August 2012
Volume XLII
Number 8

The consumer resource for pilots and aircraft owners

The Aviation Consumer®

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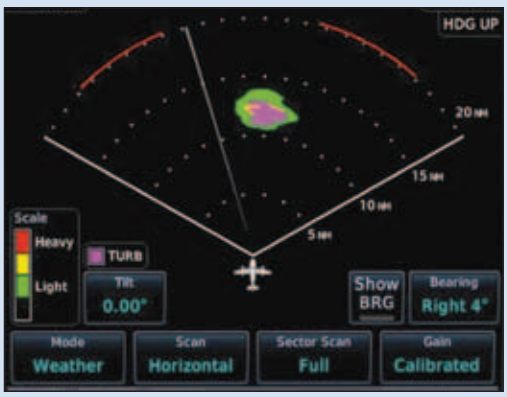

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The Aviation Consumer

EDITOR
Paul Bertorelli

MANAGING EDITOR
Jeff Van West

CONTRIBUTING EDITORS
Jonathan Doolittle
Rick Durden
Larry Anglisano

SUBSCRIPTION DEPARTMENT
P.O. Box 8535
Big Sandy, TX 75755-8535
800-829-9081
www.aviationconsumer.com/cs

FOR CANADA
Subscription Services
Box 7820 STN Main
London, ON 5W1
Canada

Back Issues, Used Aircraft Guides
203-857-3100

REPRINTS: *Aviation Consumer* can provide you or your organization with reprints. Minimum order is 1000 copies. Contact Jennifer Jimolka, 203-857-3144

AVIATION CONSUMER (ISSN #0147-9911) is published monthly by Belvoir Aviation Group LLC, an affiliate of Belvoir Media Group, 800 Connecticut Avenue, Norwalk, CT 06854-1631. Robert Englander, Chairman and CEO; Timothy H. Cole, Executive Vice President, Editorial Director; Philip L. Penny, Chief Operating Officer; Greg King, Executive Vice President, Marketing Director; Ron Goldberg, Chief Financial Officer; Tom Canfield, Vice President, Circulation.

Periodicals postage paid at Norwalk, CT, and at additional mailing offices. Revenue Canada GST Account #128044658. Subscriptions: $84 annually; single copies, $10.00. Bulk rate subscriptions for organizations are available.

Postmaster: Send address corrections to AVIATION CONSUMER, P.O. Box 8535, Big Sandy, TX 75755-8535. In Canada, P.O. Box 39 Norwich, ON NOJ1PO, Canada. Publishing Agreement Number #40016479

Electric Flight: Think Small, Slow and Modest

Following our July article on folding bikes, Woody Saland sent us the letter at right about his experience with electric bicycles for transportation at airport destinations. I asked him to send me a couple of photos and here they are. I wanted to show how he's using this bike as an interesting juxtaposition to this month's article on lithium-ion batteries. As he explains in his letter, this bike is a folder that's also propelled by a small electric motor powered by a rechargeable lithium-ion battery pack.

What's most interesting is not so much the bike itself but what it represents. Like the Prius he drives to the airport in, Saland's Phantom bike is nothing less than a hybrid. It's a pure parallel hybrid, meaning it can be powered by either electricity or—the primary means—by carbohydrate-fueled human muscle. Within the realm of electric bikes, there are two subcategories, power-on-demand or throttle-controlled designs and power-assist or so-called pedelecs that reduce human effort by providing electric assistance.

The market for such bicycles isn't huge, but it's growing for the simple reason that technology has taken a direction that buyers find practical. And that's hybrid technology and it's why there are 4 million Prius serial/parallel hybrids on the road, but only about 20,000 Chevy Volts and Nissan Leafs. Besides being expensive, plug-in electric cars simply aren't competitive with internal combustion capabilities, green or not. But hybrids generally are because they recognize and compensate for the overarching weakness in electric vehicles: The batteries simply don't have the capacity.

Can the hybrid idea apply to airplanes? After all, their development is even more stunted by battery limitations than are EVs. This is where Flight Design and Pipistrel want to go, the former with a parallel hybrid idea and the latter with a pure serial hybrid, like a diesel-electric locomotive. But what's the supposed benefit? Noise reduction and improved economy. The argument is less convincing than it is for a Prius, which can cruise around town for a couple of hours on its batteries or run the Interstate at 70 MPH all day, using a fraction of the hybrid-powertrain's total available power.

But airplanes don't work that way. They require far more power to cruise and far more of the powerplant's total available power. Plus, any hybrid needs to cart around some volume of batteries and getting the balance of battery weight against conventional liquid fuel while enjoying the benefits of hybrid drive seems like a tricky equation. I'm not a Luddite about this, but I'm skeptical that there's a parallel between practical automotive (and bicycle) hybrids and airplanes.

Pure electric airplanes are making developmental inroads, but commercial volume isn't in sight. When we last examined electric airplanes three years ago, we did so amidst the expectation of some that battery technology would improve at the same rate that computer processor power does. In other words, the notion that a Moore's law for battery capacity existed and would double battery capability within a couple of years. That, of course hasn't happened because there is no Moore's law for battery capacity. One company has recently announced crossing the 400 wH/kg battery capacity barrier, but that won't be enough to make something like an electric SR22 practical. What already is practical are small, light and aerodynamically slick airplanes that cruise closer to glider speeds than even modest piston-engine speeds. In other words, trainers and short-flight sportplanes. When will these appear on the market? My prediction is within five years. There will be enough early adopters to make these work on a limited basis. Or so I figure. We'll see. —*Paul Bertorelli*

A Bike We Overlooked

I'm a long-time subscriber to your magazine who still has all the back copies for reference. In your current issue (see July 2012 *Aviation Consumer*) you review folding bikes. I had two Montague bikes for years (which I still have), but last year I bought a Phantom X Electric.(http://snipurl.com/2492tfw).

What a great bike. She folds so nicely that it's easy to put inside my Prius as well. Seven speeds plus the electric for the same $1100 or so of the others. It won't fit a Mooney, but it's a real bike.

Woody Saland
via e-mail

VG Fan

I was really taken with your article on VGs in the June 2012 issue. I put them on my first Cessna 310 over 25 years ago. Checking them out, I feathered the right engine, put full power on the left and pulled into a steep climb. Pulled until the airplane stalled at about 5 knots slower than before.

I still had positive aileron and rudder control. The stall was smooth, straight ahead. Next, restarted the right engine, let it warm up, shut down the left and repeated the process with the same results.

I was really impressed and pleased with my decision to install them. Since then, I've been a real advocate and have even proposed that there be an AD to require them on all light twins. I still feel that way. I hope your article makes a believer out of more people. Could save a lot of lives.

Coy Austin
Vero Beach, Florida

I read with great interest the May article on angle of attack indicators. I have an Alpha Systems AOA system installed in my Grumman Tiger, that is, until a zealous FAA Inspector forced its removal during my January 2012 annual inspection. His "argument" was that it did not have PMA approval and therefore was not legal in any certified aircraft.

The AOA was installed in January 2010. It didn't take long to fall in love with this device. I routinely fly into strips as short as 1600 feet. The LED bar graph mounted on the glareshield is pretty close to heads-up display position and allows me to focus on the runway ahead—without having to glance away at the ASI.

I have found the AOA to be consistently accurate every time when indicating the stall in all phases of flight. It wasn't until the unit was removed that I discovered the true value of having it, especially on night landings.

I, in fact we, have Mark Korin of Alpha Systems to thank for pushing through the FAA to obtain approval for his device in certified aircraft. After reading the article in May, I contacted the inspector at the local FSDO. After two weeks of waiting, here is an excerpt from his written response.

"The FAA Small Aircraft Directorate has declared the [Alpha] AOA system installation to be a minor alteration and it does not require any production or design approval. Should you choose to have the system reinstalled, be sure the installation complies with Part 43.9 and 43.13(a)."

I wholeheartedly agree with Jeff Van West's conclusion that AOA systems are worth it. I made an appointment with the avionics shop the same day I received the official okey-dokey from the FAA.

Bob Reed
York, Pennsylvania

SUMPS AND PUMPS

In your story on the Citabria and Decathlon, the statements on the fuel system were incorrect. The 2004 Citabria 7GCBC I own has four sumps and my Lycoming O-320 doesn't have a boost pump; only fuel-injected Lycomings have boost pumps.

