam were established throughout Europe, Australia, Canada, New Zealand, South Africa and the U.S. Jon and Dee Hansen of Hansen Aero in Kennesaw, Georgia, serve as the U.S. distributor of the Echo kit. Currently, it's available as a 51%-legal kit only, but Jon Hansen notes that he has a list of pilots interested in a ready-to-fly Echo model. He will not take orders or deposits for that version until the light-sport aircraft proposal becomes a rule. And he should know— Hansen is a member of the ASTM consensus standards committee.

In Italy, Tecnam achieved full type certification for the Echo under JAR-VLA as a factory-built aircraft—the list of kits that started as certificated aircraft and then became kits is short.

The Italian Job

Two British builders built and flew Italy's most popular kit aircraft in six months.

BY GEOFFREY P. JONES

Early in the construction process, the author caught a glimpse of the firewall and partially completed instrument panel and cockpit area.

Team Echo

The builders of the Tecnam P92 Echo featured here are based on Guernsey, my home island in the British Channel Islands. David Williams is a 70-year-old retired sheep farmer, and Peter Franklin is a 61-year-old architect. Both are private pilots. Williams is also an accomplished glider pilot and past builder of two homebuilts: one a contender for the Kremer man-powered flight competition and the other a solar-powered design.

Franklin, with no previous building experience, held an instructor's rating, now lapsed. Both wanted a kit aircraft that they could build relatively quickly. It had to have two seats, preferably metal construction for durability, and the ability to be operated in the U.K. microlight category or the French ULM category. The aircraft also needed to fit into Williams' double garage during construction.

In late 2001, the British Tecnam dealer was Mike Rudd's MR Aviation at Hermitage, Dorchester. Thanks to Rudd's efforts with the Popular Flying Association (PFA), the P92 became a PFA-approved kit in 2000 in the small light aircraft (SLA) category. In this category, the P92's normal Rotax 912 or 912S engine is substituted with a lighter-weight Jabiru 2200A engine and a lighter fiberglass main undercarriage. Williams and Franklin chose this version, with 20 kits already under construction in Britain at that time.

But with so many kits to choose from, why the Echo? "The Tecnam almost chose us!" Williams said. In June 2001 while gliding at Lasham, Williams visited Rudd (who is also a PFA inspector) and was impressed by the design and the support available. Both builders liked metal construction, and they decided the Echo would bring them back to grass-roots flying at a reasonable cost. Also, if they experienced medical problems that restricted their regular PPLs, they could at least continue to fly their Tecnam Echo.

The kit was ordered in late 2001, and the pair started building—or more correctly, assembly—in February 2002. They began by sorting the parts and studying the manual, which was mainly pictorial and suffered from inaccurate translation from Italian to English. The early process of building was more like a working a jigsaw puzzle, trying to identify bits and components. Most of the kit was there, and Rudd provided excellent follow-up by supplying a few items that weren't included. Just before their kit was delivered, Williams and Franklin visited Rudd's workshop, where he was building another Echo. They took hundreds of photos of every conceivable part of the aircraft.

Hansen notes that since he built his own Echo, he has worked with Paola Pasquale of Tecnam to improve the inconsistencies in the manual. Now, the U.S. dealer will not sell a kit for a model that does not have accurate and easy-to-follow documentation.

Williams and Franklin called trimming and fitting the Plexiglass windshield the most difficult part of the building process.

The manual details the recommended order in which the Echo should be assembled—the undercarriage and wheels were first. By following the manual, no additional planning was required. Sometimes Williams and Franklin worked together and other times separately. To avoid discussion and possible argument between each other, if they were working on their own, they took on a small individual job. For instance, Williams assembled the two doors.

Creating an Echo

Both builders agreed that the most demanding part of the construction was fitting the windscreen, mainly because there were no reference points for a whole series of curves. Also, because the molded Plexiglas was oversize, they had to cut it—accurately! The cowling presented similar problems.

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They spent a lot of time putting parts together and then dismantling them, but nothing felt too technically demanding. Use of Clecos for holding and fixing metal skins was invaluable, but otherwise no special tools or equipment were necessary. They wore out two riveting guns, and the only tool they had to fabricate themselves was a special cranked spanner to install and tighten the holding bolts for the wingroots.

The wings arrived structurally complete, including the two wingroot fuel tanks and the ailerons/elevators. These latter items needed to be covered with fabric—a necessity in the quest to keep the aircraft's weight within its target. According to the pair, covering was also an enjoyable part of the project and required shrinking the fabric with an iron. Once the wings were complete and fitted, their alignment in relation to the tail was within 1 mm of true. The actual design plans allow a greater tolerance—this was encouraging!

Because Williams was retired, he often got to the workshop very early in the morning; by mid-morning he'd already done several hours worth of work. At least one partner managed to work on the Echo everyday. They both were looking for an acceptable and safe job, but one that could be completed in a reasonable time so that they could fly it.

When the PFA approved the design for British builders, they required about 12 small modifications to the standard Italian kit. Williams and Franklin made their own modification to the Tecnam-supplied seat when they managed to crack the molding. The 6-foot-3-inch Williams flies with the new seat fully back, with plenty of legroom.

The Jabiru 2200 wasn't ordered until they were halfway through construction; it was chosen to keep the aircraft's weight within the Microlight limits. The quality of the engine's manufacture was dazzling, and within 4 hours of it being delivered to the garage, they'd fitted it.

Then came a low point: the poor wiring information supplied by Tecnam. Alas, Williams and Franklin battled through and started the instrument

Flying the Echo

Builders David Williams and Peter Franklin were more than happy to allow me to sample the Echo for myself. Extremely light to handle, the Tecnam P92 Echo can be balanced on its mainwheels; when pulling it from the hangar, one person can do this easily by lifting the nosewheel from the ground and just pulling. External checks are quick—fuel is drained and the engine checked visually by removing the one-piece upper cowling, which is secured in place by four sturdy clips. You need to adjust the seats first, preferably with cushions. With a door on each side you can climb in, one leg in first, ducking your head inside, sitting down and then pulling the other leg in. It sounds like more effort than it really is, and I've watched the 6-foot-3-inch David Williams do this with ease.

When seated, you quickly get a feeling of spaciousness, both for your legs and shoulder-to-shoulder with your flying companion. It's wider inside than a Cessna 150, and there's plenty of headroom. The rudder pedals are in a comfortable position, and the twin sticks come easily to hand. There's a small flick-lever to engage the brakes on the two mainwheels, as well as a small hand-brake-type lever in the central console as a backup and to assist with ground maneuvering when taxiing.

A cool day and the Jabiru 2200 needs full choke to get it started—this is closed after about 3 minutes as the engine is running smoothly. The dinky, circular Microair radio and transponder are tuned, control movement and magnetos are checked. Letting the oil temperature increase slightly, we're soon ready for takeoff. Electrically operated flaps are lowered to 15° for takeoff and we're off.

As with so many aircraft of this class, the takeoff roll is short, and it's more a case of levitation than a conventional takeoff. The wind was about 15 knots straight down the runway, gusting up to 20 knots—it could have been a fairly lively day. By the end of the runway (4800 feet) we were already at 800 feet agl, climbing at 70 knots. One we were established level, I took control and started to explore the Echo's flight characteristics. The stick is firm and the controls very positive—a slight need for constant left rudder was illustrated with the newly fitted electrical turn and slip, installed in case "we accidentally fly into a cloud."

I settled at about 75-80 knots with 2500 rpm, and despite the wind, the Echo was solid as a rock. Williams and Franklin prefer to cruise at this speed because the noise level from the engine isn't excessive, and it's a more leisurely and enjoyable pace. Opening the throttle to 3000 rpm is quite practical, increasing the speed to 100+ knots. However, after removing my headset, both the engine and wind noise had increased substantially, which would be an annoyance on a long flight.

Cockpit room is excellent and the view is quite spectacular; the cockpit glazing extends over the pilots' heads so upward visibility is good. The Echo flies in a nose-down attitude, so the view over the nose is also good. The only problem is common to many high-wing planes: your head is stuck in the wing root, restricting your side view to the fuel sloshing in the two wingroot tanks.

An incredible roll rate belies the looks of the Echo—is it an aerobatic version? No, but with such crisp and positive controls, it's almost there. Slight rudder is required to maintain precision in turns, and the stall both clean and dirty is benign with just a mushy sink rather than any dramatic wing drop.

Flap limiting speed is 60 knots. Because of the wind, we flew the approach high and steep, 15° of flap for the majority of the approach at 55-60 knots. When we approached the threshold to land, we dropped the flaps to 45° and reduced the speed to 40 knots. In fact, our groundspeed was little more than 25 knots at touchdown. We could have landed safely in many of Guernsey's small fields, something many other planes could not accomplish.

I enjoyed the Echo; it would make an excellent and safe training aircraft, doubling as an economic and practical touring aircraft. I now fully understand the Echo's international popularity from building to flying—a superb all-'rounder in its class

—Geoffrey P. Jones

installation, adding a turn coordinator, a voltmeter and ammeter to the basic instruments supplied. A radio and Mode A transponder were added, and Williams then made a small dish transponder antenna out of a flattened and dished section of a Budweiser beer can.

Weighing In

Getting the weight correct was the most difficult aspect of construction. Williams and Franklin used only two coats of auto industry cellulose paint, and because of their maritime environ-

The Jabiru 2200, the lightest of the engine options, was chosen to power the Echo; it allowed the aircraft to qualify within the European Microlight category.

The Italian Job
CONTINUED

ment they sprayed all metal structures with Corrosion X before closing them up. They weighed the aircraft on high-spec scales from a local auto racing team, achieving their target weight of 265 kilograms (583 pounds). In addition, they did not fit wheelpants.

On August, 17, 2002, a low loader delivered the P92 from the garage to the Guernsey airport 1½ miles away. Assembly, mainly attachment of the wings, was rapid, as they'd done this several times before at the garage. The P92 is a fixed-wing aircraft; however, the simplicity of the wing and wingstrut attachment may entice some builders to detach the wings during periods of inactivity or to cut down on hangar rent.

First Flight

Williams and Franklin never had any doubts about flying the Echo them-

selves for the first time—Williams checked all of the critical bolts thoroughly, particularly the one securing the single strut to the base of the fuselage. The Tecnam Echo is a well-proven design, and there had been no major surprises during construction. It was built within design limits, great care was taken to get controls and flying surfaces within tolerances, and much time was spent checking angles with cardboard cutouts. The team had followed the assembly instructions impeccably, and they were confident the plane was ready.

The engine was ground run on many occasions; after each major run all critical bolts and fastenings were double-checked. Fast taxi and fuel flow tests were carried out on August 21, 2002, with the first flight taking place at Guernsey airport at 6:15 the following evening, exactly six months after construction had commenced. Franklin

Final attachment of the wings came after the project was moved to Guernsey Airport, prior to fuel flow tests, final inspection and taxi tests.

◊ Preparing for the aircraft's second flight, co-builder Williams takes the left-hand seat of the pair's finished product.


Williams (left) and Franklin completed the test flights on their own.

drew the honor of making the first flight, his flight instructor experience (and the fact he'd flown another P92 a few weeks earlier) giving him the edge.

During the first 12-minute flight, he climbed to 2000 feet, established the takeoff speed at 50 knots and the stall at 40 knots, checked out the flap operation and made a perfect landing. "The first flight wasn't really an issue," he said. "I was totally confident that it would perform exactly like the other Echo I'd flown."

Then it was Williams' turn to indulge in a 15-minute flight. Both reported straightforward and docile handling that was both agile and precise, only requiring a slight trim adjustment to compensate for the right rudder. For its class, the Echo has a great rate of roll, and the stall is benign—it doesn't drop a wing easily. The electrically operated flaps are efficient and work very quickly.

Success!

The single runway on Guernsey airport often suffers crosswinds, and Williams and Franklin enjoy the Echo's handling in these conditions. The maximum they've experienced was a 15-knot crosswind component at 90° to the runway. It wasn't an issue. Taxiing safely under those conditions, however, required considerably more skill. The Echo has electric trim, hydraulic disc brakes and nosewheel steering. As the builders put it: "It's a practical and proper aeroplane." This is exactly what they had in mind when they ordered the kit, and they have not been disappointed.

In one year from the first flight, Williams and Franklin have flown just more than 100 hours in the Echo. Every flight from Guernsey is over water, and the Jabiru-powered Echo has handled it well. The Echo passed its annual inspection easily; Williams and Franklin took the aircraft apart, greased all the relevant parts and soon had it back in the air.

I asked both builders whether they were inclined to build another aircraft. Nope, they said—they enjoy flying the Echo too much to start again.

FOR MORE INFORMATION, contact Hansen Aero, the U.S. dealer, at 770/427-6311, or visit www.hansenaero.com. The manufacturer's site is www.tecnam.com.

A Little Personality

Builders get creative with the usual creature comforts—from the inside and out.

EDITED BY CORY EMBERSON

Nothing is as irresistible to any creator as a blank canvas. For homebuilders, the thousands of hours, tens of thousands of dollars and more than a few missed dinners culminate in dessert: putting a personal stamp on your airplane. The interior of the plane is where you spend your time, so comfortable seats and a pleasing panel greatly enhance your quality of airborne life. And your choice of paint schemes really can create a powerful first impression.

Finding builders who are proud of their plane's exterior and/or interior was easy—selecting just a few was not as easy. These builders were among the many who have done something special with the appearance of their homebuilts.

Ken Balch's RV-8

My RV-8 was completed in May 2002, and the paint job was done in mid 2003. I always knew that I wanted to have a patriotic paint scheme on my plane, and after vacillating between several designs, I finally settled on the waving, rippling flag. I wanted it to appear as if the plane had flown through a large flag, which then draped back along the airplane. For aesthetic reasons, we decided to stray from the strict proportions of the actual flag, resulting in the stylized version on the finished airplane. I chose the flag design because I wanted my airplane to be a visual representation of my patriotism.

I did nearly everything myself, and my wife, Jean, bucked all the rivets I couldn't reach. She's been in every nook and cranny of the airplane as much as I have and deserves a huge portion of the credit for making the airplane building experience both possible and enjoyable.

I've flown approximately 150 hours on my plane since completion. The most significant thing I learned was just how long it takes to design and execute an artistic paint job.

I did enlist just a little professional assistance during this process. I had the seat cushions upholstered and the exterior paint scheme executed by John Stahr, an incredible artist who has also become a good friend.

Once John had the plane in his shop, the design continued to evolve. It was entirely his idea to render the stars and N-numbers to appear as if they were embroidered on fabric. It's a wonderful effect and is even more striking in person. The interior does not continue the exterior scheme, but John did paint a sort of Vargas girl on the inside of the oil door in the cowling. She's actually pretty tame!

God bless America! Ken Balch's RV-8 is the picture of patriotism and hard work. Balch called upon artist and friend John Stahr for assistance with the exterior paint scheme.