Ron Krantz
Via e-mail

Huskies Rule

Great story on the Husky in the June issue. Coincidentally, I have had some contact with Husky aircraft in the past couple of weeks. And while you were able to fly the new model with new landing gear, I tried the older version.

The Idaho Aviation Trade Show in late May featured a brand new, fully tricked-out A-1C Husky with every goody imaginable, for $336,000. Although, as your article pointed out, most new Husky aircraft sell for nearly $100,000 less, I thought the price was a bit steep for a two-seat aircraft.

The next day found us at Alpine Airpark, Wyoming, home to 14 Husky

continued on page 32

CORRECTIONS

The article on the Aviat Husky in our June 2012 issue gave the name of company's original founder as Frank Christen. It's actually Frank Christensen. In our article on the G500/G600 in the July issue, we gave an incorrect MSRP price for the G500. It's $15,995.

CONTACT US

Editorial Office
941-929-1693
E-mail: avconsumer@comcast.net

Subscription Department
P.O. Box 8535
Big Sandy, TX 75755-8535
800-829-9081

Online Customer Service:
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Cessna's Reborn TTX: A Polished Performer

The latest iteration of Cessna's only low-wing piston is a standout for single-engine-piston performance, and well positioned as the stepping stone to Cessna jets.

by Jeff Van West

CHECKLIST

- ⊕ Terrific handling, performance and comfort
- ⊕ Intrinzic (G2000) flight deck is both simpler to use and more capable than the G1000
- ~ Lack of a parachute and autopilot attitude-recovery mode will discourage some buyers

FLIGHT TRIAL

No one could blame the Cessna TTX for having a bit of an identity crisis. This latest iteration is the fourth name change for the aircraft (and is technically written TT^{X}). It also bears a striking resemblance to the Cirrus SR aircraft, which outnumber it better than 10 to one.

Today's TTX started life as the Columbia. This was a certified aircraft from kit company Lancair, whose fiberglass aerial hotrods topped 300 knots on a like quantity of horsepower with wings the size of boogie boards. The Columbia leveraged that expertise, but was a clean-sheet design. The final results were impressive: Terrific low-speed handling with a 59-knot Vso while still topping 200 knots at altitude, and impressive crashworthiness (see www.niar.wichita.edu/agate/ and scroll down to the videos).

But the Columbia remained a niche aircraft while the well-marketed and parachute-equipped Cirrus changed the face of general aviation. In 2007, Cessna bought the Columbia aircraft company out of bankruptcy. They tweaked and rebranded the aircraft a few times, but never posed a serious threat to Cirrus' dominance in this market segment.

Scroll the timeline to Sun 'N Fun 2011 and Cessna announces the TTX, with the big-ticket item being the first OEM sporting the G2000 avionics suite, dubbed Intrinzic by Cessna. Unfortunately, they also moved some production from Bend, Oregon, to Mexico in this period and then had a wing partially delaminate on a production flight test.

Cessna halted production, bought back and crushed all the existing Mexican airframes, and dug deep to find the problem. It appears to have been a freak event, but it's the primary reason the TTX has been so long in fruition.

NEW STUFF

Cessna has made the most of the extra time in polishing the TTX design and options. The new $733,950 airplane will have airbags standard. Gear fairings that once made a low-frequency rumble have been changed, and there are more interior and paint options. What was an aftermarket oil-cooling improvement is now standard. Air conditioning is standard, but can be removed to shave off 69 pounds and $10,300.

An inadvertent icing system with TKS wings and an electric prop has long been a $25,700 (and 36-pound) option, but the TTX can be had with a flight into known icing (FIKI) system for $49,500 (and about 50 pounds). Neither of these weights include the de-ice fluid, which is 10 gallons for about two hours of protection on the FIKI. The TTX will offer Iridium in the cockpit for worldwide weather and communication.

Cessna told us they are actively exploring other engine options "from any vendor or for any fuel." But there are none yet that match the performance of the Continental TSIO-550. They also described a few improvements in the pipeline that will come out later this year or early next, for both the airframe and the Intrinzic, that aren't ready for public consumption. Suffice it to say that what we

consider a good airplane is progressively getting better.

HEAD TURNER

No matter what name the airframe has sported, it's always been a standout on the ramp. Differentiating it from the similar Cirrus is a slightly more rakish look and a sharper angle to the tail. Its cabin doors open gullwing style, with a slightly higher sill that the Cirrus and slightly more restricted access to the rear seats.

Taking Cessna at its word that there are no lingering issues with Mexican parts production, the composite work on the TTX is still top-tier. All the control surfaces are composite as well. TTX buyers can work with paint designers for personalized paint schemes. We weren't exactly enthralled with the paint scheme of the demonstrator we flew, but it does make the aircraft stand out.

The TTX has a tangible beefiness about it, with two locks on the baggage door and a positive closure to the gullwing cabin doors. Inflatable doorseals significantly cut cabin noise, but you'll still want a noise-cancelling headset. Elevator and ailerons are controlled by a side-stick moving pushrods rather than cables. The result is butter-smooth, backlash-free control that responds to even slight inputs.

Front seats have ample room and a wide range of adjustment for pilot size. The rear seats have good forward visibility, but less headroom than a Cirrus. The 120-pound baggage area has great access, but it's slightly smaller than the Cirrus, and the lack of a rear window makes the baggage and rear seat area darker.

FLYING IT

Startup for the 310-HP Continental TSIO-550-C is conventional. Overhead master switches give that big-airplane feel, but most hard switches sit between the power controls and the touchscreen controller that drives the Intrinzic system. The environmental controls, four-place oxygen system, and several other system have no hard switches. They are controlled via the pedestal-mounted touchscreen between the front seats. That single touchscreen is also the heart of the Intrinzic flight deck whose two screens dominate the TTX panel. The Intrinzic warrants its own section on pages 7-8.

Taxi is what you'd expect with a free-castering nosewheel. You won't need brakes so long as you taxi a bit faster than the FAA-recommended fast walk. Takeoff has two small quirks: The big Continental will bog down for a moment if you advance the throttle too rapidly, and the TTX won't abide by feet-on-the-floor climbs.

Instead of rudder trim, the TTX has a rudder-hold switch. Slightly overcorrecting with rudder, engaging the hold, and then putting your feet on the floor results in a coordinated climb. Just remember to get your feet

Highlights of the TTX front office: 1: Backup G2000 controls, 2: Autopilot controls, 3: G2000 14-inch PFD and MFD, 4: Go-around and speedbrake controls, 5: G2000 touchscreen control center, 6: Integrated pulse oximeter, 7: Trilogy 4-in-1 backup flight instruments.

back on the pedals to ease off the rudder when transition to cruise or you'll enjoy a nice fishtail when you turn off the switch. There is no option for a yaw damper.

We saw 1450 FPM off the runway on a hot day at mid weight. That settled down to about 1250 climbing at 110 knots, and was still a respectable 750 FPM by 13,500 feet. Bragging rights go to the TTX for 235 knots at 25,000 feet, but real-world numbers that you're more likely to see are 185 knots cruise below 10,000 feet, the 190s in the mid-teens and the low 200s in the flight levels. This is essentially on par with a Cirrus SR22T.

Our demo plane didn't have oxygen available, so we could only test up to 13,000 feet where we saw 196 knots true at 3 degrees C and 23.5 GPH running rich of peak. Cessna is reworking the TTX's manuals to allow lean-of-peak ops up to 85-percent power. This saved us 7 GPH at the price of 10 knots—well worth it, in our view.

The TTX gives you about 1000 pounds of useful load to play with, 612 pounds of which could be fuel (102 gallons, which is 10 more than a new Cirrus). You could make a short flight with four big people or go far with two and bags. Economy range tops 1200 miles, but 900 is more realistic with a high-power, LOP cruise and 45-minute reserve.