The exact paints used were selected by John, and I couldn't be happier with the results. He chose the perfect red, white and blue shades and added a nice pearl as well. After several coats of clear and a lot of wet sanding and polishing, the plane looks fabulous! The exterior paint process (filling, priming, etc.) took about six weeks to complete. How much did it cost? More than I like to recall.

Would I do it again the same way? Absolutely! Building my RV-8 was a completely life-changing experience. Even more than the technical expertise I acquired, and beyond even the pure joy of flying my creation around the country is the incredible camaraderie I've found among my fellow RV builders. It is marvelous to find so much knowledge that is shared freely between total strangers (but for the RV bond), who would later become friends.

I found that there was no cohesive group of RV builders and pilots in the eastern New England area, so I formed the Boston RV Builders Group in September 2000. That group now has more than 80 members and has hosted two annual fly-ins (each June at KASH). I'm very proud of my association with these guys!

Everywhere I go, people come to view the plane. My flight back to Massachusetts from the paint shop in Oregon was quite an experience. Three different cops complimented me on the plane, and a regional airline captain sent his crew to their airplane and continued on the shuttle van with me to view the RV. Even a Coast Guard helicopter crew shut down their machine and ran over to see N118KB when they saw I was about to start up and leave. Nearly everywhere I land, people watch, wave and point as I taxi by. Tower controllers usually have something complimentary to say on the frequency as well. The reactions to my paint scheme have been unanimously and vociferously positive.

Kissimmee, Florida
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PHOTOS: THE BUILDERS

A Little Personality
CONTINUED

Bob Gross' F1 Rocket

I came up with the idea for the Rocket's paint scheme when I built a "boss hoss" custom bike a few years ago. I spent many hours admiring paint jobs on other bikes and settled on the flames idea. When it came time to paint the Rocket, the blue and flames idea seemed as far from the traditional "white with trim stripe" as I could get. The lettering on the cowl reads, *Adequate Overkill*. I'd still love to see more airplanes with trick paint jobs!

I wanted to paint the Rocket myself, as I think that paying someone is the easy way out. By doing it myself, I not only felt immense gratification, but also got it down the way I want and saved a truckload of money.

When the project was nearly complete, it was ready for paint. It took me 21 months to get this far. I had never taken on such a big project before, especially painting.

The colors I used were "laser red" and "electric blue pearl coat." Each part took at least one day. The elevators and rudder took four days each. I used two types of fillers; all of it was on top of PPG Industries DX 1791 wash primer, which gives the metal a gold color. The fillers are Z-grip for big area, and "Icing" for thin areas. This Icing stuff was fast and easy to sand; it's sandable after 25 minutes. The last coats are K-36 primer.

I also designed a handy homemade spray booth, made from PVC pipe and plastic sheeting. There are three box fans with filters to provide airflow through the booth and then outside through a rollup garage door. I can control the door opening—and thus airflow—with a garage door opener remote control. There are eight fluorescent lights inside the booth and two portable 500 watt floods—still not enough light, I'm afraid.

An unexpected benefit of this ambitious project was that I am now a great painter and own five different paint guns.

What did I learn? Wow. I learned what works. I discovered that K-36 is the most fantastic primer made. I learned that you can paint an airplane with a 2-hp compressor using an HVLP gun even though they said it couldn't be done. I learned about respirators, induction periods and how to sand bugs and dust from my paint.

I did all the work myself—every stinking bit of it. No professional assistance here. I used the usual sheet metal shop tools. It pays to get a nice shear and brake. And of course, I used lots of good sandpaper and an Ingersoll-Rand 4151 DA sander. It took two years, two months to build the plane, and four months of working pretty hard to paint it. Total cost of building: $71,800, $2500 to paint it.

Would I do it again the same way? Not a chance. If anyone had told me it would take four months working everyday to paint this aircraft, I'd have thought they were crazy. Next time, I'll pay someone to paint it and settle for his quality. Painting was really hard. But flying it is really, really fun.

Jupiter, Florida
rpgross@bellsouth.net
www.f1-rocketboy.com

The idea for the Rocket's paint scheme was spawned from a "boss hoss" custom bike that Gross built a few years ago.

Aside from learning how to build his F1 Rocket, Bob Gross discovered he has a knack for painting, too. However, with flying being his first love, he says he'll leave the painting to a professional next time around.

Choosing colors known as "laser red" and "electric blue pearl coat," Gross said it took him about one day to cover each area—the elevators and rudder took four days each.

Greg Cardinal's Pietenpol Air Camper

This is the instrument panel for the Air Camper that my friend Dale Johnson and I are building. The front cockpit panel features a veneer that is matched to the rear panel. The veneer was glued onto birch plywood. The instrument panel is burled black walnut veneer; I would like everyone to know that Dale is responsible for the furniture-quality work.

I didn't have a specific design inspiration for my panel—only a desire to use a unique wood and to keep it simple with as few instruments as possible. The instruments are laid out symmetrically, and no unneeded instruments are included. The compass, which is also homemade, will be mounted on the cowling behind the windscreen, and the airspeed indicator is a windvane mounted on one of the left struts.

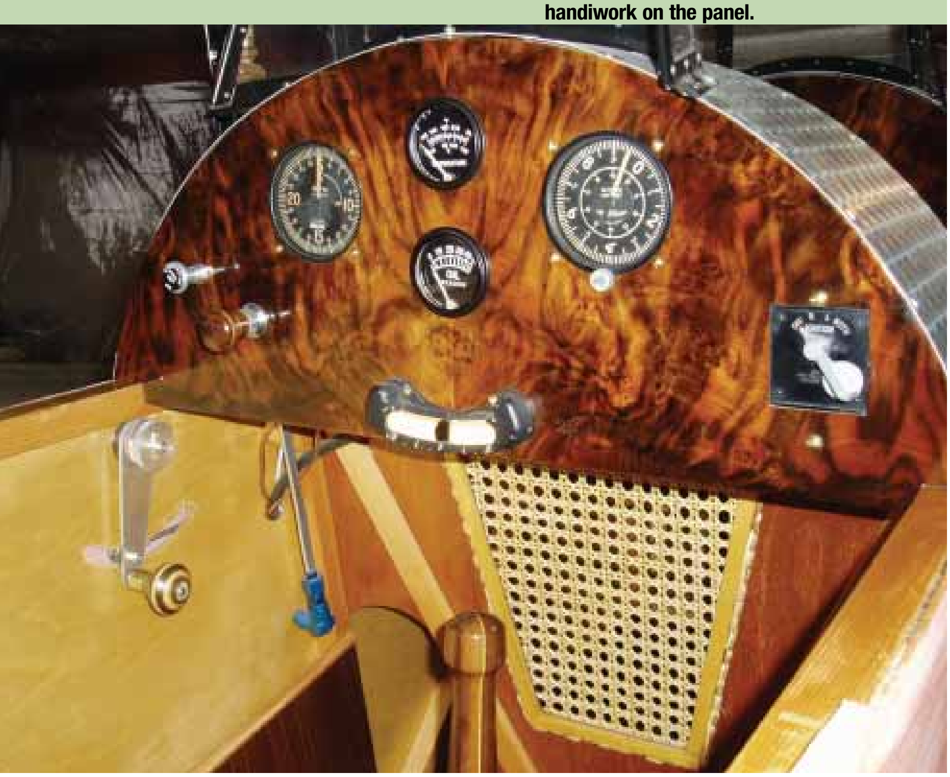
Dale and I live just 10 minutes apart here in the Twin Cities. He has a beautiful workshop at his house, and we wanted to build something that was unique *and* high quality. We stayed close to the original design with minor exceptions. Instead of a steel tube control stick, we turned a walnut block that had been laminated with maple to the same dimensions as the stick in a WACO ATO. The control column is walnut with maple inlay. I always wanted WACO stick time, and this is as close as I'll probably get! The primer and throttle knob are laminated and hand-turned.

The seat bottoms are also walnut veneer, and the seat backs are hand-wickered instead of made of plywood.

It's a lot of fun to hear compli-

Taking it to the next level—using PVC pipe and plastic sheeting, Gross designed his own homemade spray booth.

Almost ready to go—Greg Cardinal's Pietenpol Air Camper is prepped and ready to be painted in time for its expected debut flight in spring 2004.



The furniture-quality instrument panel in Cardinal's Air Camper is made of burled black walnut veneer. Cardinal credits his friend and co-builder Dale Johnson for the handiwork on the panel.

A Little Personality
CONTINUED

ments and answer questions about a project like this. Doing quality work does take extra time, and I would estimate that this project has taken about three years longer than necessary to complete due to the extra work. Dale is a master craftsman, and after working with him I learned the true meaning of quality work.

The airplane is in the final stages of painting and is expected to fly in spring 2004. The wings have been painted to completion, and the tail feathers only need the blue trim.

All of the work was done by us with the exception of the engine mount welding, which was farmed out. We made wheel hubs, some of the turnbuckle barrels, compass, cowlings and windscreens. Even the cowling access panel latches were turned out of brass and soldered together.

A Pietenpol is an inexpensive plane to build. We estimate the completed cost to be about $12,000. If we build another one, it will be built to the same standards—it won't take us as long the second time.

Minneapolis, Minnesota
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Bryan Lee Fisher's Kitfox Speedster

I spent four and a half years off-and-on building my Kitfox. I originally bought the kit as the long-wing model, and I decided to cut the wing down to the Speedster wing to add all the Speedster mods that were available from SkyStar. These mods include the shorter wing, the Speedster radiator cowl, Speedster wingtips, intercoastals in the tail feathers, wheelpants and lift strut aerodynamic dress-ups. I am running the Rotax 912 with a Warp Drive prop under the round cowl.

I really wanted to make this plane something special and incorporated several changes in the kit. I made and added streamlined cuffs on the jury struts and tail feather struts. I built my own custom storage area, which really dressed this area up. I put all tinted windows in and made my own trim pieces to surround the door windows.

The door latch and door interior covers were my own design, as was the seat upholstery. I had a picture of 912KS digitized onto a disk, and the embroidery shop put the picture onto a piece of interior seat fabric. The Experimental placard is also embroidered onto the doors.

I am a high school shop instructor, and the instrument panel is my own design, based on what I wanted. I made it bigger and then covered it with Carpathean burled elm. I sat around and organized cutouts of instruments onto a piece of cardboard; once a size was decided on I cut out the aluminum panel and then attached the cutouts on this. I then started cutting the holes for the instruments. I ordered the veneer and glued it to the aluminum, cut out the openings, and applied two coats of what is called Envirotex—a thick, glossy two-part varnish that you see on a lot of wood clocks. I was worried about how well it would hold up but it has been on since early 2000, and it still looks fine.

Aside from the instrument panel, both the door latch and door interior covers were designed by Fisher, as well as the plane's seat interiors.

I designed and made the pieces for the cabin to wing area. The paint scheme came from the Speedster prototype. I used Dupont Imron White 7372 and Berry Red Metallic 44464 paint; the accent stripe is Silver Metallic 44434, all over Stits fabric.

I built the plane myself with some help from my wife and two kids. The only things that I received outside help with were the embroidery work on the seats and the stitching of the actual seat itself. The rest of the interior I did myself.

I first flew the plane in August 2000 and flew it to Oshkosh in 2001, where I was blessed by winning the Outstanding Workmanship award in the homebuilt class. I was also proud and happy to receive the Builder's Choice award from SkyStar. I love to talk airplanes and will be glad to speak to anyone about my plane. It usually draws a crowd of onlookers, who want to ask questions. This really makes me feel good and that the time spent on building was well worth the effort.

The Kitfox Speedster is a blast to fly, and with the fact that this plane may fit into the sport-pilot license, I believe there will be many of them flying for a long while.

Emporia, Kansas
620/343-6086

Originally purchasing his Kitfox Speedster as a long- wing model, Bryan Lee Fisher decided to trim down the wing on his plane so he could add more mods to it, such as the Speedster radiator cowl and Speedster wingtips.

The color scheme for Pat and Carol Fagan's Bearhawk was based not only on Pat's background as a former air tanker pilot, but also on his fondness for Aero Union's paint scheme.

Pat and Carol Fagan's Bearhawk

We completed our plansbuilt Bearhawk #232 in January 2003, after 4200 hours of building throughout six and a half years. We were the eighth Bearhawk to fly, with nearly 700 plans sold. We followed the basic plans, making changes only in the basic paint scheme, adding patroller doors, rear cargo doors, a skylight and side steps. My husband, Pat, engine-turned the instrument panel.

Pat had a background in air attack aircraft and liked the color scheme of Aero Union's planes. A friend of ours owns a Maule, which had patroller doors, and we loved the visibility factor and look of them. Cargo doors? Why would anyone not add them? They are so useful and practical. We both had flown airplanes with skylights and liked the visibility in steep turns and especially in the landing pattern. Side steps? No one has long legs like the Bearhawk designer Bob Barrows! We decided we wanted them, and Bob looked over our plans and advised us on proper support needed for loads and stress.

Because Pat used to fly air tankers and liked Aero Union's paint scheme, he designed ours around that. Since he flew air tankers and we had a Bearhawk, we designed the decal and named our airplane *Smokey Bearhawk*. We used the original designer's Bearhawk logo for our seats and put his decal on our wingtips.

We wanted to make our airplane nice looking and practical. Our results have been so personally satisfying from friends, builders and airshow attendees—they really like what we did.

Known as *Smokey Bearhawk*, the Fagans' plane is equipped with an instrument panel that was personally designed by Pat.

We learned that we worked well as a team, brainstorming ideas and communicating about what we wanted out of our airplane. My husband was so good about making it *our* plane, even though he did 99% of the work. He learned to TIG weld, we took a fabric workshop together and did all the work ourselves, except sewing the upholstery on the seats we designed.

Pat made the first flight on January 26, 2003, and we have 190 hours on it at the time of this writing. Our EAA Technical Counselors and Flight Advisors, as well as the Tools Coordinator's experience, were exceptional. Our DAR gave us some good advice on securing the fabric on the trailing edge of our skylight. We agreed with him—we did *not* want our fuselage fabric to turn into a banner tow!

Pat had the desire to build an airplane, and he is very happy and proud to fly his own plansbuilt airplane. But, unlike other builders, he won't do another. This project took care of his urge to build. He is now back to restoring old cars. ✈

Pear Blossom, California
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Building A SeaRey, Part 3

We design and install the electrical system, assemble the SeaRey and prep it for inspection.

BY DON MAXWELL

Last month, we installed the engine in the SeaRey, hung the propeller, designed and cut out the instrument panel, and selected the trim for the exterior of the fuselage. This time, we'll delve into the electrical system, cover the wings and tail, and *finally* assemble the SeaRey. And of course, we'll walk through what needs to be done before the FAA inspector shows up.

The Schematic

The next step was to draw up a schematic diagram of the entire electrical system, then work out the best routing for the wires. While this might seem like an overwhelming task for someone new to electronics, I had worked as an aircraft radio repairman in the Army decades ago so I knew that it wouldn't be too tricky.

Basic schematics for the electrical system (including the electric trim, flaps and hydraulic landing gear) came with the kit. And each other electrical device I had added came with a schematic or wiring diagram. So all I had to do was combine them into one comprehensive diagram. In essence, I just had to be sure I hadn't left anything out and that positive connected to positive and negative to negative. The diagram didn't need to look beautiful—I used a pencil and did plenty of erasing. When I was sure it was complete, I photocopied it for a more permanent version. Of course, it *wasn't* complete, and later I added several things. But all that's needed, really, is a way to keep your thoughts clear during construction and a reliable reference for repairs or modifications later on.

The Wiring

With the schematic finished, I had to decide where to run the wires in the airplane. (Actually, I was working on this while drawing up the schematic, but I've separated the steps here, hoping for clarity.)

There are only a few basic considerations, but they're common to just about all aircraft. One is to use wires designed for aviation. In practical terms, this means stranded copper wire with Teflon insulation that will withstand at least 160°C. Insulated connectors should meet the same temperature requirement. Another is that the wire gauge must be sufficient for the current drawn by the equipment it supplies and the resistance of the wire itself, which increases with length. And you need to wire the grounds, rather than

Following this month's tasks, the SeaRey anticipates first flight.

The author built a wing rotator stand of 2x4s to support the root end of the wings.

relying on the aircraft's framework for ground connections.

Also, wires that might conduct or radiate electrical noise to the radios and intercom need to be shielded, and as much as possible they should be kept apart from the other wiring. In my case, this meant running the shielded ignition wires along the left side of the fuselage from the engine to the ignition switch. The rest would pass along the right side.

It was at this point that I thought I'd be clever and prepare wire bundles on the bench before installing them in the fuselage. It was a good idea—except that it just about doubled the time for the job, because it was necessary to measure the length of the wire runs, up, down, around corners and everywhere else. It would have been much easier to run each wire separately and cut it to length right in place. Also, I later found myself adding a few circuits, so the whole process turned out to be harder than necessary.

Originally I planned to wire the panel separately and use multi-pin connectors to connect it to the fuselage wiring. That, I reasoned, would make it easy to remove the panel from the airplane when repairs or modifications were necessary. In the end, however, I scrapped the idea and used the panel for the starting point of almost all circuits. With no connectors, there could be no connector corrosion, and because the SeaRey would be wet a lot—it *is* a seaplane, after all—that seemed to be a better idea. Adding about 3 feet to the wire bundles allows the panel to be unfastened and laid across the seats without disconnecting anything.

When all of the wiring was in place, I tested every circuit (except for those extending to the wings, which weren't even built yet). Then I enclosed

Here's the wing structure—the author riveted the pre-formed aluminum-tube wingribs to the fore and aft wingspars.

Covering the aircraft according to the Stits Poly-Fiber method proved one of the most enjoyable parts of the project. The first step in the process is to prep the framework with Poly-Brush (the pink stuff).

PHOTOS: DON MAXWELL

Build a SeaRey
CONTINUED

all of the wire bundles in split-loom tubing to protect the wires and hide my later additions.

And so the fuselage was finished. Well, finished enough to roll it outside and test-run the engine for the first time.

Clear Prop

With my son Jonathan standing by with a fire extinguisher and the tailwheel tied to two hefty dog-tethers corkscrewed deep into the ground, it was time to see if the Rotax would run. I had primed the lubrication system with compressed air, and then turned the engine over with the lower spark plugs removed until the oil began circulating and the needle of the oil pressure gauge came off the peg. I had checked the oil level and double-checked the fuel connections and the wiring—this was it.

Master switch on.

Auxiliary fuel pump on.

Choke on. (Yes, Rotax four-strokes come with a choke on each carburetor.)

"Clear prop!"

Turn the switch and…

"*Whooie*!"

With the fuselage completed and parked outside under an inflatable "hangar" made of 6-mil polyethylene and a window fan, there was room in the main hangar to build the wings.

The Wings

I had been anxious about this part of the project because the wings are fab-


Next, the fabric is glued to the framework using a special cement called Poly-Tak.

ric-covered, and I had never done any fabric work before. But I jumped in, and in the end found that the fabric was in many ways the most enjoyable part of the whole job.

First I built a wing rotator stand of 2x4s to support the root end of the wings and used a tall box to hold up the tip end. Later, I worked out a way to support the wingtip with a single steel rod inserted in the navigation light hole so that I could rotate the wing from the root end without any assistance.

The wing framework is aluminum tubing—two hefty spars and struts bolted together and made amazingly rigid by two crossed cables inside each wing.


Prior to ironing, the fabric looks as though it doesn't stand a chance of providing any lift.


Turn up that iron to 250°, and the fabric tightens up; iron over it again at 350°, and it's as taut as a drumhead.

The ribs come pre-formed of ½-inch aluminum tubing, which I riveted fore and aft to the spars. The only tricky part was remembering to align the ribs perpendicular to the *rear* spar, not the swept-back forward one.

The fiberglass wingtips needed only slight trimming and holes cut for the nav lights. Before riveting them to the end ribs and bolting them to the rear spar, I temporarily installed the aileron and flap frames to be sure that there would be sufficient room for them inside the aft-curved wingtip.

The leading edge of the wing is a pre-formed cuff of light-gauge aluminum pulled tight against the forward spar and riveted over the ribs, top and bottom, and the fiberglass wingtip. Working alone, I used eight nylon ratchet straps to hold the cuff tight while riveting it in place.

I remembered to install wires for the navigation lights, strobes and landing lights, and then it was time to cover the wing and tailfeather frames with fabric.

Fabric

The SeaRey wings and tail are covered with the Stits method—now called the Poly-Fiber system. It uses polyester cloth, a special cement and three types of vinyl-based coatings: a sealer, a UV protector and the finish paint. Unlike the old doped fabric coverings, a finished Poly-Fiber wing does not burn readily.

I had previously attended a half-day Poly-Fiber workshop at Sun 'n Fun

After smoothing out the fabric, the author again went back to ironing, but not before he applied finishing tape over the ribs and seams.

and would highly recommend it because it gave me the experience of covering an elevator, making and correcting mistakes, shrinking the fabric and then uncovering the framework. I certainly wasn't an expert afterward, but at least I'd had some hands-on experience with fabric work and knew how forgiving the Poly-Fiber system is. I had also read the instruction manual twice and watched the video of Ray Stits covering an airplane.

I found a product called Liquid Gloves indispensable; rubbing a small amount on my hands protected them from absorbing the chemicals in the Poly-Fiber system.

The work went quite easily. Prep the framework with Poly-Brush (the pink stuff), then glue the fabric to it using a special cement called Poly-Tak.

With the fabric cemented onto the frame, it was time shrink it taut. Following the Poly-Fiber instructions, I calibrated an ordinary clothing iron's thermostat for 225°, 250° and 350°. And then the magic part of the project occurred.

Before ironing, the fabric is baggy, and it doesn't seem as if it could possibly produce any lift. Iron it at 250° and it suddenly tightens up. Iron it again at 350° and it's taut as a drumhead.

It won't *sound* like a drum yet, though. Wait until the first coat of Poly-Brush is dry! That seals the weave of the fabric and is the second stage of the magic, causing the fabric to go "boom" when tapped.

Next, I applied finishing tapes over the ribs and seams, ironed them smooth—you get *lots* of ironing practice!—then sprayed on two cross-coats of Poly-Spray (the silver stuff) to block UV light that would otherwise degrade the polyester fabric.

The last step in building the wings is attaching the fiberglass leading-edge extensions—they keep the ailerons flying until well after the inboard portion of the wing has stalled.

Fiberglass leading-edge extensions attach to each of the SeaRey's wings. These keep the aileron flying until well after the inboard portion of the wing has stalled.

Painting

Paint is the final part of the Poly-Fiber system. I decided to use Poly-Tone, the easier of the two choices, because it's a one-part vinyl paint, chemically similar to the other materials and, like them, soluble in MEK. That means it's easy to apply and easy to repair. The only disadvantage in my view is that it's slightly less glossy than the other choice, Aerothane, a two-part epoxy paint that requires a forced-air respirator instead of the passive one that filters out Poly-Tone. Aerothane is also harder to repair because you can't just wipe it off with MEK.

I selected Insignia White because that color is close enough to the fiberglass gelcoat that I wouldn't have to paint the fuselage. Two coats were sufficient. I sprayed in cool weather, which retards the drying, thereby increasing the shine of the finish enough so that it matches the gelcoat quite well. A coat of Carnauba paste wax protects the finish and makes it shine quite nicely.

For all of the spraying, I used an inexpensive HVLP gun from Home Depot; it was easy to use and did an excellent job.

Final Assembly

With the painting finished, all that remained was to move the three main parts to the airport. The wings and miscellaneous things fit easily into a 26-foot U-Haul truck. The fuselage would have fit into the truck, but that would have required building a ramp and removing the prop, so I used a trick from the SeaRey web site—I hired a tilt-bed tow truck.

The final assembly completed at the airport, the SeaRey awaits its airworthiness inspection.

The driver simply winched the fuselage up the inclined bed, tilted it level and strapped everything down good and tight. No problem! (Of course, I was nervous, following behind.)

With the three major parts in the hangar, my son Chris helped me attach the wings. Normally this is a three-person job, but we managed it by using a length of 2x2 as a stand-in for the other son, who was too far away to help. (I think he was a little let down that it didn't require at least a 2x4.)

Two AN4 bolts attach each wing to the root tube, and a third—a heftier AN5—holds the struts to the fuselage main bulkhead.

After that, connecting the fuselage-to-wing electrical wiring and the pitot hose went quickly.

When everything was connected, I rented a set of certified scales and weighed the airplane. (This is where I had second thoughts about adding all those extras.) Working out the weight and balance figures was relatively easy because the kit includes typical data.

And—*finally*!—the airplane was ready for the FAA inspection.

The Conclusion

Will I finally get to fly my new SeaRey after all these months of hard work? Find out in next month's series conclusion when I discuss some of the complications that occurred—before I could get my SeaRey into the air! ✈

FOR MORE INFORMATION on the SeaRey, contact Progressive Aerodyne at 407/292-3700 or www.searey.com

From Steam Gauges to

Glass Panels

The glass cockpit promises a clear view for aviation, but don't overlook transition training.

BY GARY JONES

Here's what the G1000-equipped Cessna 182 instrument panel looks like; the screen on the left is the PFD, and to the right is the MFD. Three "steam"-powered instruments remain below the displays for backup.

Nothing has revolutionized the modern flight deck like the glass cockpit. Instead of viewing dozens of steam-powered gauges scattered around the instrument panel, everything is now in one spot. Aviators who are privileged to use this technology now are truly looking at the future.

For those readers who haven't yet had the pleasure of flying one, a glass panel resembles a flat-screen computer monitor; multiple overlays can be viewed at the same time. For example, the pilot can overlay weather and traffic data on top of the moving map. It's wonderful to have this critical information, but it will take time to learn how to both digest and sort out.

Behind the well-deserved hoopla and hype, there is a serious learning curve for the new user. The novice aviator might think the transition from round gauges to the flat-screen presentation would be a snap. The truth is that it will require several hours of instruction and practice before a pilot will be comfortable with this display. Once it is mastered, however, no one will want to return to the technology that saw us through the first 100 years of aviation history.

A few years ago, I was sent to Montreal, Canada, to get checked out in the Canadair Regional jet. This aircraft has six glass panels that encompass everything from flight information to system analysis. Sharing my experiences might prove helpful for those considering flying behind a glass cockpit.

New Technology, New Terms

Conveniently mounted in front of the pilot is the primary flight display (PFD) screen, which comprises the attitude indicator, altimeter, airspeed, directional gyro and vertical speed information. The great thing about having everything in one spot is that the pilot no longer has to scan as much to find what he/she needs. It's all there; it simply looks much different.

To the right of the PFD is the multifunction display (MFD). This display is used for weather radar, GPS, engine instruments, traffic advisories, radio frequencies and more. "Knobology" is important here—knowing what knob to use to get the screen you want will be frustrating at first. You've heard that in real estate the three most important things are location, location and location? In this arena, the most important things are practice, practice and practice.

The first thing that caught my eye on the PFD was the large attitude indicator sitting at the upper center portion of the screen. Underneath what is referred to as the skypointer is a small rectangular shape. The rectangle skids left or right to let the pilot know if the turn is coordinated. That's right, the turn and bank as you remember it is gone.

Flanking the attitude indicator are the airspeed indicator on the left and the altitude indicator to the right. Both indicators are vertical tape gauges. It seemed unusual to me to have tape gauges here, but in time I was comfortable with them. A great feature of the airspeed tape is that it turns yellow and red when approaching a stall. It also encompasses a trend vector that will let the pilot know what the airspeed will be in the next 10 seconds.

Beneath the attitude indicator is the HSI/directional gyro with a heading bug. The proximity and size of the flight instruments made scanning the instruments less demanding. On the other hand, it took time to get used to the vertical tape gauges. Keep in mind that this display is quite different.

Once you've got the layout down, the next challenge is translating the information into the proper mechani-

PHOTOS: COURTESY AEROTRONICS AND GARMIN

Aerotronics debuted this all-glass Lancair IV-P panel at Sun 'n Fun this year. The main features include the following: (1) Sierra EFIS from Chelton Flight Systems, (2) Dynon D10 EFIS, (3) Sandel electronic HSI, (4) TruTrak DFC-250 or -300 digital autopilot, (5) Garmin 530 and 430 panel-mount GPSs, (6) Garmin GNC 340 audio panel, and (7) Garmin GTX 327 transponder.

Glass Cockpits
CONTINUED

cal inputs so that the airplane is doing what is required—it is like learning how to walk all over again.

Take Time to Train

So much data can be displayed that it is sometimes a bit intimidating. There are a number of overlays that can be placed on the MFD. The challenge is learning how to interpret all the data. Something that will help is to limit the number of overlays you are looking at. It is incredible to have so much information, but taking it one overlay at a time will speed up the learning process and reduce the frustration level. Once you have one overlay mastered, you add another. You may want to limit yourself to three overlays at one time once you have your interpretation skills mastered.

It is no secret that Cessna Aircraft and Garmin have joined forces to offer glass cockpit technology for 2004. This year's Cessna 182 and Cessna 206 come with the Garmin G1000 package. I'm a demo pilot/salesperson for Cessna, and I recently got the opportunity to attend a seminar addressing the Garmin G1000 and the training program that Cessna has implemented. Any customer moving into the Garmin G1000-equipped aircraft will be given 8 hours of ground school plus 3-5 hours of flight instruction. All the training revolves around how to use and interpret the new instrument presentation.

It is my responsibility to check out customers who are picking up their new aircraft. Cessna recognizes the need for training to get customers up to speed before turning them loose with a glass-equipped airplane. We in the Experimental class of aircraft should seriously consider this professional approach before entering the world of glass.