TV CESSNA TTX

AVweb

http://snipurl.com/248hcv3

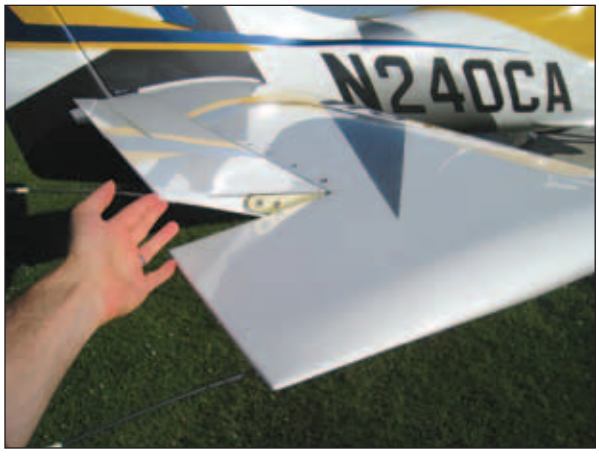
In a word, the TTX's handling is superb. Control feel is crisp due to the pushrods. Roll rates are sporty enough to be enjoyable without sacrificing stability. Control harmony is excellent, and low-speed control authority is terrific. Stalls are a minor event. We think the TTX is easier to trim precisely than the Cirrus, however, when accidently perturbed in pitch it takes longer to work its way back to the trimmed speed.

Pilots transitioning to high-altitude airplanes are often surprised how light the controls become at 25,000 feet. If the controls aren't light at altitude, they're likely heavy at high speed and low altitude. This is the case with the TTX. While aileron and elevator felt just right at pattern speeds and in cruise in the teens, they're noticeably heavy by the bottom of a 180-knot descent. Standard speed brakes offer a bonus 500 FPM down without picking up speed as an alternative.

As we said, the TTX controls feel perfect at pattern and approach speeds. Crosswind authority feels good, although we didn't have an opportunity to really press it. Gross weight landing distance is published at 2640 feet over an obstacle with 1280 feet of that as ground roll. After two easy landings, we would have taken the TTX into any decent runway of 3000 feet. Shorter would be reasonable with precision, especially at less than gross weight.

Autopilot controls are just under the glareshield, as you'll find on Cessna jets, and we think Garmin's GFC 700 autopilot coupled with their digital servos set the bar for a light-aircraft autopilot. The Intrinzic's flight planning allows sophisticated vertical management,

Fit and finish of both airframe and interior is top notch. The gullwing doors have a strap to help close them while sitting. Rear headroom is a bit tighter (and darker with no top window) than a Cirrus.



including custom crossing altitudes, as well as unpublished holds. If you want to fly hands off from just after rotation to just before the flare, you could probably do in adjusting little more than the flight plan as you went.

Like its Garmin-powered Cirrus rival, the TTX includes Garmin's stability protection and coupled go around. The former is a system that's active when the autopilot is off. Bank over 45 degrees and the autopilot servos will coax the aircraft back toward 30 degrees of bank. Overspeeds and underspeeds are likewise protected.

A button just above the throttle activates go-around mode. Push it as you add power, and the autopilot will pitch up to climb without disconnecting while the Intrinzic sequences for the missed approach. If you forget to add power the aircraft will still pitch up, but only enough to hold minimum speed while it squawks at you to do something about the problem.

What's notably lacking in the Cessna version of this autopilot, however, is the one-button recovery to straight-and-level. Tarreld Shriner, business leader for the TTX, told us this was by design and foretells of autopilot capability down the line that, "will do far, far more than just level the wings."

We find this answer lacking. A hinted-at autoland capability has fascinating potential, but emergency attitude recovery is clearly available today. The TTX is already one-down in many prospective buyers' eyes because it lacks an airframe parachute. Emergency attitude recovery might mitigate that for some. Shriner tells us that the

EFIS+IPAD: THE G2000 UP CLOSE

With avionics and app manufacturers perpetually trying to outdo each other, it's tempting to make "This is Spinal Tap" references when talking about the G2000 ("But our EFIS goes to *2000* ..."). Garmin gets our kudos, however, for making a system that is simultaneously more capable and easier to use. While the G2000 isn't as easy to use as your iPad, it's not much harder, and the skills from app-land can now fly an EFIS.

The G2000 differences are all where you can see them: the three screens and the software they run. In fact, the hardware tucked into the TTX fuselage (the other LRUs) are exactly the same as G1000-equipped Corvalises.

Let's clarify a few things about the system. The PFD and MFD are *not* touch sensitive. The MFD softkeys only function during reversionary mode when the MFD becomes a PFD. The PFD is controlled with softkeys G1000-style.

The GTC-570 touchscreen controls the MFD, the nav/com system and several other onboard systems, such as the intercom and the environmental. If you've used a Garmin GTN 750 or Garmin's Pilot iPad app, you'll feel right at home with the G2000's touchscreen, with its home screen and radio controls.

Garmin did an impressive job at keeping the most important functions as eight dedicated on-screen buttons and organizing most everything else so it's only a couple of taps away. The on-screen buttons are turbulence-friendly big, and the infrared-sensor touchscreen is phenomenally accurate with taps and drags—even when wearing gloves.

It takes a few tries to get the full swing of managing both screens. Some buttons on the touchscreen do things on the touchscreen. Tap a standby frequency and you'll get a pop-up right there for entering a frequency. Even better is to look up a frequency in the airport information and tap it. You'll get a pop-up asking where you'd like the frequency to go. (There are knobs below the screen to dial in numbers if you're feeling retro, but you'll quickly forget they are there.)

Other home-screen buttons both call up options on the touchscreen controller *and* change the view on the MFD. Tapping the

Charts button prompts you through the list of charts on the touchscreen, while your selections simultaneously bring up the charts on the MFD. Return to the home page on the touchscreen and the MFD remains in the chart view. Tap an icon to split the screen and you can have two different MFD pages up at once. It sounds more complicated than it is in practice. And some tasks, like flight plan editing, are so easy it feels like cheating.

There are a few quirks. The button to monitor the comm not in use is physically beside the standby frequency when you actually will hear the active frequency. Because the touchscreen controls the MFD, looking up something like a frequency will change your MFD view, at least temporarily.

The 14-inch screens run at 1280x800 pixels with new video processors make the all the images crisp and the animations smooth. This is most noticeable on the PFD with synthetic vision. LED backlights make the screens both brighter and better at dimming than the G1000. The PFD will look familiar to any G1000 user, as will a set of buttons above the PFD match the old G1000 bezel controls. These exist to offer flight plan and nav/comm control in case the touchscreen fails. It's also where you set your altimeter.

While all this gadgetry is cool, is it really necessary? With a few exceptions, such as user-defined holds, a G2000 won't expand your mission capability beyond what you could do with a G1000. But the steps for a given task are almost always easier, quicker, and most importantly, far more intuitive. We see that as an enormous improvement.

current TTX has the avionics and mechanicals to be upgraded when (or if) the uber-autopilot becomes a reality.

TTX OR SR22T?

We think Cessna has the TTX's role in long-term customer loyalty just right. The TXX is a realistic leap for a competent Cessna 172 pilot, so long as they get good instruction. New TTXs come with 12 hours of transition training. Moving straight from a TTX to a light jet should be a reasonable reach as well.

But the more pertinent question for wider sales is whether the TTX is a better buy than a Cirrus SR22T. We originally had a comparison chart, but the book values for capacity and performance of the two airplanes were too similar. Granted, top speed for the TTX is 11 knots faster, but at realistic altitudes and power settings, we believe the difference is less.

The G2000-based Intrinzic has serious appeal. Cirrus still offers its G1000-based Perspective avionics suite. But given the avionics arms race, we don't expect this distinction will exist much longer.

Comparing prices is somewhat unfair because of the avionics difference, but the difference significant. As evenly equipped as we can make them, a non-FIKI Cirrus SR22T GTS is $712,600 while the equivalent Cessna TTX would be $772,925—a $60,000 difference. For FIKI versions, the delta drops to $50,000. But as we said, this comparison is unfair because the TTX flight deck is really a generation ahead of the Cirrus.

No matter how well equipped, or with what bold paint scheme, turning the lesser-known TTX into a real contender against the popular kid from Duluth will be tough. Even Wichita Approach was confused as to what we were flying on the demo ride. We bet they'd know a Cirrus.

However, the right buyers should recognize the Cessna TTX for what it is: a fantastic traveling airplane with an avionics suite that, for the moment, is second to none.

CONTACTS

Cessna Aircraft
800-423-7762
www.cessna.com

Your Li-ion Future: Promise, But Risk Too

Lithium-ion batteries are coming to aviation, both as main starting batteries and for electric airplanes. But they'll require careful steps to reduce the fire hazard.

by Paul Bertorelli

For the great wide world of transportation, the lithium-ion battery is the shining city on the hill, that pivotal bit of technology that will have us whizzing around in silent cars banishing the evils of carbon dioxide. For aviation, lithium-ion is both an enigma and an opportunity.

To understand both, you need only to grasp three numbers: 50, 150 and 1700. The opportunity part resides in the first two numbers—a lead-acid battery's energy density is about 50 Wh/kg, a third or less than that of the typical lithium-ion's 150 Wh/kg. Now for the enigma. The 1700 is the Wh/kg energy content of gasoline, adjusted for the typical internal combustion engine's 20 percent efficiency. The very best lithium-ion batteries can do at the moment is 400 Wh/kg and these don't exist commercially yet. That means the practical electric airplane may be on the horizon, but it's not around the corner.

Lithium batteries ought to be a slam dunk for one application, though: starting and main aircraft batteries. "They're twice the capacity and half the weight," says Skip Koss of Concorde Battery, a leading GA supplier. The only thing is, he says, they've been known to erupt in violent flames from time to time, thus Concorde isn't satisfied that the technology is yet worth the risk.

ELECTRICS CARS ARE DRIVING

The market for lithium-ion batteries in aviation is bifurcated and although not strong yet, it's certain to go that way. What's driving development, including capacity improvement, new chemistries and safety, is the emerging electric vehicle market. But two other segments are promising, too: grid batteries that are used for smoothing out and backing up commercial electrical grids and IT/data applications. Aviation will be a fraction of this, but it's still seen as a growth market.

For aviation, primary batteries for electric airplanes have thus far been based largely—although not exclusively—on the lithium-cobalt-oxide technology that's popular for notebook computers. Panasonic and Sony are big players in these markets and these batteries find their way into developmental airplanes through companies that buy the individual 3.6-volt cells and custom package them for specified voltages and amp-hour requirements. The battery pack in the PC-Aero Electra One Solar electric airplane we saw in Germany last spring uses a 60-volt system that PC-Aero's Calin Gologan told us is a compromise between safety and efficiency.

Electric airplanes have been—and remain—hamstrung by battery energy density considerations. Even though the best mass-market lithium-ion technology is now capable of nearly 200 Wh/kg, twice that density would make them more marketable. Panasonic, whose batteries Gologan uses in the Solar One, promised higher watt density batteries, but hasn't delivered.

"The technology exists. I think they don't bring it for economical reasons. They don't want to start to the production lines,"

Electric airplanes are out there and more are coming, such as the Antares motorglider, below. A leading U.S. lithium-ion manufactuer, A123, plans to market its iron-nanophosphate chemistry, right. It's considered more stable and thus suitable for aviation.

UPS has lost two aircraft to fires, top, and although lithium-ion batteries weren't directly implicated, investigators pointedly noted batteries were aboard both. Research at Northwestern University has yielded a Li-ion anode with a theoretical ten-fold energy density increase.

Gologan says. Meanwhile, PC-Aero has equipped its soon-to-be intro airplane with solar cells that can extend flight time by 50 percent. Gologan believes for the fly-for-fun market that electric airplanes will represent initially, 90 minutes to a couple of hours of slow-speed endurance is sufficient and he believes currently available batteries can do that. Obviously, if electric airplanes are to become serious contenders in, first, the training market and later personal transportation, better batteries are a must. Everyone in this field we spoke to tells us they're sure these are coming, but no one knows when or what their capacity will be. In Slovenia, innovative Pipistrel has been offering an electric version of its Taurus G2 motorglider since 2007. Total sales so far? One, although more are expected to ship this year. Current battery technology allows two climbs to 4000 feet, followed by 3.5 hours of charging, says Pipistrel's Tine Tomazic, who takes claims of battery capacity doubling within five years with a pound of salt.

"Since 2007, when we flew the prototype G2, the energy density went from 163 (Wh/kg) to 185 for the same power required," he said. That's not much progress in five years, although Pipistrel says it's confident enough in better batteries to plan an all-electric version of its new Panthera and also an electric Alpha trainer. Meanwhile, Pipistrel is also developing a hybrid. (See sidebar opposite page.)

WHERE ARE THE BATTERIES?

With the industry stuck at the 200 Wh/kg barrier, if not practically a lot less, where and when is this new battery capacity supposed to appear? These turn out be difficult questions to pin down. We spoke with Bill Mitchell, VP of commercial solutions at A123, a startup company that has become a leader in EV batteries but who also sees potential in aviation.

A123 is championing a lithium-iron-nanophosphate technology that it claims has good energy density and is more stable than the cobalt-oxide chemistries that currently dominant the market. The holy grail of lithium efficiency is to move lithium ions through the electrolytes and electrodes more efficiently and A123's nano-size particles do that, says Mitchell. Further, because they vent when thermally stressed, they're less volatile than oxide batteries, whose electrolytes of lithium salts dissolved in flammable organic solvents are highly susceptible to intense fires. (A123's claims notwithstanding, its cells were used in a Citation that torched in a battery fire last year. More on that later.) Mitchell told us the working nameplate energy density of today's cells is 130 to 150 Wh/kg and he sees that doubling over the next few years. "Few" is fuzzy, but if it's three to five years, that's unlikely to shift the electric airplane market into high gear.

Pipistrel's Tomazic said doubling energy density would open up some possibilities, such as two more takeoffs in the G2 motorglider before recharge or more "get home" energy from a longer flight. He reckons most operators would opt for the takeoffs and use the G2 as a glider trainer.

What about longer term? "Ten years from now? The crystal ball gets a lot more cloudy," says A123's Mitchell. "There are a lot of chemistries out there that have promise to increase energy density, but they're still at the early stage."

One of those was revealed at last spring's CAFE Electric Aircraft Symposium in Santa Rosa, California, where battery researcher Cary Hayner from Northwestern University discussed what has become know as "10X" technology, implying a ten-fold increase in energy density.

"The 10X issue is a bit tricky," Hayner told us via e-mail. "Although we increased the capacity ten-fold in the anode electrode—you can also say equivalently that we increased the anode energy density (Wh/kg) by roughly ten-fold as well, maybe slightly less like eight-fold—consumers will not be able to see the ten-fold increase in energy in electronics on the market," he explained.

That's because the cathode hasn't been upgraded yet, although even with current technology, Hayner believes the new anodes could improve energy density by 30 or 40 percent, and the new anode may be commercially viable with current cathodes over the short term.

"To fully realize the ten-fold increase in energy density, we would need to couple our anode technology with an oxygen cathode electrode, which may not be feasible for many more years—this is what is called 'Li-air' technology," Hayner said. The Northwestern team improved energy density by inserting "in-plane" defects in their graphene anode material, allowing more efficient movement of lithium ions.

A CITATION BURNS

That lithium batteries bring promise with peril was illustrated by Cessna's recent experience. In a well-suppressed event in Wichita last fall, a Citation CJ4 equipped with a lithium-ion battery with A123 cells caught fire and burned, according to an FAA-

AIRCRAFT HYBRID DRIVE

Almost from the moment the internal combustion automobile appeared, the electric car has been nipping at its heels, never successfully. Stunted range due to low energy-density batteries that were also heavy to cart around has stifled electric car development.

In 1997, battery capacity was still the pits, but Toyota eked out a toehold for the electric car with its Prius serial-parallel hybrid. Toyota simply dealt with the battery limits of the day by designing a clever hybrid drive that worked around the problem.

Two aircraft companies plan to test the same idea for airplanes, albeit with different approaches. First, some terminology. A pure serial hybrid drive depends on a combustion engine to spin a generator that drives the wheels through electric motors. A diesel-electric locomotive is the best example, with traction motors on each driving wheel but no batteries for propulsion. A World War II-era Fleet Class submarine is similar, but with batteries to run electric motors. Neither example can run mechanically directly from the internal combustion source.

Parallel hybrids can run from either an internal combustion source or the electric source or both at once. In the automotive world, these are sometimes called "mild" hybrids, but milds aren't true parallel hybrids since their electric motors act more as helper propulsion and can't move the car on their own via electric power. The Prius and newer systems from GM and Ford blur the line between the two systems, operating in both parallel and serial mode.