Sterling Ainsworth had Aerotronics create this instrument panel for his IV-P. As you can tell, it would be difficult for a steam-gauge-only pilot to hop in and fly without transition training.

Here's another IV-P panel designed by Aerotronics, this one for builder Craig Gainza. With as much glass equipment as is available, the possibilities for panel configuration are endless.

Common Challenges

Here's a list of typical problems for glass-panel newbies along with some suggestions:

•Is the panel configured correctly? Do you know the difference between green needles and white needles? Green (CDI) needles mean that the airplane and autopilot are receiving and using data from a VOR or ILS. When these needles are white, the airplane and autopilot are receiving and using data from the GPS or flight management system (FMS). It is easy to fly across the country in white needles but forget to switch back to green needles to shoot an instrument approach. The results can be disastrous if the pilot forgets this important step. Remember, this is new technology that requires new procedures.

•The crew has been cleared for approach and has switched from white needles to green needles. Watching the needles and the moving map on the MFD, they see the aircraft blow through the final approach course. It is highly likely they forgot to arm the approach mode and left the FMS in the heading mode.

•A crew member is twisting a knob for all he or she's worth to get the desired overlay on the MFD. Finally, out of frustration, he/she starts looking for the problem. It is highly likely that in the heat of the moment they began twisting the wrong knob.

•Don't forget to fly the airplane! It is easy to get so wrapped up in "knobology" and screen interpretation that a new user will often spend far too much time inside the cockpit and not enough time looking outside. Stay focused.

•Get professional instruction. Because this is new technology, getting experienced people to train you may be easier said than done. Garmin used the same methodology/knobology on the Garmin 430/530 as it did in the G1000. It would help to familiarize yourself with how these units work. Some avionics shops have these units in their showroom for potenial customers. Spending a few minutes twisting the knobs will be enlightening.

•Enjoy the transition process, and don't be in a hurry. After a thorough checkout, fly in VFR conditions until you feel comfortable. Then, and only then, should you consider IFR conditions.

A New Beginning

Last year, the world celebrated the first 100 years of flight. We have come an unimaginable distance since Kill Devil Hill—from oil-drinking transports to aircraft that offer countless amenities to travelers as they're transported across oceans and continents.

Having embraced the world of the glass cockpit was a definite highlight in my career. I won't be around to celebrate the next aviation centennial, but based on the first 100 years, we've only just begun. ✈

FOR MORE INFORMATION on the Garmin G1000, visit www.garmin.com.

Instrument panel photos provided courtesy of Aerotronics, a professional avionics shop located in Billings, Montana. For information on the products and services offered by Aerotronics, read "Avionics with Aerotronics" in the October 2002 issue of KITPLANES®. Or contact the company directly at 406/259-5006 or www.aerotronics.com.

Critical mach number and its effects.

The performance of homebuilt and kit airplanes has increased steadily over the years. Recently, the availability of relatively low-cost turbines and jets has led to a rapid increase in the top speed of the fastest homebuilts. In addition to new designs, many builders are producing turbine conversions of piston-engine airplanes. These conversions almost always increase both horsepower and speed dramatically. The new turbine-powered machines are flying higher and faster than ever before.

High-altitude, high-speed flight brings a set of aerodynamic problems we don't encounter at lower speeds and altitudes. Today's fastest homebuilts are entering the speed range where Mach number becomes important, and some tricky and potentially dangerous aerodynamic phenomena appear. This "transonic zone" was first encountered by early WW-II fighters as speeds and altitudes increased.

Transonic Flow

As air flows over an object, it changes speed. Near the nose, the air is slowed. Further aft, where the air is accelerated, the local airspeed is actually higher than the speed of the airplane. When the speed of the airplane gets high enough, the local flow will go supersonic on some parts of the airplane. The critical Mach number of the airplane is the flight Mach number at which the local flow first goes supersonic on the wing. The overall airspeed is less than Mach 1, but there are local bubbles of supersonic flow embedded in the overall airflow.

The critical Mach number depends on the configuration of the airplane. The thicker the wing, the more the air accelerates when passing over it. Some of the early WW-II fighters, notably the P-38 Lightning, began to run into some transonic aerodynamic effects at Mach numbers as low as 0.68—68% of the speed of sound in level flight. When supersonic flow begins to appear on a wing or tail surface, aerodynamic characteristics change rapidly. These changes can have major effects on the controllability of the airplane. Pushing into this flight regime, particularly with an airframe that was not designed for it can be very risky.

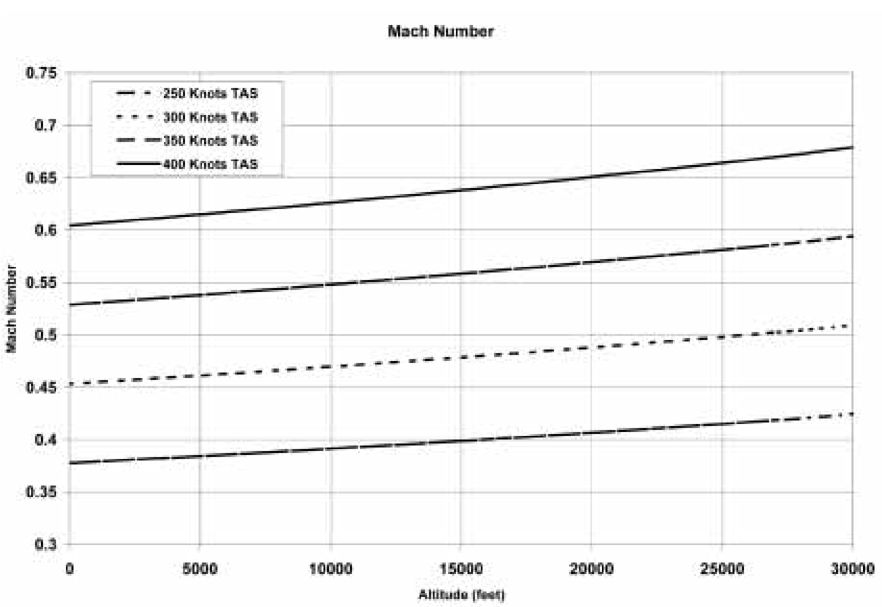


Figure 1. The curves demonstrate how altitude and true airspeed affect Mach number.

Mach Number and Critical Mach

The Mach number is the ratio of the airspeed to the speed of sound. The speed of sound itself varies with altitude. At sea level on a standard day, the speed of sound is about 662 knots. At 20,000 feet it is 614 knots, and by 30,000 feet it has decreased to 590 knots. This means that a 300-knot airplane has a Mach number of 0.45 at sea level, 0.49 at 20,000 feet and 0.51 at 30,000 feet.

If we take an airplane flying at a constant true airspeed and increase its altitude, two things happen. First, the indicated (or equivalent) airspeed drops as the density of the air drops. In order to produce enough lift to keep the airplane airborne, the wing must fly at a higher angle of attack and lift coefficient. The air moving over the top of the wing is accelerated more to generate the lift in the lower-density air.

At the same time the speed of sound is dropping as altitude increases. If the airplane maintains constant true airspeed, then the Mach number will increase.

The combination of these two effects increases the local Mach number of the air flowing over the upper surface of the wing. Accordingly, the higher the airplane flies, the lower the true airspeed at which it will reach its critical Mach number.

There are airplanes that fly safely above their critical Mach numbers. Jet transports with swept-back wings are designed specifically to fly safely at "supercritical" Mach numbers, and supersonic fighters fly faster than Mach 1, so the flow is supersonic over the whole airframe.

Despite this, exceeding the critical Mach number, or some limiting Mach number slightly higher than that, can lead to some nasty aerodynamic effects—effects that can be extremely dangerous.

Mach Tuck

As a wing exceeds its critical Mach number, the aerodynamic center moves aft, causing a nose-down pitching moment. The combination of this aft shift in aerodynamic center and shock stall can lead to a dangerous condition known as "Mach Tuck." If the Mach number gets high enough, the airplane will begin to nose down on its own due to the aerodynamic center shift. The elevators must be deflected upward to trim the airplane and keep it from nosing down. If the horizontal tail is too thick or the tail download is too high, deflecting the elevators causes a shock wave to form on the underside of the tail at the elevator hinge line—the elevators shock stall causing the airplane to pitch over and dive. Because the shock stall has reduced the ability of the elevators to raise the nose, the pilot has no immediate way to recover. The airplane will nose down and accelerate to even higher speed in the dive.

WW-II fighter pilots called this a compressibility dive, and it was often fatal. The only hope for recovery was to wait until the airplane had dived to a lower altitude where the speed of sound is higher, thus reducing Mach number. If the airplane was still in one piece at that point (which was by no means certain), it was possible to recover once the elevators regained effectiveness. Often the high speed in the dive or a too-abrupt pullout at the bottom of the dive would cause the airplane to break up.

For some WW-II fighters, Mach Tuck was a constant danger that limited the airplanes combat effectiveness at high altitude. The speed at which control would be lost was not far above the maximum level flight speed. An aggressive dive to attack or evade an enemy aircraft could easily increase Mach number above the maximum safe value, sending the pilot on a long, dangerous downhill ride. While homebuilders are unlikely to be diving on enemy aircraft at high altitude, they are flying slippery airplanes that quickly pick up speed if the nose is lowered. It is easy to end up going much faster than you expected if you don't manage power carefully on descents, or through inattention to airspeed in cruise.

The curves in **Figure 1** show how altitude and true airspeed affect Mach number. Notice that an airplane flying 400 knots at 25,000 feet is at a Mach number of 0.66—above the critical Mach number of some of the more common airfoils currently in use. If the airplane is capable of 350 knots in level flight, a relatively minor drop of the nose could easily get it above 400.

Shock Stall

We mentioned the shock stall briefly above; it is a stall caused by the presence of a shock wave in the flow over the wing. The rapid pressure rise across a strong shock can cause the airflow to separate, leading to shock stall. The thicker a wing is and the higher the lift coefficient it is trying to generate, the lower the Mach number at which it will experience this phenomenon. This is important because most single-engine light airplanes have relatively thick wings and hence will encounter shock formation on the wings at relatively low Mach number—particularly if they are flying at high altitude, where the lift coefficient is higher.

The consequences of shock stall vary from relatively minor to catastrophic. If the airplane can maintain level flight without shock stalling, then the shock stall is likely to feel much like a conventional stall. In a turn or a pull-up, the shock will form and cause the airplane to buffet. Returning to level flight will cause it to stop as long as the pilot does not allow the airspeed to rise. The critical difference between a shock stall and a conventional stall is the effect of airspeed on recovery. In recovering from a conventional stall, we want to increase airspeed. However, in recovering from a shock stall, we want to unload the airplane to 1G without allowing the airspeed to rise because going faster increases Mach number and exacerbates the shock.

The effect of shock stall on the airplane is dependent on the configuration of the airplane. For some configurations, it could be very dangerous.

One example of this is a canard airplane with a highly loaded foreplane. Because the foreplane is flying at a higher lift coefficient than the main wing, it is likely to shock stall before

ILLUSTRATION: BARNABY WAINFAN

the main wing, causing the nose to drop. Unfortunately, it will also cause Mach number to increase, thus making the problem worse. If the airplane first encounters the shock stall while exceeding the critical Mach number of the canard in level flight, it might incur a Mach Tuck even more dramatic and less recoverable that a conventional aft-tail airplane.

However, this does not mean that the classic Rutan-style canards like the Long-Eze, Berkut and Velocity are unsafe to fly within the limits that they have already been tested to. But, it does mean that taking such an airplane to high altitude and driving it much faster than they are currently flown might be dangerous indeed. If the airplane exceeds the critical Mach number of the canard in level flight, it might not be possible to keep the nose up—even at full aft stick.

Shock stalls can produce some dramatic effects including loss of control. During flight tests of one of the early wide-body airliners, the airplane shock stalled when tested at its maximum altitude, gross weight and cruise Mach number. It pitched up to more than 2G and rolled to 100° of bank angle before the pilots could recover. The airplane landed safely. Modifications cured the problem, and the airplane had a long, safe service history.

We are not always so lucky. Some years ago there was a series of accidents involving early model Learjets. These airplanes had enough thrust to exceed their maximum safe Mach number in level flight. They were equipped with Mach number warning systems that sounded a buzzer when the maximum allowable Mach number was reached, but a few foolish people chose to disable the system and fly the airplanes faster. Unfortunately, at that speed, a relatively mild turn or pull-up would cause shock waves to form and stall the upper surface of the wing just forward of the aileron hinge. This caused the ailerons to snatch, and the airplane would roll uncontrollably and head down. Sadly for those aboard, once this initial roll-off happened, there was no way to recover. Even pulling power and extending spoilers and gear could not slow the airplane enough to recover. The airspeed rose so rapidly that it became impossible to pull out without repeating the shock-stall/roll-over sequence; the airplanes dived into the ground at approximately Mach 1.

The sad thing about these accidents is that the airplane was safe when operated within its published limits, but lethal when they were exceeded. The pilots who deliberately disabled the warning system stepped over the edge of an aerodynamic cliff.

After these accidents, an AD was issued that required the installation of a stick puller system that automatically pulled the nose up when the airplane approached its safe Mach number limit.

The Lear experience is relevant to the homebuilt world because many builders are pushing airframes to ever-higher speeds with new engine installations. As builders fly them higher and faster than they have ever before, they take a risk of encountering some of the effects we have been discussing. In the homebuilt world, we do not have access to wind tunnels or sophisticated computational fluid dynamics codes to help predict Mach number effects. As we push the performance of our airplanes ever higher, we are approaching the performance of some of the WW-II piston-engine fighters. Designers of such fast airplanes would be well advised to study the hard-learned lessons learned by the WW-II designers and others who followed to avoid repeating some very frightening history. ✈

Aerodynamic questions of a general nature should be sent to editorial@kitplanes.com. Use "Wind Tunnel" as the subject line.

We test the ILS radios.

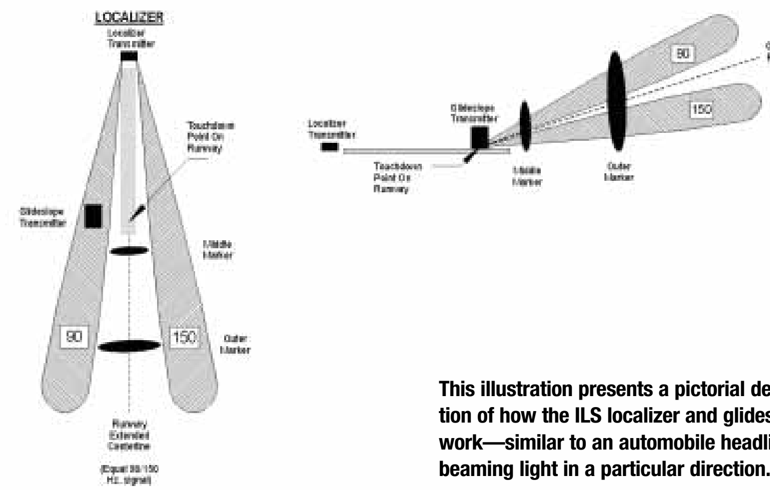
Hoo boy, here we go again! In the last 10 years of this craziness, I've taken you down some long and winding paths, but this one is the doozy of all time. We are about to design a test box that will allow us to simulate a full-house ILS installation in our airplane as well as test the VOR installation.

It is not going to be easy. I doubt more than 50 of you in the next year will actually make one or more of the circuits that we are going to describe in the next half-dozen articles. That's right—six articles to get this whole system up and running. But that's OK; these columns will survive for at least a dozen years in the archives; and the ILS/VOR system will survive far longer than that. And, those of you who actually *do* make one of these boxes will loan it to at least a dozen friends.

GPS is sexy. Loran is bonehead simple and megawatt powerful. But the ancient and honorable ILS system is still the only thing that will get you down to an instrument approach of 200 and a half. GPS *can* do that, and someday it will. But today the ILS is the only thing that gets you down onto concrete when the clouds are in your way.

The funny thing is that the ILS is inherently 10 times less accurate than GPS or Loran; ILS is based on 1940s technology that hasn't been upgraded since it was invented. Be that as it may, it still gets us down to where our wheels are just a little bit above the pavement when the weather gets tough.

There are three components to an ILS and one to a VOR. I'll take you on a tour of the ILS this month—just so we know where we are headed in future columns. I'll look at the VOR later.



This illustration presents a pictorial description of how the ILS localizer and glideslope work—similar to an automobile headlight beaming light in a particular direction.

A Little Local Color

The first part of an ILS is what is called a *localizer*. The localizer is nothing more than a radio signal that tells you where you are relative to a straight line down the runway—it's simply an electronic extension of the dotted lines down the center of the runway.

To get an idea of how the localizer works, think about an automobile headlight that beams light in a particular direction. Now think of a yellow headlight at the end of the runway that is pointed slightly to the left of the centerline and think of a blue headlight pointed slightly to the right of the centerline. When you are down the middle, you will see the yellow and blue headlights equally. Off to the left the yellow headlight predominates, and off to the right the blue headlight predominates. If you had a yellow/blue meter on your instrument panel, you could tell whether you were left or right of the centerline.

Radio waves work just like light. You point one beam to the left side of the runway, another beam to the right side of the runway, and you can tell where you are relative to the runway centerline by measuring the strength of the two beams.

Let's stop talking in circles and instead discuss how the localizer really works. There is a ground transmitter that is channeled to a VHF frequency between 108.1 and 111.9 MHz on the *odd* 100 kHz. Channels such as 108.1 and 108.3—roughly 100 watts of output power split into two 50 watt signals. One of these splits is amplitude modulated at 90 Hz and is run to the beam antenna pointed to the *left* of the runway centerline; the other split is amplitude modulated at 150 Hz and is run to the beam antenna pointed to the *right* of the runway centerline.

Get the picture? Tune your nav radio to 110.5 (for example, Marysville,

ILLUSTRATION: JIM WEIR

California—MYV), and inside the radio there are circuits looking to detect the relative amplitudes of the 90- and 150-Hz signals picked up by the antenna on your airplane. If there is more 90- Hz signal than 150, the radio drives your nav-head meter to the right (fly right). More 150, and the needle goes to the left.

Actually, rather bonehead-simple amplitude tone modulation, but it works remarkably well and is very reliable. Then again, the same basic principle applies to touch-tone dialing, and that system has worked flawlessly for a few dozen years.

So, for a localizer test we need a carrier wave on an odd-kilohertz frequency from 108.1 to 111.9 split into two parts—one part modulated by a 90-Hz signal and the other part modulated by a 150-Hz signal. We know, however, that if we have equal amounts of 90 Hz and 150 Hz that the localizer needle will be centered. But a good test unit will let us switch-select to deflect the meter at the half- and full-scale points. We'll do a heuristic design (hammer, file, kick in the edges, weld shut and paint to match) to figure out what *full-scale* means in terms of DDM (difference in depth of modulation).

The Glideslope

There is another component of the ILS that is at least as critical as the localizer, and that is the glideslope. Now there are many instrument students (including yours truly 40 years ago) that would swear that there is some tiny little gremlin inside that indicator that is playing chin-ups on the glideslope needle while you are trying to keep it somewhere near the center of the scale. Sorry, it just isn't so. However, the glideslope is about five times more sensitive to per-foot errors than the localizer. The net result is that most of us chase the glideslope about five times more aggressively than we do the localizer.

Be that as it may. The glideslope RF frequency is channeled to the localizer frequency by a scheme known only to some little gnome in Oklahoma City who has long since retired. It greatly resembles how Japanese house street numbers are assigned—the first house constructed on the street is No. 1, the next house (perhaps across town) is No. 2, and so on. Glideslope frequencies are paired to localizer frequencies in the same manner; there is no rhyme or reason to how this pairing takes place.

If you are *really* interested in the pairing frequencies, refer to the AIM Table 1-1-4 that shows each localizer frequency and its associated glideslope frequency. Note that you will never set your glideslope receiver manually to a frequency—you set the localizer frequency, and magic electrons (internal circuits) set your glideslope receiver to the proper channel.

What *is* true is that the same modulation frequencies that we used for the localizer are also used for the glideslope. The 90-Hz beam says you are too high, and the 150-Hz beam says you are too low. When these two beams are received by the glideslope receiver, the 90-Hz circuits drive the meter down, and the 150-Hz circuits drive the meter up. Again, bonehead-simple amplitude modulated signals, but inexpensive and reliable.

It is worth noting as we leave the glideslope description that the transmitter power is a relatively low 5 watts. While you might be able to receive that 100-watt localizer signal at 50 miles or so, the glideslope range at best is from 8-10 miles.

Marker Beacons

One more system, and we can start to work on the electronics of this problem. We'd like some indication of rough distance from the runway, and we get that with the creaky old marker beacon system. Again, we have an amplitude modulated set of transmitters located a reasonably accurate distance from the runway.

There can be up to three of these transmitters associated with the ILS—outer, middle and inner/fan marker transmitters. They all operate at the same 2-watt 75.0-MHz RF (carrier) frequency, but they are modulated with different tones. The outer marker is a 400-Hz tone, the middle marker is a 1300-Hz tone, and the inner or fan marker is a 3000-Hz tone. These tones also light three different colored lights on the marker display—traditionally blue, amber and white, respectively. The outer marker (which may or may not be the final approach fix, by the way) is about 5 miles out, the middle marker is about half a mile out, and the inner marker is about 500 feet out. This inner marker is used mainly for a Category II airline type approach and in general doesn't apply to those of us flying light single engines. However, the 3000-Hz tone is also used on what is called a fan marker, which can be used as a distance indicator on some approaches such as San Diego-Gillespie (LOC-D); these are few, far between and being eliminated one by one.

Our Plan of Action

Dang, all these words, and as yet, not a single electron has been emitted in the cause of getting us some ILS test equipment! Patience, patience. This is going to be a long series and a complex one at that. Let's take it one step at a time. I will write these ILS test box columns every *other* month so that we don't have them jamming each other up. In the meantime, relax, build the boxes one step at a time, and let's go for it!

If you want to get a head start on the August column, go buy a 30-cent 32.8-kHz tuning-fork crystal, a couple of LM324 opamps, and the following 50-cent CMOS digital ICs: 4011 NAND, 4013 FF and 4040 Counter. You can get these parts from the usual gang of suspects: Mouser, Jameco and Digi-Key. The total cost should amount to less than $10. ✝

Jim Weir is the chief avioniker at RST Engineering. He answers avionics questions in the Internet newsgroup rec.aviation.homebuilt.

Check out his web site at www.rst-engr.com/kitplanes for previous articles and supplements.

Getting Your Feet Wet

Part 2 – Floats for Homebuilts

Following up our float-flying intro, we delve back into the subject and examine the options for Experimental aircraft pilots.

BY RICK LINDSTROM

In the May 2004 issue, we published the author's introduction to float flying for the Experimental aircraft pilot. Response was good, and it's clear that we're not the only ones who feel that float flying is as much fun as it looks. As a follow-up, we contacted some of the major float manufacturers to provide an overview of what's available for homebuilts.

Aqua Floats

Since 1965, Aqua has been building straight floats for both certified and Experimental aircraft with displacements from 950 to 3500. The Cubby was the first Experimental to be flown with a set of Aquas and has been joined by later designs such as the Kitfox and the Avid Flyer and Magnum.

Aqua Floats feature flat decks and bottoms, and according to the manufacturer, most field repairs can be accomplished with a flat piece of aluminum. Sold with rigging, fittings and water rudders included in the price, the certified models range from just under $15,000 for a set suitable for the Taylorcraft or Piper Cub and PA-11, to near $28,000 for the larger floats flown on the Cessna 180 series or the 206. Contact Aqua directly to discuss your specific needs and to find the right float system and the latest related pricing.

Brandon, Minnesota
320/524-2782
www.aquafloat.com

Baumann Floats LLC

Designed for certified aircraft such as Cubs, Maules, Cessnas, Huskys and Taylorcrafts, these straight floats aren't typically sold to the Experimental crowd. But you might find a used pair on the market with a bit of research. Available in several models from 1420 to 2750, Baumanns feature fluted bottoms for enhanced rough water performance, large storage lockers and anodized exterior fittings.

The company prides itself on high quality construction while keeping the weight to a minimum, and it uses an innovative hull design to eliminate the need for spray rails. Prices start at around $15,000 for the smallest set and include everything needed for installation except the paint stripe to match the aircraft color scheme.

New Richmond, Wisconsin
715/246-9352
www.baumannfloats.com

Czech Aircraft Works

In addition to building three Chris Heintz designs under license and building major airframe components for Zenair, OMF Symphony and New GlaStar, Czech Aircraft Works (CZAW) offers a full line of straight and amphibious floats suitable for ultralights up through four-seat aircraft. Nine different float sizes are available—all are aluminum and are fully assembled at the factory.

They're not certified, of course, and this is reflected in extremely competitive pricing with a set of 1400 straight floats, mounting kit, crating and shipping well less than $10,000, for example. Sky Shop maintains a very close working relationship with CZAW in Eastern Europe, and these floats are now flying on many Experimental designs, including a few low-wing aircraft.

Czech Republic
www.airplane.cz
U.S. Distributor:
Sky Shop Inc.

Stuart, Florida
772/223-8915
www.skyshops.org

Full Lotus Manufacturing

One of the most innovative float companies has got to be Full Lotus, founded 18 years ago by yoga devotee Don Arney. Full Lotus has the distinction of being the only *soft float* on the planet, using inflatable bladders and a flexible, replaceable hull cap that allows its floats to operate in extremely shallow waters without damage. The rubberized nylon skins resist dents and dings, and the system only requires a monthly inflation check to ensure the bladders are pressurized around 2.25 psi. If you can put air into a tire, it's a no-brainer.

Full Lotus floats can be found on ultralights to four-seat Experimentals and even on the Rotorway Exec series of helicopters. Single mono floats are also available for ultralights and light aircraft in 1000 and 2000 models, with companion wing-mounted sponsons to keep things on the level. Full Lotus owner Jeff Holomis calls his products "the four-by-four of the float industry" for their ability to go where other floats can't. Available in sizes suitable for the lightest of airplanes to the 3200 series, Full Lotus builds a totally different kind of float, and proudly so.

Vernon, British Columbia
Canada
250/260-3714
www.full-lotus.com

The Montana Float Company, Inc.

One of the few concerns to offer both straight and amphibious 2200 series floats in both finished and kit form, the Montana Float Company is a relatively new company of six years. However, it uses the latest in CNC design and manufacturing to produce rugged, all-aluminum floats in 2200 and 3500 (preassembled amphib only) sizes. Intermediate sizes of 2400 and 2800 are currently in the works and should be available shortly.

With aircraft like the GlaStar and PA-18 firmly in mind, the 2200 straight or amphibious float kit saves close to 40% over the cost of the finished variety, if you *really* need something else to build after the airplane is done. Base prices range from $9000 for the straight kit to $23,500 for the preassembled set not including rigging, crating and shipping.

The most expensive model is the preassembled and amphibious 3500, which will set you back a bit more than $40,000 by the time it's sitting under your Super Rebel or Moose. But the amphibious versions do come with all the sophisticated gear status annunciators and visual and aural warning systems commonly found on the pricey certified variety, to help avoid those embarrassing wrong gear position/wrong surface moments.

Libby, Montana
406/293-9026
www.montanafloat.com

Murphy Aircraft Manufacturing, Ltd.

The Murphy philosophy of building all-metal, rugged airplanes that use many identical parts also extends to its straight and amphibious floats, which are available in kit or assembled form. Simplicity in design and building is achieved with simple curves, identical bulkheads, and 90° side-to-keel angles (allowing the use of simple extrusions). Originally designed in 1500 and 1800 sizes with the Rebel and Elite in mind, the kits cost roughly half of the fully assembled variety. If you're willing to do all the work yourself, a pair of 1500 straight floats can be had for a mere $5830, not including the rigging kit ($1060), crating or shipping.

The 1800 amphibious kit goes for $10,070, less rigging and other charges. If you'd prefer to have your Murphy floats arrive assembled, then add $7420 for straight floats or $8480 for amphibs to the bottom line. With regard to the straight float kits, assembly can actually cost a bit more than the price of the float kits themselves. Assuming that you'll spend around 700 hours to build a set of floats, having the time available to build will definitely save you some coin.

Development and refinement continues on the straight and amphibious versions of the 3600 float series—intended to be the perfect companion to the Murphy Moose.

Chilliwack, British Columbia
Canada
604/792-5855
www.murphyair.com

Wipaire, Inc.

Building a wide range of certified floats since 1960, Wipaire has an incredible amount of experience with all sorts of float planes from Super Cubs to Dehavilland Twin Otters. But the company recognizes the Experimental market as well, with interest in the GlaStar and Murphy Moose leading the pack. For example, a simple set of straight Wips for your GlaStar will set you back a tad over $22,000 with rigging, not including installation ($2200). Going the amphibious route will add another $15,000 or so to the package. The Moose amphibious package is roughly double the cost of the GlaStar amphibs.

The float product line centers around certificated, heavy-duty aircraft flying commercial missions as well as for pleasure, and the 2100 and 2350 series represent the low end of the scale. Given the high quality of the float construction and the expertise of the company behind them, the investment in Wips for your Experimental, although sizeable, may be worth every penny for those flying their floats to the limits operationally or geographically.

The Wipaire web site is unusually informative for those seeking specific float suitability, specifications and pricing information. It features both new and used floats, skis and even aircraft. Given the high-tech aspect of the Wipaire amphibious float gear systems, including laser-based surface type detection and the gear advisory system, the comprehensive web site isn't a huge surprise. For anyone just sticking a big toe into the water, it's well worth the visit.