Coming from Flight Design and Pipistrel are one of each. Flight Design has done well with its line of LSAs and is developing a certified airplane called the C4. What it has in mind for a hybrid system is a parallel design that would use an electric motor in a power-boost function running in parallel with a conventional gasoline engine.

"Our design goals are to obtain a system that, in pure combustion operation, provides adequate power (with some reserve) for cruise flight," says Flight Design's Oliver Reinhardt.

"An electric drive boosts the combustion power to the correct takeoff power range. This brings us to our setup of having a 140-HP basic conventional engine power, boosted with 40-electric HP to a total of 180 HP at takeoff. The weight of the system shall be equal or less than that of an installed conventional 180-HP engine, including fuel and batteries."

Reinhardt said such a system could be certified and available as quickly as two years from now. What's the sales pitch? Fuel economy, a bit less noise, redundancy for safety and green appeal, but the larger goal may simply be—as Toyota did—moving forward with a combination of available technologies that work now.

Reinhardt told us that Flight Design believes electric propulsion has a future for aircraft, but that the technology isn't sufficiently mature. The hybrid approach allows the company to gain some experience while battery energy density catches up.

On the other hand, Pipistrel thinks energy density is almost there for pure electrics, but plans both an all-electric and a serial hybrid version of its under-development Panthera. That Pipistrel is a company driven by a vision is evidenced by its time schedule: It wants to have the hybrid flying by early 2014.

Pipistrel is pursuing the locomotive paradigm. For its experimental G4 NASA Green Challenge airplane, Pipistrel developed a great honking 200-HP brushless DC motor. Tine Tomazic said Pipistrel proposes to drive the motor with an internal combustion engine/generator set, with a battery pack smaller than a full-electric airplane would need.

Takeoff would be on electric power—to reduce noise—and cruise would be on gasoline/electric. Or more accurately, multi-fuel/electric, since the engine is intended to burn a variety of fuels. Tomazic said Pipistrel has the electric motor, the internal combustion engine and the generator, although he declined to describe specifics.

"We'll keep it behind shades until it's ready. It's the kind of a thing that when you develop it, when you show it, it has to be done properly. Otherwise, it's the target of laughter from competitors and people who don't believe in the technology," Tomazic said.

It's also important not to over promise for airplanes that don't exist. On paper, the Panthera hybrid will be about 50 kg (110 pounds) heavier than the conventional gasoline model, powered by a 210-HP Lycoming IO-390. Pipistrel expects that with its minimal battery pack, the hybrid Panthera will carry four people but no baggage or three people and some baggage. It will cruise 20 knots slower than the IO-390 version.

The market for the pure-electric version, says Tomazic, is the high-performance trainer market while the hybrid version—with up to 1000 miles of range—would presumably be pitched as a green transportation machine with strong pull in Europe, where flyover noise limits are in place and enforced.

Pipistrel Panthera

LITHIUM CHEMISTRIES COMPARED

Just as with any technology and as shown in the chart below, lithium batteries paint a matrix of plusses and minuses. So far, the various chemistries do relatively well with energy density, but there are tradeoffs. Consider lithium cobalt oxide, for example. It's the type of chemistry used in laptop computers and portable rechargeable power tools where high energy density gives good performance and reasonable endurance.

LiCoO2 batteries are also the chemistry of choice for many of the all-electric airplanes in development, primarily because of their energy density. As the chart shows, they have good energy density with relatively good cycle life and because this technology is manufactured in large volume, it's also economical. Its significant downside is sensitivity to overcharging and a tendency toward thermal runaway.

With an oxide electrode present in the battery and a highly flammable organic solvent electrolyte, thermal runaways in LiCoO2 batteries tend to be violent, spectacular and uncontrollable. Cruise YouTube and you'll find some impressive videos of LiCoO2 fires and explosions.

How often these occur is difficult to establish, but Concorde Battery's Dave Vutetakis told us the industry estimate is once per one to five million cells. And that's individual cells, not battery packs. Furthermore, it applies only to cell internal shorts or failures, not overcharging events.

Lithium iron phosphate seems to be the coming chemistry for vehicle batteries and although it's considered less volatile than LiCoO2, Cessna still appears to have lost a Citation to a lithium battery fire. LiFePO4's tradeoff is lower energy density than LiCoO2, but this may improve over time. The big comer in lithium is lithium air (Li-Air) technology, whose theoretical estimated energy density is as high as 1700 Wh/kg, which rivals gasoline. Even at half that, Li-Air would fundamentally reshape vehicle battery economics. However, Li-Air is on the research bench and sources tell us it's years from practical production, if it ever gets there.

CHEMISTRY	ENERGY DENSITY	CYCLE LIFE	SELF DISCHARGE RATE/MONTH	SAFETY AND ENVIRONMENT
LITHIUM COBALT OXIDE $LiCoO_2$	140-145 WH/KG	700	1%	POOR
LITHIUM MAGANESE OXIDE $LiMnO_4$	105-115	500	5%	GOOD
LITHIUM NICKEL MAGANESE COBALT $LiNiMnCoO_2$	140-155	700	1%	GOOD
LITHIUM IRON PHOSPHATE $LiFePO_4$	90-110	1800	.05%	EXCELLENT

issued AD on the incident. We're not sure if the airplane was a hull loss, but it sustained significant damage. Neither Cessna nor A123 replied to our requests for additional detail.

Whatever the case, Cessna immediately issued a recall service bulletin to remove lithium-ion batteries for about 50 CJ4s and on October 6, 2011, an emergency AD appeared requiring the same. The batteries were replaced with lead-acid or NiCad, by owner choice. Cessna did say it is committed to lithium-ion technology and hasn't given up trying.

Significantly, the Citations had battery installations approved by the FAA, which has expressed serious reservations about lithium ion for aircraft main batteries and has developed stringent certification requirements. According to the FAA, since 1991, there have been 53 aviation-related incidents—fires and minor explosions—involving consumer-grade lithium-ion batteries. These have occurred on cargo aircraft, passenger aircraft and in terminals. (To be fair, lead-acid, NiMh and NiCads have also been involved in more incidents.) It's possible, if not likely, that two major hull losses have occurred because of lithium battery fires, both in UPS aircraft. One occurred in Philadelphia in 2006, the other in Dubai in 2010. The latter, a 747, was carrying 81,000 lithium-ion batteries, but in neither case could investigators say with certainty that the batteries ignited the fires. Nonetheless, the risk is viewed as so serious that the FAA restricted passenger airplanes from carrying non-rechargeable lithium batteries as cargo in 2004 and new regulations will go into effect next year requiring more stringent labeling and packaging. Without these, a study by ICAO predicted an aircraft loss every two years due to battery fires. All of this tends to taps the brakes on lithium batteries for GA.

WHAT'S THE PROBLEM?

The principle source of volatility in lithium-ion batteries is their highly flammable lithium salt and organic solvent electrolytes. Lithium metal itself is highly volatile, but only small coin or camera cells have metallic lithium. That's a good thing, for these have been implicated in some lively small-scale explosions.

Although lithium chemistries vary in their sensitivity to overcharging, a single overcharged cell in a pack can initiate thermal runaway. "When one goes, it tends to propagate to the other cells and you have a real problem," says Concorde's lithium-ion expert, Dave Vutetakis. A single cell is difficult to extinguish, but with several popping off, losing the airplane is likely and this may have been what happened in Cessna's Citation fire.

Lithium-iron nanophosphate—A123's specialty—is considered one of the most stable chemistries, but it still has a hull fire on its record.

Several layers of redundant protection are thus needed, starting with electronic battery management systems that monitor the cell temperature and keep charge rates balanced. BMSs also keep the battery from discharging entirely, in which case it's ruined.

"I think it would be foolhardy to market a lithium-ion battery without good electronics," Vutetakis said. A

continued on page 32

ADS-B From Garmin; Avidyne's 430 Slide-in

For AirVenture, Garmin rolls out remote and portable ADS-B products. Avidyne unveils the IFD440, a slide-in replacement for the Garmin GNS430.

by Chet Ludlow

As we go to press this month, Garmin is poised to announce a slew of new products at EAA AirVenture, including a new combined traffic/weather ADS-B box, a portable ADS-B receiver and updates to the established GTX 330 transponder. Not be left behind, Avidyne is right on Garmin's heels—literally—with a new slide-in replacement for Garmin's GNS430 mapcomms, the most populous navigator in the GA market. Garmin expects additional products later in the year.