South St. Paul, Minnesota
651/451-1205
www.wipaire.com

140 Templeside Place N.E.
Calgary, Alberta
Canada T1Y3M2

Murray Cherkas' Murphy Rebel

After eight years of building, I finally flew my Rebel on November 7, 2003. I built it right out of the manual with the exception of some reinforcing for the heavier engine. Throughout the building process, the Murphy staff was very helpful. A fun plane to fly with a sports-car feel, it is powered by a 160-hp Lycoming O-360 with a Sensenich fixed-pitch prop. I will get some taildragger time in before I go amphibious.

As has been said before, this plane is a great performer and I would recommend it to anyone. I would also like to thank our e-mail group for their technical expertise as well as keeping my spirit up to get it done.

218 Tailwind Drive
Seguin, TX 78155

Ron and Delores Morton's BD-4

My wife and I started BD-4 N404BD in January 1998—the kit had been in storage since 1969. We used a Grumman nosewheel assembly and a 200-hp IO-360-A1A engine. In order to keep it simple, we used a four-blade Warp Drive prop. We chose the BD-4 after finding it was the only homebuilt that met our criteria for speed, payload and the biggie—cost. I'm still tweaking the prop and installing gap seals, leg covers and vortex generators, but even now I'm thrilled with the performance.

Thanks to Jim Bede for much advice and a great design, our neighbors at Elm Creek Airpark for their encouragement and a special thanks to our daughter, Laura, for her weekends home from college helping with sanding, riveting and the many general tasks involved when building an airplane.

3204 Old Richmond Road
Danville, VA 24540

H. Dan Davis' Van's RV-9A

On October 12, 2003, RV-9A N47DD was flown for the first time after 27 months and 2350 hours of construction from a kit. While this may seem like a long time, this is my seventh airplane built from a kit, built from plans or restored; it will probably be my last, so I wanted it to be as near perfect as I could build it.

The RV-9A is equipped with a sliding canopy, full gyro panel, King navcom and King transponder, Garmin GPS, all lights and AOA system—to name a few. It was fully painted inside and out, and primed inside before assembly; the plane has a Cleveland Tools interior. Equipped with a balanced ECI O-360-AIA engine and a Hartzell constant speed propeller, the plane was still kept light at 1070 pounds. At gross weight, the aircraft will maintain a climb of 2000 fpm or better at 100-110 mph indicated airspeed.

The aircraft flies hands-off and is extremely stable in all flight attitudes. It was built to last a long time so that it could be flown by not only me at 66 years old, my 38-year-old son, and my grandson who is now 3 years old and already "airplane crazy." If I built the RV-9A again, I would change absolutely nothing.

Sycamore, IL
johnrahn@rotorheads.net
www.rotorheads.cjb.net.

John Rahn's RotorWay Exec 162F

The 300 hours that RotorWay said it would take to build my helicopter turned into three and a half years. The many modifications made to the kit as well as me being a bit of a perfectionist must have added to the time! As with any worthwhile project, there were many highs and lows during construction; however, it was one of the most rewarding experiences of my life. I was fortunate enough to be awarded the Rotorcraft Grand Champion (Gold Lindy) at Oshkosh AirVenture '03. The entire project can be viewed on my web site.

Submissions to "Completions" should include a typed, double-spaced description (a few paragraphs) of the project and the finished aircraft. Also include a good color photograph of the completed aircraft (slides are also acceptable) that we may keep. Please include a daytime phone number where we can contact you, if necessary. Also indicate whether we may publish your address in case other builders would like to contact you. Submissions should be sent to: Completions, c/o KITPLANES, 239 New Road, Suite B-201, Parsippany, NJ 07054.

10565 N. Thaum Blvd., Ste. B110
Paradise Valley, AZ 85253

Jerry and Bettye Sparks' GlaStar

Taking more than four years to complete, my GlaStar project N447WP began on my back patio and was later transferred to my garage during a summer monsoon. With final completion at Deer Valley Airport on July 4, 2002, I flew my GlaStar for the first time on November 29, 2002. The plane is powered by a Lycoming O-320-D3G rebuild with a three blade Catto prop. Performance is 155 mph at 75% power and 6000 feet.

I enjoyed the building process as much as I have enjoyed flying my Star, but I have to admit that without the help and advice from my friends, the plane would have never flown. A very special thanks to my kids for bucking and deburring, and very patient wife who let me work long hours and store parts in the living room.

15500 Bubbling Wells, #128
Desert Hot Springs, CA 92240
rpmoss@earthlink.net

Ronald Moss' Sky Raider Ultralight

I picked up my Sky Raider ultralight kit on July 10, 2001, from Flying K Enterprises in Caldwell, Idaho; the plane was completed on October 12, 2003. The cowl was designed for an HKS engine—as a result it was necessary to construct a pod on top of the cowl to clear the top of the Rotax 503 engine. Everything else was straightforward. The propeller is a Power Fin three blade; the covering is Poly-Fiber and the finish poly-tone. The plane flew for the first time on October 21, 2003.

I would like to thank my friends Ray Hughes and Dan Konopatski for their help and advice.

St. Joseph, MI

Bill Yamokoski's GlaStar

I began construction of my Eggenfellner Subaru-powered GlaStar in February 1997, with first flight occurring on October 2002. The extremely smooth engine is coupled with a Quinti prop and carries me along at 140 mph at 75% power cruise while drinking about 6 pgh. This all-electric plane has a Skyforce IIIC GPS, Navaid autopilot, Grand Rapids Technologies EIS and Microair 760 comm radio, among other goodies. It's just a wonderful VFR plane. Since first flight I've put on 220 hours and I'm having way too much fun! My logs show 2100 hours of construction time, plus at least another 2100, which involved all the reading, head-scratching, cursing and smiling that accompany all first-time build projects. This is also the first plane I've ever owned—there's just nothing quite like it. Keep building!

Durban, South Africa
dwg@iafrica.com
http://mysite.mweb.co.za/residents/dwg/index.htm

Dave Grosvenor's Bushbaby

My Bushbaby from Kitplanes for Africa is finally complete after purchasing the kit in July 1997. Project delays included a two-year overseas work contract and the addition to the family of my son (and future co-pilot). The engine is a Rotax 912S with a Warp Drive ground-adjustable prop. With the first flight occurring on December 28, 2003, all subsequent flights have gone well. This plane is a real pleasure to fly and has no negative characteristics.

A huge thank you has to go to my wife, Wendy, who has not only put up with the project, but also helped and encouraged me to get it finished. Thanks also to the members of EAA Chapter 645 for their encouragement, and to all the guys on the Kitfox list. The project is detailed on my web site.


185 Grandma's Hill Road
Amherst, VA 24521
llambdin@aol.com

Lanny Lambdin's Loehle Sport Parasol

I received the first two packing crates of parts in July 1992 for my Loehle Sport Parasol, Lambdinger (a name my oldest brother, Ken, used to identify his old tractor creations) and began measuring, cutting and gluing small pieces of wood together to make the wingribs and tail feathers. Following several life changes, as well as breaking three ribs after falling through the roof of the 28x70-foot hanger that I built, the plane finally flew—11 years and two months later—on August 24, 2003. With 21 flight hours and 173 landings, the thrill is undiminished. Performance is per the Loehle specs, and the view from 500-1000 feet, the rush of takeoffs in less than 100 feet ground roll and the ease of landings make me kick dirt on the rental C-172 the few times I have flown it since August 24.

I want to praise and thank the Loehle family, especially Mike and Sandy, who are wonderful people and made this possible. I am grateful to my brothers, Byron and Paul, who helped with construction and encouraged me with their excitement and support. Thanks also to Byron's son, B.J., who called 911 the day I fell through the hanger roof. Special thanks goes to my wife, Betty. Without her love and encouragement and the reassurance that I was really ready to make the first flight, the Lambdinger may still be earthbound.

I'm interested in sharing flight data/experiences with other Loehle Sport Parasol flyers; please feel free to contact me via e-mail.


140 Templeside Place N.E.
Calgary, Alberta
Canada T1Y3M2

Murray Cherkas' Murphy Rebel

After eight years of building, I finally flew my Rebel on November 7, 2003. I built it right out of the manual with the exception of some reinforcing for the heavier engine. Throughout the building process, the Murphy staff was very helpful. A fun plane to fly with a sports-car feel, it is powered by a 160-hp Lycoming O-360 with a Sensenich fixed-pitch prop. I will get some taildragger time in before I go amphibious.

As has been said before, this plane is a great performer and I would recommend it to anyone. I would also like to thank our e-mail group for their technical expertise as well as keeping my spirit up to get it done.


Memphis, TN
csbrumbelow@fedex.com

C. Scott Brumbelow's RV-8A

On October 28, 2003, the FAA informed me that my RV-8A was an airplane—the next day we proved them correct. The first flight was Made by Jerry Carter (another RV-8A builder/pilot at my airport), and I followed with the second; both flights were non-events. Powered by a new XP360 and Hartzell constant-speed prop, my RV-8A has a panel that is basic VFR.

A big thanks to Jerry for checking me out in his RV and for performing the first flight in mine, to my wife and kids for enduring and to God for a safe flyoff period. I wish I had the space here to thank everyone else individually, but the list is just too long! The chance to share aerobatics with my kids was a key reason for building the RV, and their peals of laughter while doing so are helping to make the 1553 hours of construction worthwhile. Flying it is a blast!


3544 W 100 N
Kokomo, IN 46901

Thomas J. Gebeau's Zenith Zodiac 601

A no-rush build time of 1200 hours allowed me to complete my CH601 HD Zodiac kit, which I flew for the first time on July 25, 2003—but not before I underwent dual flight instruction at the Ontario Zodiac distributor. Built with a Rotax 912 engine, Warp Drive prop, Grand Rapids Technologies EIS, Microair radio and basic VFR instruments, the plane's lightweight Panasonic battery kept empty weight at 600 pounds. This plane really goes up—even with a larger-than-standard guy like myself at the helm. So far, I am more than satisfied with my Zodiac and even after just slightly more than 50 hours of flying time, I have noticed positive attributes, such as lower fuel costs and easy maintenance.

I would like to thank my many friends and EAA Chapter 235 for their help and encouragement.

John Grindon's Glasair

My kit was delivered in 1984 and the dream began. As this was my first taste of aviation, I was also getting my pilot's license during the same time as I was building my project. Nineteen years later and some 15,000+ hours of build time, the plane flew on October 24, 2003. The aircraft has a 180-hp with a MaCauley constant-speed prop. At 24 squared my plane cruises at a nice 200+ mph. With two people and full fuel, both the aileron and rudder trimtabs are dead neutral.

This project has been a life altering experience...one I wouldn't change for anything. A special thanks has to go out to my good friend George Spence, for all his help and support over the past 19 years. Of course the biggest thanks has to be reserved for my wife—the most patient person in the entire world. If anyone has any questions about the project, drop me an e-mail.

Thomas Sled's Helicycle

In 1969 I became an Army helicopter pilot and flew Hueys in Vietnam. After seeing Helicycle designer B.J. Schramm flying the helicopter at El Mirage in 2000, I decided to build one myself. In August 2001 I received the first crate of Helicycle parts from Schramm's company, Eagle R&D. With the detailed videos and well-packaged aircraft-quality parts, I found the Helicycle a relatively easy to build kit.

Both Schramm and Homer Bell came to my airport, L52, in Oceano, California, to adjust, fix, fine tune, high speed balance and test-fly. I finished the Helicycle in November 2003 and had my FAA inspection on December 9, 2003. Eight days later, on the morning of December 17, the Helicycle helicopter N3722T had its first flight! At the controls was Schramm, who took the helicopter for a 10-minute first flight after making a few "quick stops." He then came back and did an autorotation nice and soft; he had it up to 120, flying smoothly through the whole range. The next day was my turn to start hovering the ship and doing quick stops. I, too, found it to be smooth and responsive, and with that turbine, the power is always there.

July

2-4—EL DORADO, KANSAS
EAA Chapter 88 annual fly-in at Captain Jack Thomas Airport (EQA). Aircraft judging and awards, flying events and banquet. For more information, contact Bob Blanton at 316/683-9759; e-mail juneblanton@hotmail.com.

7-11—ARLINGTON, WASHINGTON
Northwest EAA fly-in at Arlington Municipal Airport (AWO). For more information, web www.nweaa.org; e-mail flyin@nweaa.org.

17—SAN LUIS, COLORADO
San Luis Valley Pilot's Association airshow and fly-in will be held at San Luis Valley Regional (ALS) from 9:30-12:30. Classic WW-II warbirds and current military, experimental and homebuilts will be on display. A pancake breakfast will be served from 7:30-10:30. For more information, contact Paul at 719/852-9850 (home) or 719/754-9080 (office).

25—MARSHFIELD, WISCONSIN
EAA 992 annual fly-in pancake breakfast at Marshfield Municipal Airport (MFI). Stop by on your way to AirVenture 2004 in Oshkosh for Young Eagle and Old Buzzard rides. For more information, contact Jack Bremer at 715/384-8700; web www.eaa992.org; e-mail jcbremer@charter.net.

27-2—OSHKOSH, WISCONSIN
EAA AirVenture Oshkosh is one of the year's biggest fly-in events. Covering more than 5.2 miles with more than 2,800 show aircraft participating, come view some of the industry's best homebuilts, antiques, classics, warbirds, ultralights and rotorcraft. For more information, contact the EAA Aviation Center at 920/426-4800; web www.airventure.org.

August

14—CADILLAC, MICHIGAN
EAA Chapter 678 fly-in/drive-in breakfast at Wexford County Airport from 7-11. For information, contact Jim Shadoan 231/779-8113.

14—BEAUMONT, KANSAS
The Beaumont Hotel pancake breakfast fly-in. Come experience a Midwest tradition and taxi down Main Street to the best pancake breakfast served in Kansas. For information, contact Travis W. Atwood at 620/843-2422; web www.hotel-beaumontks.com; e-mail gm@hotelbeaumontks.com.

21-22—FORT EDWARD, NEW YORK
EAA Northeast fly-in at Floyd Bennett Memorial Airport, Glens Falls, New York, from 8-3. With visiting aircraft as the main feature, come fly your antique, homebuilt or warbird. New standard biplane rides will also be available. For more information, contact Hank Clark at 518/747-4670; e-mail hclarck4@adelphia.net.

24-25—MONROE, WASHINGON
Western Regional Powered Parachute Championships are the first competetive event for powered parachutes in the western U.S., at Lord Hill Farms. For information, call 360/896-8916; web www.westernppa.org; e-mail westernppa@qwest.net.

28—MEXICO, MISSOURI
Zenith Aircraft Company will be holding its annual open hangar day at Mexico Memorial Airport from 8-3. Fly or drive-in. Kit production facilities will be open to the public, and the company's factory-demonstrator kit aircraft wil also be on display. For more information on the open house, call 573/581-9000; for the Mexico Memorial Airport, call 573/581-0162.

September

9-12—WILLIAMSVILLE, NEW YORK
3650th Basic Military Training Wing (BMTW), Sampson Air Force Base Veterans Association will be holding its reunion for all veterans of the air force base, Permanent Party, Women's Air Force, Basic Trainees and Special School Trainees from 1950-1956. For more information, contact Chip Phillips at PO Box 331, Williamsville, N.Y. 14231; phone 716/633-1119; e-mail chip34@aol.com

18-19—PETERSBURG, VIRGINIA
The Virginia Council of EAA Chapters presents its annual Virginia state EAA fly-in at Dinwiddie County Airport (PTB). For more information, contact Judy Sparks, fly-in manager at 703/590-9112; e-mail jhsparks@aol.com; web www.vaeaa.org.

24-26—MT. VERNON, ILLINOIS
Annual KR gathering will feature seminars and flying KRs. For information, contact Larry Flesner at 618/985-2373.

NOTE: Clubs, associations and groups planning homebuilt aviation events are invited to submit dates and information for publication in Calendar. Please ensure that a contact person is listed along with that person's address and telephone number. For fast, accurate submissions use our web site: www.kitplanes.com. For publication in the magazine, information must be received at least four months prior to the event date. We cannot be responsible for changes in dates and locations after the information has been submitted. Be sure to check dates before attending. For a more complete listing of events, visit www.kitplanes.com/events/.

BY DAN JOHNSON

Are these the future LSAs?

Smooth and shapely, the German-designed CT has become a recognized LSA even before the FAA's rule is released.

The FAA's newest rule is on the horizon. Indeed, it may be announced around the time this issue hits the newsstand. Planning in several organizations has shifted to a faster gear, and excitement is starting to build. SportPlanes™/light-sport aircraft (LSA) appears to be gaining the traction it needs to become a success.

Organizations like this magazine and the EAA are preparing to help readers and members sort through the rule and its effect on their aircraft and their flying. Others, like the Light Aircraft Manufacturers Association for one, are preparing to perform the proposed voluntary quality audits that will allow airframe builders to demonstrate that they have met the LSA consensus standards. In addition, the FAA has established offices to deal with the new pilot ratings, inspection personnel, designated examiners and more. Information is going out to FAA field offices to support local officials.

All of this activity is known to European producers. In the EU, most countries have allowed ultralights to weigh up to 992 pounds (450 kg). However, many newer designs were created for an eventual gross of 500-600 kg or 1100-1320 pounds.

Because light-sport aircraft will be certified at a maximum takeoff weight of at least 1232 pounds, many European designs are already well positioned to enter the U.S. market. With that in mind, let's look at a few likely candidates. Of course, until the rule is published and analyzed, we can't be certain which aircraft will qualify. This review is not intended to include all possible candidates.

An Early Contender

Even though the rule has yet to arrive officially, one aircraft already has the enviable position of being perceived as the Piper Cub of the segment. That airplane is the Flight Designs CT2K of Germany, imported by Connecticut-based Flightstar.

As with many European entries, the CT2K has a multinational heritage. The composite aircraft was designed by German-based Flight Designs with major airframe fabrication handled in the Ukraine.

The CT2K is an efficient, speedy design (132 mph under LSA rules) that exhibits fine flying qualities. Its spacious interior will accommodate larger

With a sailplane heritage, the Remos G-3 Mirage boasts a 15:1 glide angle and sturdy composite construction for the fuselage.

PHOTOS: DAN JOHNSON

Where to Learn More

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www.bbardaviation.com

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Americans, and its controls and instrument panel should satisfy general aviation pilots as well as recreational flying enthusiasts.

Ultra Sleek

Though only one is now flying in the U.S., more G-3 Mirage orders are awaiting passage of the new rule. Designed in Germany, built in Poland and brought to the U.S. by Rollison Light Sport Aircraft, the aircraft appears to be a high-end member of the fleet-to-be.

A sleek composite design, the G-3 Mirage was created by well-regarded German engineer Lorenz Kreitmayr. Owing to its design heritage including sailplanes, the Remos aircraft boasts a 15:1 glide that makes a reach to a field easy sport. The handling is gracious yet responsive, and the interior is nicely finished in the spirit of a top-choice LSA.

Everyone's Fantasy?

Sleek as the rest, Allegro from Fantasy Air is a newer arrival to U.S. soil. However, it fits with the likes of the CT and G-3 quite well, being a composite design with aluminum wings. It is available with the Rotax 912 in either 80- or 100-hp variants or a Jabiru.

The Allegro is known for its easy flying characteristics, which have helped make it popular in French flying schools. Higher performance models fill out Fantasy Air's line, but the best candidate for the LSA segment is the Allegro 2000. Like many of these candidates, the Allegro 2000 can carry nearly its own weight. Its payload (occupants and baggage) is well more than 500 pounds.

A Conventional Import

Yes, it looks like a Kitfox—and the design heritage is obvious as a cumulus cloud. Nonetheless, AeroPro has reportedly changed enough of the EuroFox so that it isn't the same airplane SkyStar sells today in its Kitfox line.

I call this one "conventional" because it is the only one featured this month that is not made of fiberglass or carbon. One benefit of the simple but clean construction is a lower price—about $50,000 ready to fly. But because of the ever-changing dollar-to-euro ratio, the price can go up or down overnight.

The EuroFox continues the great tradition started by the Kitfox with responsive handling and those easily folded wings that make storage or trailer transport much simpler.

More To Come?

The four models mentioned above are but a few in the wave of aircraft that may come to the U.S. in search of buyers. And Europe is not the only source outside America—Australia and India are two other nations gearing up for LSA, and more are bound to follow.

One more aircraft to watch for is the Ecolight from Lightwing. Ecolight was introduced by legendary Swiss designer Hans Gygax, the name behind such aircraft as the Flightstar and C42. His Ecolight was expressly designed for LSA according to the draft of the rule. It can be a working aircraft or flown for fun, and the New Piper Aircraft has expressed some interest in it. Ecolight is not presently represented in the U.S., and this applies to numerous other aircraft from overseas.

Back home, American producers are not going to sit still while builders in other countries prepare their machines. Many manufacturers of ultralight aircraft will offer LSAs, some designed to the new rule with others entering in their present form (after meeting ASTM standards). Additionally, established general aviation players such as Maule, Mooney and American Champion Aircraft have indicated that they plan to enter the segment.

No matter the actual outcome of FAA's newest initiative, the aircraft offered should present a range of exciting options for American pilots.

TO REVIEW ALL "Light Stuff" columns that have appeared in KITPLANES®, visit www.ByDanJohnson.com, which links to the KITPLANES® web site with articles of interest.

The Czech Republic offers a number of LSA candidates and none cleaner looking than the attractive Allegro 2000 from Fantasy Air.

Resembling the popular Kitfox, the EuroFox claims numerous changes throughout the aircraft, while retaining the responsive handling and folding wings of the original.

BY JOHN M. LARSEN

Are you ready to be

your own mechanic?

Currently, as the builder of an Experimental aircraft, you can be certified as the repairman to do the annual inspection on your plane. This includes regular maintenance, upkeep and all those duties that fall on the shoulders of an airframe and powerplant mechanic when dealing with certified aircraft. SportPlanes™/light-sport aircraft (LSA) are coming soon, and you can acquire training to be your own mechanic for an LSA as well.

Many homebuilt pilots recognize that one of the great things about owning an Experimental aircraft is that you don't have to pay an A&P to do your annual inspection. Some even avoid doing an annual inspection because they feel they do not have to. Either one of these opinions can lead you into trouble. Anything man-made that flies, from an ultralight to the space shuttle, must have maintenance on a regular schedule—and that schedule needs to be adhered to religiously. Not only that, but whoever works on your plane needs a lot more than a piece of paper to be competent for the job.

It is presumed by the FAA that if you built the aircraft, then you should be able to repair it. Therefore, they will issue a one-plane-only certification for your creation. This is not without problems, however, as some kits have primitive controls with some steel-on-steel working pieces that must be lubricated if they are going to last. So far, I have not found many Experimental pilots that have a lubrication schedule that they follow for their plane.

As for the engine, the most sought after are the plug-and-play firewall-forward installations that allow the builder to slip the engine on by hooking up a few wires and installing some bolts. These are wonderful packages, but since the builder did not install the accessories, induction system or fuel delivery systems on the engine, he/she may not have a clue about how the engine really works. Therefore, he/she will be seriously hampered as to how to repair much of the package.

Defining the Job

One thing to ask before setting out to be a mechanic/repairman is this: just what is a mechanic? Often, our idea of a mechanic is based on what you see at the auto dealership—the grinning service rep handles all your questions while the mechanics are those people in the coveralls who are always working on something. You can't talk to them (you are told) "for insurance purposes." I suspect what they really mean is that you are barred to ensure that the repairman doesn't waste company time talking to you.

The term *mechanic* is a generic term, like *teacher*. There are many levels of the trade. The level you want to be in is the one where you do your plane right. I have a friend, Roger, who has spent his life working on motorized vehicles of one sort or another. He has a laid-back demeanor that is disarming. Expose him to an engine, however, and he becomes another creature. Roger will just freeze and listen when first examining a faulty engine. To be satisfied with what he hears, he may get out a stethoscope and touch different parts of the powerplant. He checks oil pressure, temperature and compression, often feeling some parts with his hand as he makes his diagnosis. You can appreciate a figure skater or a violinist without being one yourself, and although I have been a mechanic at times in my life, I can always appreciate the master.

You don't need a store full of tools, but a basic set of wrenches and sockets in both metric and U.S. inch sizes is a must along with good pliers and a screwdriver assortment.

After Roger has diagnosed the problem, I tear the engine down and find his every prediction to be true. One of his colleagues had more than $30,000 of personal tools in three 6-foot rollaway

PHOTOS: JOHN M. LARSEN

Along with your basic tools, you'll need torque wrenches calibrated in inch-pounds and foot-pounds. A compression tester is mandatory to track the condition of your engine's cylinders.

tool chests. Roger got by on $15,000. These mechanics take their trade just as seriously as a heart surgeon or a nuclear physicist. They specialize as well, concentrating on hydraulics, transmissions or (like our A&P's) on aircraft-related construction and repair. It's hardly necessary that you spend several years as a hands-on mechanic just so you can work on your Experimental or LSA plane. The point is that it is a serious business not to be taken lightly. To be a good repairman, you have to learn to think like a good repairman.

Secrets to Success

Here are three things to put in your mental toolbox:

(1) Know your plane. You will be responsible for its maintenance and upkeep. Read the owner's manual for your engine, paying attention to the specifications for rpm, compression, oil temperature and pressure. You need to know all you can so you will be able to spot trends in performance that can head off some major failure. All of the professional mechanics I have known have access to the service manuals of their current project. They never guess at things like specifications or torque values, but they have the necessary facts on hand.

(2) Pay attention. The great mechanics I have known have the mindset of a perfectionist when it comes to their task. When you are working on your plane or engine, do not let anything interfere with your concentration. It is said that the Piper Cub is the safest airplane because it can just barely kill you. We have to remember the integrity of our flying machine is much more critical than any other motor vehicle you will ever ride in or drive.

Some A&P disciplines require that the mechanic have a toolbox with cutouts in foam in each drawer to cradle every tool. This is so one quick glance will tell the A&P that all the tools are back in the rollaway, not left in the plane. Patty Wagstaff almost crashed because her mechanic left a pair of pliers in the plane. When Wagstaff was doing her aerobatic routine, the loose tool jammed the controls. You must develop a mindset to ensure that everything is serviced and in its proper place with nothing omitted.

(3) Finally, have adequate tools. You don't need thousands of dollars worth, but have a good basic set. If you buy or build an LSA or an Experimental kit, chances are the U.S. parts will have bolts and drills in inches. The engine may be from Japan or Austria, in which case the bolts and allen screws will be metric. Sizes up to 1 inch in U.S. and 20 mm in metric will handle about everything except wheel retaining nuts. A large pair of channel lock pliers will work for the random larger sizes. A good set of torque wrenches is required; both inch-pounds and foot-pounds are necessary to check fittings on an engine, and the wrenches are mandatory for propeller work. A compression tester is a good tool to have. Aircraft use the comparison tester, but either type will work because you are basically looking for compression trends that may indicate other problems.

There is also loyalty among mechanics as to tool brands. Just as some motorcyclists think the only real bike is a Harley, a "real" mechanic would not use tools from Craftsman or Harbor Freight, but rather Snap-on,

To work like a mechanic, you need to have the mindset of a successful mechanic.

Matco or some other sophisticated brand. My father was a Snap-on man, and I inherited his rollaway full, but I have some Craftsman and a little bit of "Made in China" stuff for minor areas. This is strictly to suit your own taste and wallet.

Some pilots seem to have the attitude that the FAA and their regulations exist just to harass the airman and make bureaucrats happy. The FAA has required scheduled maintenance to keep accidents to a minimum and you need to develop and practice a maintenance program and follow it as if there were no FAA.

I have one of my master mechanic friends read my columns to check for errors and to see if he thinks I have covered the topic adequately. He thought I should emphasize that the pilot/mechanic should be completely certain that everything required to be in the plane is in it and everything that does not belong has been removed and accounted for. He remembered many incidents—one of the most spectacular was the total loss of an armed F-105 due to a screwdriver left in the controls.

The Right Mindset

I could go on for pages talking about tools and tricks. That would obscure the point that you must start thinking about your plane as the most important piece of equipment you will ever work on. If you have the right mindset, you will figure out the rest. If you know why something works, you can much more quickly deduce how to fix it. Know your plane and all of its specifications, and keep the numbers handy. Develop the mindset of a perfectionist and learn to focus when you are working on your plane. You can't step out on a cloud and repair what you forgot. ✈

John M. Larsen has an extensive history building race engines and replacing/repairing powerplants for Experimental aircraft, automobiles and motorcycles. E-mail questions and comments to jopatco@mindspring.com.