That ADS-B is where the current action is obvious from Garmin's introduction of two products—the GDL88 and the GDL39 portable. The GDL88 is an ambitious product that's a remote ADS-B transceiver capable of ADS-B in on both 978 and 1090 MHz and out on 978 with a low-power 1030 MHz transmitter for local traffic.

At $3995 for the most basic model, it's designed to display on Garmin's line of panel mounts. Furthermore, several models offer installation flexibility. For instance, it can be configured as ADS-B out only as a low-cost means of meeting the 2020 requirement for ADS-B within certain airspace. Or it can be in only, for FIS-B and TIS traffic. The top of the GDL88 line allows all of these features and includes WAAS capability for $5995.

In a pre-AirVenture briefing, Garmin showed us the GDL88's sophisticated target-tracking capability, which includes target grouping and on-the-fly relative motion analysis and display.

With iPad interfaces multiplying like ants at a picnic and portable ADS-B gadgets keeping pace, Garmin's got its own now, the $799 GDL39. The GDL39 can receive both traffic and weather. It can be battery or ship powered, and will display on Garmin portables all the way back to the GPSMAP 396 through hard cabling and to the aera796 model through Bluetooth. The 396 and 496 show traffic only (eight-target limit), but all the other display options are capable of both traffic and weather.

Garmin didn't forget the iPad. The GDL39 will display on that through Bluetooth, both weather and traffic up to 30 targets. For now, you'll need Garmin's Pilot app, but going forward, we wouldn't be surprised if the GDL39 plays with other apps. Check out Garmin deals at AirVenture for show special offers. Garmin is also offering ADS-B updates for the GTX330 transponder.

While Garmin is busy shoving new products out the front door, Avidyne continues its fierce competition with slide-in boxes first to replace Garmin's GNS530 and now, with its just-announced IFD440, Avidyne has the GNS430 in its crosshairs.

Like the IFD540, the 440 mashes up touchscreen with conventional keys and knobs, the reasoning evidently being that not all GNS430 owners will want to replace those with touchscreen GTN650s from Garmin. So Avidyne is ready with the IFD440, which has leading-edge FMS architecture that meets SBAS/LPV precision approach guidance and the position-accuracy required for ADS-B. In other words, Avidyne is looking forward to 2020 with what may be perfect timing.

This latest product continues Avidyne's efforts to fill out a Garmin competitive line to include the AMX240 audio panel, the AXP340 Mode S/ADS-B transponder and the DFC-series autopilots. The IFD440 will retail for $14,995.

Garmin's GDL88, top, is a blind box that does ADS-B traffic and weather. The GDL39, center, is a new ADS-B portable. If you've got an aging Garmin GNS430, Avidyne can replace it with an IDF440, right.

Ship's Radar Upgrades: Garmin Leads the Way

Garmin already revived a stagnant radar market with the powerhouse GWX68. Now it aims high with a new turbulence-sniffing Doppler system.

by Larry Anglisano

If you're stepping up into the world of higher-end twins and some high-flying singles, you'll eventually be faced with maintenance of onboard weather radar. Upgrading and maintaining weather radar is an expensive investment, and the benefits of real-time ship's weather radar might not be obvious to today's datalink pilot. But resist the urge to yank ship radar from the airframe—it still has its place.

On a recent trip up the East coast in a small twin, we were picking our way along the back edge of a slow-moving line of Gulf-fed buildups that offered no shortage of drama for hundreds of miles. It was a tense flight, but tempered by the NEXRAD images steadily arriving from XM.

Avidyne's EX-series MFDs play with a wide range of radars and are a great choice when it's only the display that needs replacement.

Singles are usually limited to 10-inch antennas due to small, wing-pod radomes. These are still useful for close-in, tactical maneuvering—exactly where NEXRAD falls short.

But as we motored closer to a large cluster of buildups, XM's image just wasn't jiving with our view through the windscreen. A watchful controller then offered a heading through a gap that would have been through the heart of a red NEXRAD return. However, overlaying a stabilized image from the Bendix/King radar on the MFD moving map confirmed just what the controller was painting: a comfortable path that NEXRAD said didn't exist. That's how ship's radar earns its keep.

SHIP'S RADAR 101

Pulsed radar locates targets by transmitting a microwave pulse beam that reflects off precip and back to the radar receiver as a return often called an echo. The microwave pulses are focused and radiated by the system's antenna, located in the nose of twins or enclosed in a wing pod on singles. The same antenna is used for both transmitting and receiving.

The returned signal is processed and displayed on either a dedicated radar display, or as a remote input to an MFD. The MFD option has been the saving grace for a mostly stagnant GA radar market because the color MFD has greatly enhanced the display and effective usefulness of aging systems.

Still, it's not all roses. An accepted limitation for small airplane radars is the diameter of the antenna, which is limited by the radome you have to fit it inside. The radar beam is much like the beam of a spotlight; the farther the beam travels, the wider it gets. The smaller the antenna, the wider the radar beam and the more its energy is dispersed over each mile it travels away from the aircraft. A 10-inch antenna (the size you'll typically find stuffed in a wing-mounted

pod) has a 10-degree beam. A 30-inch dish in the nose of your average airliner shoots a three-degree beam.

When scanning longer distances with a smaller antenna, a storm won't fill the beam's entire width. Energy is lost as it moves past areas where water droplets reflect it back. A small-dish radar sniffing out 100 miles might paint a puny return for the pilot that is, in fact, a Level-6 disaster waiting to happen. Wide-beam radar needs to be closer to the storm to assess it accurately. Talk about the proverbial cat in a room full of rocking chairs.

BENDIX/KING RDR2000

Honeywell's four-color RDR2000-series digital radar came trickling down from its higher-end system's years ago. The higher-powered RDR2100 system adds a 120-degree scan plus an auto-tilt feature that smartly manages tilt angle while the aircraft climbs or descends. But Honeywell no longer sells this system with a dedicated display, expecting you to use a KMD850 or Avidyne EX-series MFDs. The systems *sans* display are the ART-2000 and -2100 for $22,682 and $42,186, respectively.

The 2000-series is a solid-performer that's been used extensively as original and aftermarket equipment in everything from Beech Barons to turboprop singles and twins. It was also an integral component with the Honeywell IHAS integrated hazard awareness suite, overlaying weather on the KMD850 MFD. There's an EFIS interface for older glass panels, and software is in the works to play on the new Avidyne IFD540, which replaces older Garmin GNS 530s.

The ART-2000 is stabilized, which means it gets a pitch reference from an attitude gyro or AHARS source. This stabilization is an important part of seamless radar operation, keeping the picture in proper orientation with the aircraft's nose. The ART-2000 makes 4 KW of peak power and has a vertical profile mode.

This vertical profile feature made the RDR2000-series a big seller for Bendix/King and on the used market. It still remains one of the more sought-after radars for light twins and turboprops. It's a proven performer, with a 227-nautical mile range and a magnetron (what actually generates the radio energy) with

GARMIN DITCHES THE MAGNETRON

The expensive nag with radar upkeep is the looming failure of the high-powered magnetron. Just like the cavity tube you find in older transponders, in time the performance of the radar tube decreases. That's why magnetrons may only offer a few thousand hours of service. Airliners and modern biz jets use solid-state radar technology, and that's exactly what Garmin's done with its new GWX70.

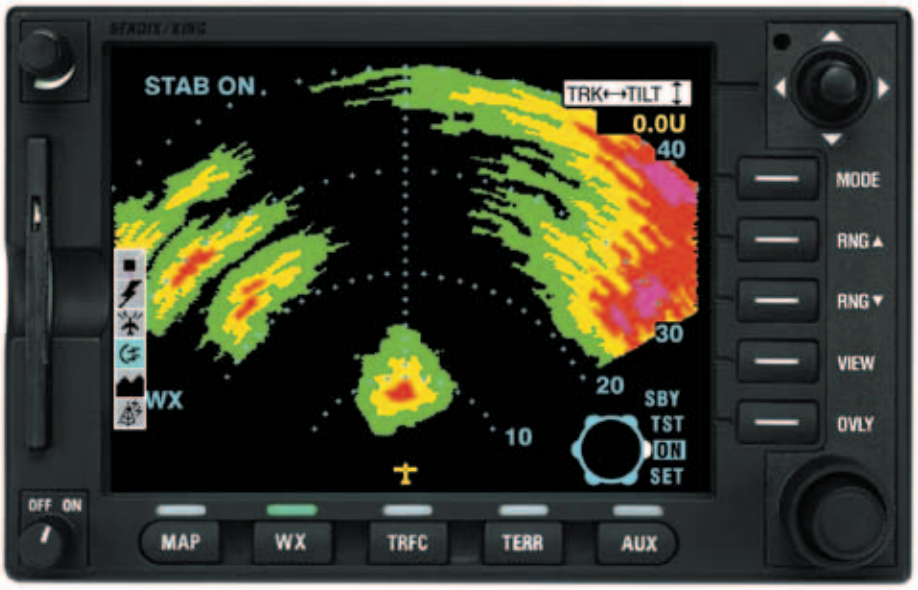
A core challenge with ship's radar is getting an accurate and defined picture at long ranges. The more power you pump out, the further it can see, but the poorer the resolution of the final image. The clarity can get so poor that you might entirely miss a small, close-in cell.

Garmin's new GWX70 betters the range of the 6500-watt magnetron GWX68, but does it with only 40 watts of power output, so you get the best of both worlds. It also contains modern processing using digital signal processor technology in its receiver. Solid-state radar design offers sizeable benefits in performance with exceptional control over the radar's pulse width, pulse phasing and signal output.

The GWX70 enables Doppler capability, which you won't find in a magnetron-powered system. This means the GWX70 can offer turbulence detection out to 40 nautical miles and enhanced ground clutter suppression. Suppressing unwanted ground object echoes in the radar return is key to an accurate picture and an accepted anomaly with older analog radars.

To reap the benefits of these advanced features, including the Doppler capability, you'll need the GWX70 in 12-, 14- or 18-inch flavors. Garmin told us the 10-inch antenna beam is too wide for Doppler capability. Remember, a larger antenna offers a narrower and more efficient beam. You can also bolt a GWX70 into the place of a GWX60 if you're so inclined.

The GWX70 starts at $20,995 for the 10-inch model, which is identical to a GWX68. If the GWX70 turns out to be the solid performer we predict it will be, we can't see why buyers would buy into magnetron technology at all.



Honeywell's RT2000-series radars are proven performers, but will require an MFD display, such as this Honeywell KMD850.

an advertised 8000-hour average life. That's a long time in the life of magnetrons.

The RDS-81 model was good radar in its day, but we're seeing more failures as these systems age. A popular fix is to bolt the ART2000 in its place. The interface connector is different, so you'll pay for some wiring work.

We spoke with a couple of respected radar shops, including Duncan Avionics and Fieldtech Avionics, and got the impression there's still reasonable repair support for the RDR160 and RDS-81, but the RDR2000 series is clearly the favorable upgrade on the used market. Healthy, lower-time RDR2000s earn impressive dough—over 10 grand in many cases.

The new Garmin GWX 70 can replace a GWX 68 to add turbulence detection.

GARMIN GWX 68

Believe it or not, Garmin's $20,995 GWX-series digital radar started life as the once-popular general aviation King KWX58. In the late 90s, Garmin purchased the KWX, if only for an R&D building block. The brilliantly re-engineered system sports a magnetron with 6500 watts of transmit power. (See the sidebar for the just-introduced GWX70, a solid-state descendant of the GWX68.)

Like other remote units in Garmin's modern line of glass cockpit technology, the GWX 68 is considered a Line Replaceable Unit (LRU) with an open architecture that outputs weather radar data to an external MFD, including the GMX200 Radar MFD, G600 PFD/MFD-combo (or G500 with an enablement card), G900X and G1000 avionics suites and the GTN750 navigator with version 3.0 software. The GWX 68 communicates with other LRUs in the suite using ARINC 429/453 or Ethernet.

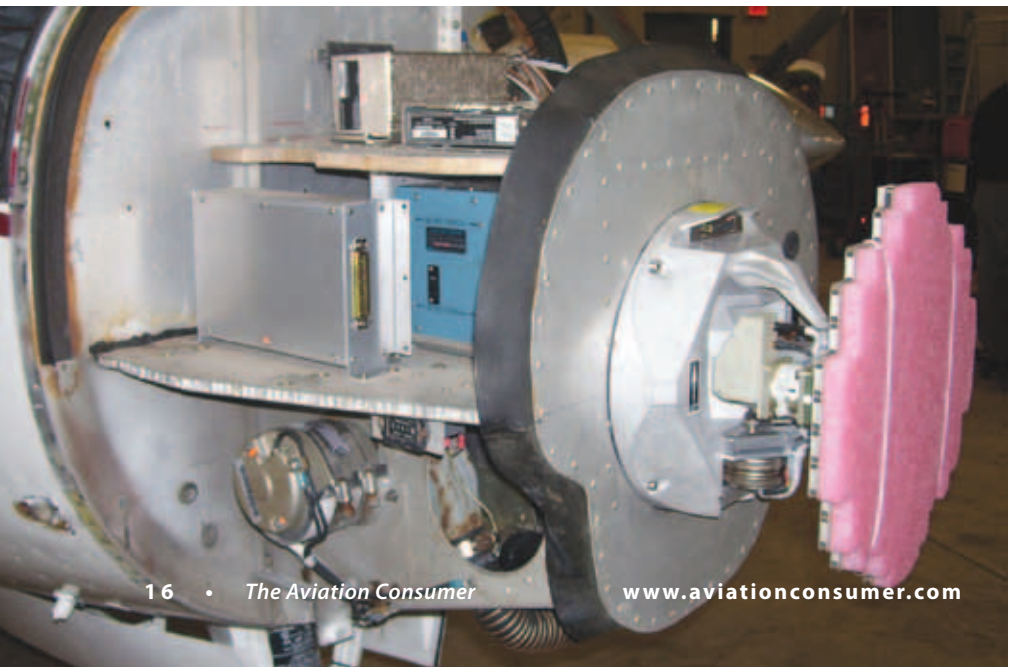
A flat-dish design, the GWX 68 is offered in 10- and 12-inch antenna sizes to accommodate a wide variety of light twins and high-flying singles and is stabilized. There's also a feature called sector scan. With user-adjustable scan angles of up to 90-degrees, scanning sectors is helpful for a focused look at storms in a given sector. Vertical scanning looks up and helps to analyze storm tops, gradients and cell buildup activity at higher altitudes.

Garmin tries hard to overcome the shortcomings of magnetron-based radar with what they call Weather Attenuated Color Highlight (WATCH). This helps to identify where return echos are weakened by intense precipitation and may not fully reflect weather that exists beyond what's being painted. The GWX68 is always at work with a Weather Alert mode that looks ahead for intense cell activity up to 320 miles out, even if the pilot isn't monitoring returns at that distance.

MFD BOOSTS PERFORMANCE

While failures of a radar transceiver might be more common than display failure, a faulty CRT is usually a throwaway. Moreover, old monochrome technology isn't exactly your ticket to modern cutting-edge weather mapping.

Saddling an existing radar with a MFD is an easy ticket to jumpstarting the older, but otherwise healthy, system. Avidyne offers the most MFD/radar combinations. The drill is to install a pre-fab radar interface cable between the existing radar and an Avidyne EX600 (or older EX500). An adapter board and software inside the MFD create a dedicated radar page and an overlay on the MFD moving map—a real gain in utility compared to a standalone screen. However, the MFD must have a heading signal for proper weather



orientation. An AHARS-feed or 400 Hz analog synchro signal from an HSI will do the job.

Garmin's new version 3.0 software for the GTN750 touchscreen navigator enables the play of ARINC label 708 digital radar, including Honeywell's ART2000/2001 and RS181, as well as Garmin's GWX-series. This real-time weather overlay includes the vertical scan functionality. Given the suitability of the GTN-series for a wide variety of aircraft, this new interface opens up a huge opportunity to play ship's radar in aircraft that can accommodate a radome. There's no radar overlay on the smaller-screened GTN650.

DECISION TIME

Whether to repair or remove your aging radar really comes down to mission need and the age of the gear. We wouldn't sink real money into anything older than an RDR2000, or perhaps an RDS81 if a qualified shop blesses it as a keeper. For those units, though, we think it's worth keeping, especially if display on an MFD is an option.