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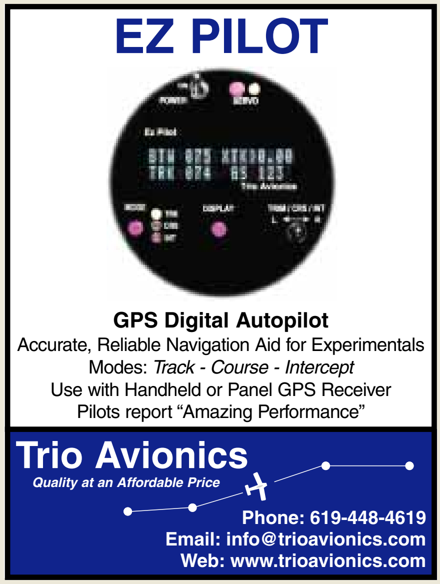

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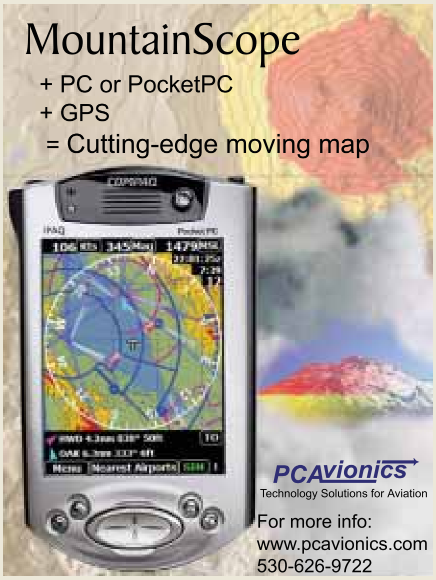

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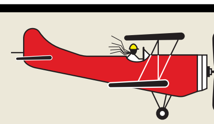


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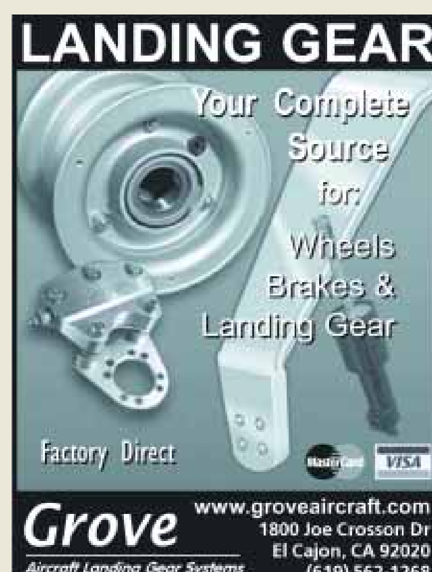
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At least they don't refer to you as 'loveable'......yechh!

BY KEN ARMSTRONG

Our resident helicopter expert continues the

transition to gyroplanes.

For the August 2003 issue, we sent our "Rotor Roundup" columnist for a bit of an education. His mission? Learn to fly gyroplanes. As someone who had only flown in gyros a few times in his life, the author found that even as a 14,000-hour test pilot, a little more education wouldn't hurt.

With his initial visit to Joe Souza's Gyroplanes at Yuba County Airport in California, this time the author ventured farther north—to Scappoose, Oregon—where he visited Sport Copter and checked out the company's new Vortex II gyro.

The Men

Sport Copter is a second-generation family business that started as Vancraft under Chuck Vanek in 1958. The company has an excellent history of safety and has been a leader in the gyro industry since then. Vancraft came out with the first two-place gyro in the '60s, and now, as Sport Copter, has won many awards for its innovations under the leadership of Chuck's son Jim. Jim and Chuck were both honored at the gyroplane convention in April 2003 at New York's Hofstra University with a Gyroplane Pioneer Award.

The Machines

Sport Copter produces a selection of advanced kit gyros to suit purchasers' needs; their market success is well-proven with more than 100 currently flying. A step-by-step video and manual is included with each machine, and build times are quoted as 50-200 hours for the various gyros.

The single-place Vortex is typically built in 120 hours and may be powered by a selection of engines that include the Rotax 582 and Subaru EA-81 2.2- and 2.5-liter. According to the company, the Vortex boasts the most advanced options list among available gyroplane kits, including full instrumentation, body enclosure, impact-absorbing seat, separate fuel cell (for safety) and a new shock-mounted rotorhead system.

The Lighting is an ultralight version usually powered by a Rotax 503. This ultralight achieves the 254-pound weight limit, but high-quality materials are used throughout the design. The triangulated airframe is built of large-diameter aluminum tubing with an undercarriage designed to tame rough fields. The Roto-Control system is patent pending, and the Lightning incorporates the composite Cyber seat, shock-mounted rotorhead and independent toe-operated hydraulic disk brakes of the other Sport Copter models.

The Factory

Jim Vanek offered me a chance to tour the Sport Copter factory and fly the newest company gyro: the two-place, tandem Vortex II. The company currently has two new two-place machines under development. These designs will be built to comply with the proposed lightsport category and will be available to purchase either fully-assembled or in kit form. They will both be side-by-side and will have float capabilities. One will be more cost-effective and will be sold in stages; the other, the SC-II (Sport Copter II), will be a more sophisticated gyroplane.

Adding the two-place Vortex II to the product line provided a quantum leap for the company as training became a possibility, and agencies such as the police, fire and border patrol have shown an interest in these adaptable aircraft. Capabilities such as short takeoff and landing from minimal strips, slow-speed handling and the inherent safety provided by minimal- speed touchdowns make these inexpensive aircraft a natural for just about any aerial surveillance.

An extensive tour of the 12,000-square-foot facili-

Jim Vanek poses with the company's three current offerings: the two-place Vortex II (right), the single-place Vortex (middle) and the ultralight Lightning.

PHOTOS: KEN ARMSTRONG

ty proved the company was well-organized in production capabilities, spare parts supplies, documentation files and quality control; aircraft-quality materials and practices were well-established everywhere we looked.

Open-Air Flight

As one approaches the Vortex II, the strength and design features are obvious, and the combination explains the popularity of the Sport Copter's offerings. The rotorhead is beefy and well-designed for maintenance and parts replacement. The landing gear is as tough as any I have seen on gyros, and the cockpit layout shows a great deal of forethought. The Vanek family's 45+ years of experience with gyros is apparent with this design evolution, which has led to the two-place.

The impact-resistant seat was comfortable and provided excellent support, and the full harness system left me feeling secure for my subsequent open-air flight. The liquid-cooled engine provides electricity for forced-air cabin heating and ventilation, and the cargo space below and behind the rear seat provides space to stow baggage. During solo flights, the rear seat and control stick are removable to create a large cargo hold.

Starting up the NSI Subaru auto conversion was as easy as starting a car. We taxied with good directional control using differential brakes coupled with the swiveling nosewheel. With the north wind behind us and the rotors stationary, we maneuvered along the taxiway serving the threshold of Runway 33. Turning into the light wind, we spooled up the rotors using the effective pre-rotator and with checks complete, lined up and firewalled the throttle. Acceleration was quick, and the rotor system rpm increased steadily. In little time the nosewheel was light, and we were off and accelerating to the 45-mph climb speed in approximately 1500 feet. Full power rate of climb with about 430 pounds of useful load aboard was 400-500 fpm in a temperature of 60° F. The control feel was moderate, as was the response in the light turbulence caused by terrain variations near the end of the runway.

Downwind we indicated 70-75 mph at a low-to-moderate power setting as circuits were our prime intention. Later, we flew over Scappoose at speeds in the 90-100 mph range buffeted by the high wind speed. (An enclosure is available for this aircraft, but of course would add weight to the structure.) The rudder/fin and end plates provide good directional stability, and the horizontal stabilizer adds safety margins in pitch stability.

We flew the two-place conservatively, and a number of touch-and-goes proved the gyro was solid and fairly easy to fly. There were no untoward handling characteristics that would surprise a low-time gyro pilot like me.

The Training Program

While I have flown hundreds of fixed-wing and helicopter types, gyros are a blend of both and yet neither of either. Their characteristics are different from other aircraft, and training is absolutely mandatory. While the ultralight could theoretically be legally flown without training, the idea is absurd. Trust me, training is mandatory if you don't want to reduce your aircraft to a collection of worthless junk. Sport Copter is adamant about this and quotes the gyroplane rating requirements of FAR 61.113(B) in its sales data. The commercial requirements are in 61.63(C), parts 1 and 2. While no flight time is legally required for qualified helicopter folks like me, to obtain the rating one must demonstrate proficiency to an examiner. To be honest, this would require approximately 5-10 hours of dual instruction to safely meet the standards; a few hours of ground school would be a good investment as well.

Regular KITPLANES® readers will recall the first segment of my indoctrination/training in the Joe Souza side-by-side gyro at California's Yuba City Airport. After a few hours of circuits and emergency procedures, Souza signed me off as qualified for solo flight. Truth be told, I felt minimally qualified at that point and decided more dual instruction was required to feel confidant enough to launch off on my own. What better way than to fly another gyro and get input from another instructor?

Well, it turns out that Vanek does not have an instructor's rating, although he has planned to fit it into his schedule for a few years. While Vanek is an exceptionally capable gyro demonstration pilot, his lack of instructional experience led to the equivalent of nagging during our flight. He demanded adherence to accurate flight speeds on my first flight in his gyro with no structural members to serve as a horizon reference. After thousands of hours of instructing, I have learned that an instructor should concentrate on correcting the most important, safety-related student miscues first and let the small details fall into place as training progresses.

As a result, the intention of using additional flight instruction to enhance my confidence was actually somewhat counterproductive. This highlights a significant problem for gyro students—

Vanek demonstrates the Vortex's takeoff for the author.

The Vortex II is powered by a 160-hp NSI converted Subaru engine. It allows for a 400- to 500-fpm climb at full power with 430 pounds of useful load.

The new two-place tandem is designed so that the front cockpit serves as a "student" seat; Vanek demonstrates.

there are very few qualified instructors in North America, and no imminent solution unless a number of high-time gyro pilots seek these additional skills.

So, my pursuit of comfort and self-assurance has proved slightly elusive. In some respects, this bodes well for readers as your KITPLANES® correspondent seeks further two-place gyro flights to hone his fledgling skill level and determine the capabilities of these training machines.

Stay tuned for the continuation of Captain Ken's Gyro Training Program. +

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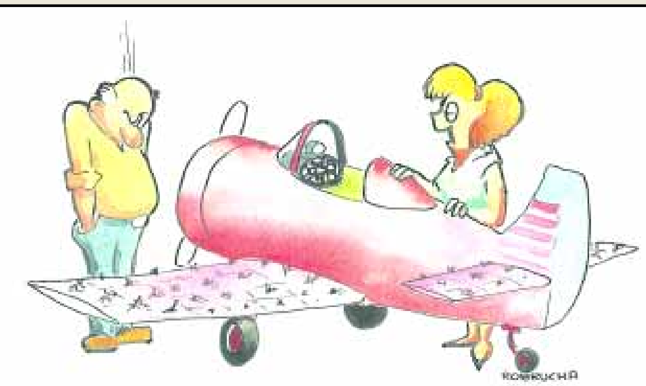

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SUN 'N FUN COVERAGE
Find out what was new and noteworthy at the annual EAA fly-in in Lakeland, Florida. A staff report.

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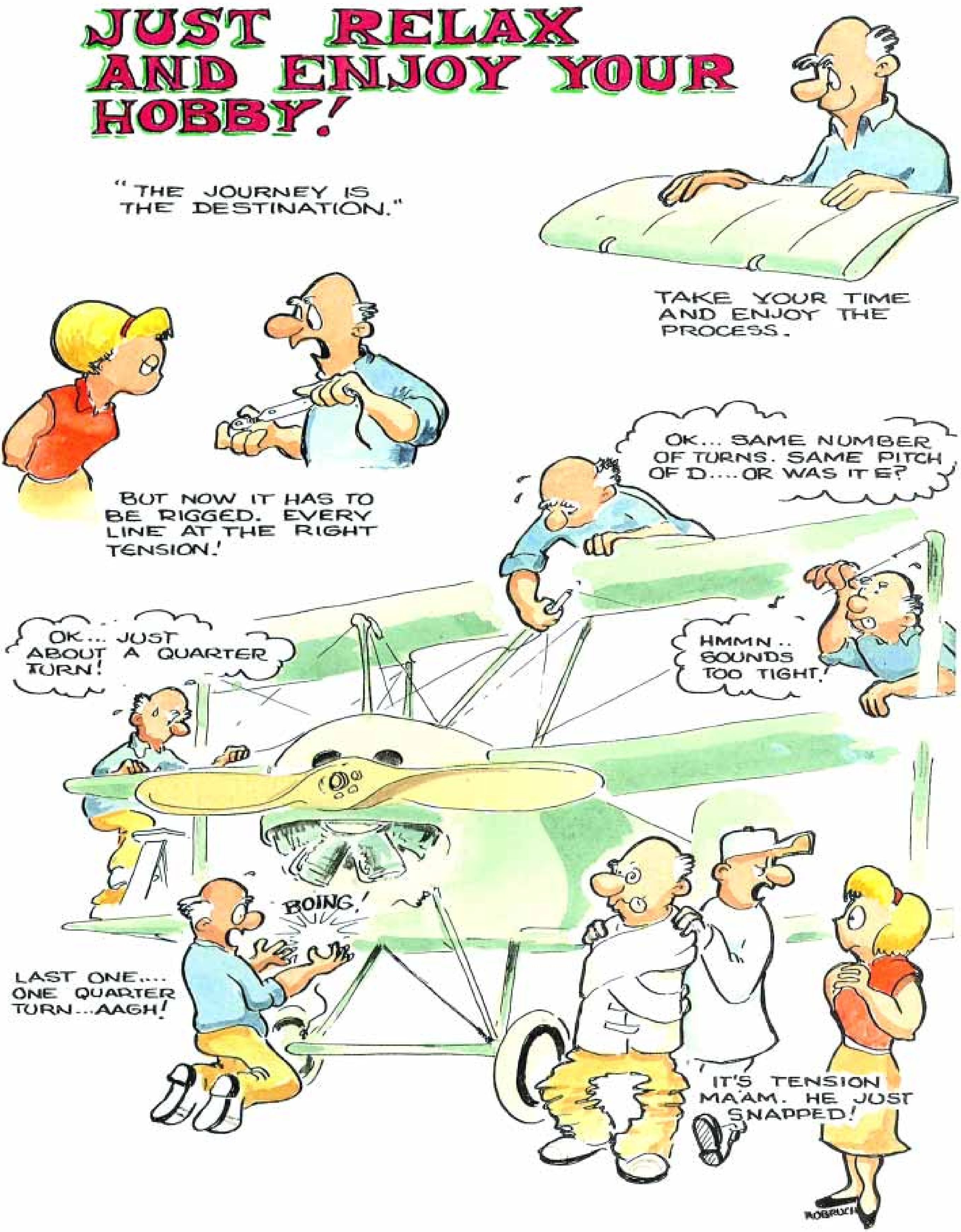
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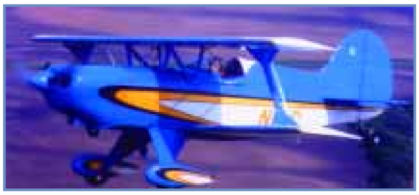
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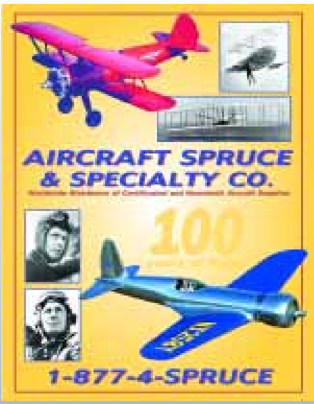

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