Buying new? Our experience over time with the GWX68 has convinced us that it offers solid performance and reliability that's priced right. For bigger turbines, the new GWX70 seems the logical match.

Lastly, we think Garmin's new GTN750 radar-enabling software will solve a huge problem for a lot of owners who otherwise go without radar because they don't have space for a MFD. There's a sizeable investment involved installing a GWX68 or 70 but we think it's smart money for high-flying and go-places aircraft with a place to put the antenna. In fact, a GWX+GTN750 combo might be the ship radar for GA to date.

CONTACTS

Garmin International
www.garmin.com
800-800-1020

Honeywell Bendix/King
877-712-2386
www.bendixking.com

Avidyne Corporation
800-284-3963
www.avidyne.com

Personal 406 Beacons: ACR ResQLink+ is Tops

Even with a 406 MHz ELT, there's a place for a PLB. If all you have is a legacy 121.5 MHz ELT, then something that gets the satellite's attention is a must.

by Jeff Van West

When we last looked at Personal Locator Beacons (PLBs) in 2008, the global satellites were still listening on 121.5 and the cost of a fancy 406 MHz ELT could hit $4000. Today the only people who might hear your cry for help on 121.5 are CAP patrols or a passing airliner, and 406 MHz ELTs can be had for $600-$1400. (See the June 2010 *Aviation Consumer* for the most recent review of these units.)

Is there still a place for PLBs the cockpit? We think so. Not everyone has or wants to upgrade to a 406 MHz ELT. Even if the hardware cost isn't off-putting, the bill for the required rewiring might be. If you end up in the water, the PLB can stay with you even if the plane sinks. If you're in remote territory, you can let the ELT activate on its own and have your own PLB to activate after the ELT battery runs out. It's almost always best to stay with your downed aircraft, but you can easily take the PLB with you if need be. And you can take it on a hike even if you didn't crash.

PLB technology has also evolved. Today's devices are feature-rich with GPS positioning and built-in strobe lights, while simultaneously costing less than they did four years ago.

ACR

ACR is part of Cobham, who also owns Artex and is a well-known name in beacon systems. ACR's latest PLBs are the ResQLink and ResQLink+. The "plus" version's only difference is that it floats (both units are waterproof). Buoyancy makes the ResQLink+ an ounce heavier, half an inch thicker and about $10 more expensive. Or you can get the regular ResQLink and buy the $20 flotation pouch to both store it in and keep it above water. Either way, the total cost will be around $280 and weight about five ounces.

PLBs are different from ELTs in that they require manual activation. Activating the

The ResQLink+ packs all the key features into a small unit that can be activated one handed.

DEVICE	SIZE (INCHES)	WEIGHT (OZ)	GPS	STROBE	FLOATS	MINIMUM TRANSMIT TIME	STREET PRICE
GME							
MT410	5.3 X 2.8 X 1.5	8.3	NO	YES	YES	24 HOURS	$350
MT410G	5.3 X 2.8 X 1.5	8.8	YES	YES	YES	24 HOURS	$400
ACR							
RESQLINK+	4.5 X 1.9 X 1.6	5.4	YES	YES	YES	24 HOURS	$275
RESQLINK	3.9 X 1.9 X 1.3	4.6	YES	YES	NO [1]	24 HOURS	$265
KANNAD							
XS-ER GPS	5.7 X 3.1 X 2.1	10	YES	NO	YES	48 HOURS	$485
XS-4	4.2 X 1.9 X1.3	5.3	YES	YES	NO [1]	24 HOURS	$240
MICROWAVE MONOLITHICS							
MICROPLB	4.8 X 2.4 X 1.1	8	NO [2]	NO	NO [1]	48 HOURS	$758

1–NON-BUOYANT PLBS ARE STILL WATERPROOF. 2-CAN BE CONNECTED TO AN EXTERNAL GPS

ResQLink requires unhooking the antenna (which lives wrapped around the device), flipping the antenna up and then pushing the activation button. We had a non-transmitting unit for review and could do these steps one-handed with a non-dominant hand. Remember, the good arm could have been broken in a crash.

The activated PLB should be placed face up for the GPS to get its coordinates. This can take some time with any of these units, but the 406 MHz signal will transmit immediately. Both ResQLink PLBs include a strobe in the face of the device to help rescuers pinpoint you at the end of the search. The ResQLink+ actually floats partially facedown, so you'll want to get it out of the water for the light and GPS to work properly.

The only other button on the device is a test button to make sure it has sufficient battery life and all circuits are working. There's a service (see below) that actually tests the signal reception at the satellite if you're so inclined. The battery should be replaced after five years (or if actually used). These batteries aren't user-replaceable, so you must send it off to an authorized shop.

ACR also has a product called SARlink, which has a bit more transmit power and an optional view-screen to show you your GPS position and battery life remaining. But given a cost of $375-$475, we think there are better options if you want extra battery life.

This Accusat combines antenna deployment and activation into a single flip-and-release of that black lever.

GME ACCUSAT

The AccuSat MT410G by Australian company GME, was our top pick in 2008, and it's still a solid choice. Plusses in its column are rugged construction, two strobes for better visibility (and it floats stobes-up), and the simplest activation of all the PLBs. To turn it on, you release a lever on the back and swing it 180 degrees. This deploys the antenna and turns it on in one motion.

The MT410G also has an audible alarm, but we're not sure whether this is a plus or would just drive us nuts while waiting for help.

While the MT410G used to be one of the lightest PLBs, it's now one of the biggest and heaviest. This is relative, of course, as it's about the size of two iPhones strapped together and weighs less than nine ounces. The price is a bit heavy as well: $400 for the MT410G and $350 for the MT410, which is the same unit but without the built-in GPS.

Unit and battery testing is done using a plastic pin that is attached to the unit's lanyard. You can test the basic unit, or the GPS as well. The battery lasts seven-years, the longest of any PLB here, but must be replaced by a service center.

KANNAD

Kannad is also a well-known name in aviation beacons, but their newest aviation PLBs are actually McMurdo FastFinds. There's no price or feature advantage that we can see to buying it under one brand name or another.

The Kannad XS-ER is the only Class 1 PLB in our lineup. Class 1 PLBs guarantee 24 hours of operation down to -40 degrees C. All the other PLBs here are Class 2, which only guarantee 24 hours of operation down to -20 degrees C. Most of us non-Alaskans wouldn't make it 24 hours at -20 anyway.

The better battery does mean the XS-ER guarantees to transmit for 48 hours, whereas most of the PLBs only guarantee 24 hours and in practice don't go much past 30 hours. This could be an important feature if you're downed in seriously remote country or where weather might prevent rescue for days. This battery is also user-replaceable.

Kannad's activation is three steps: Lift the red cover, pop off a second cover that allows the antenna to pop out, and then push the activation button. This can be done one-handed if you use your teeth to pull off that cover in step two.

As you might imagine, the bigger battery life comes at the expense of size, weight and, well, expense. The XS-ER is 10 ounces and almost six inches long. Street prices run just under $500. Kannad also offers the shirt-pocket sized, strobe-equipped XS-4. It and the ACR ResQLink (nonplus) tie for the smallest and lightest PLBs, and cost about the same. The XS-4 has a three-step activation with that internal cover, however. Both units are waterproof, but only the XS-ER floats.

MICROWAVE MONO

Microwave Monolithics makes the other 48-hour PLB we looked at. It's significantly smaller and lighter than the Kannad's XS-ER and has been shown to transmit in the field for as long as five days.

That said, it's weaker in features in not having an internal GPS, strobe or buoyancy. You can connect an external GPS with the right cables, but we don't relish the thought of trying to find the cable and get it working in a survival situation.

Kannad's XS-4 (left) is a good shirt-pocket choice. But for a 48-hour PLB, we'd go with this Kannad XS-ER (right).

Activation starts with removal of a cover that frees the antenna. We actually couldn't do this one-handed, but banging the thing on a rock would probably break the cover and free the antenna. Turning it on requires pulling a pin hand-grenade style. Teeth work well for that.

It also costs $758. Maybe that's why it's a favorite of the military, but we think there are better options.

MESSAGING VIA PLB

PLB test signals are normally ignored by the COSPAS-SARSAT satellite system. But ACR runs a website called 406link.com where you can pay $40/year to get an email or text message that your PLB was received by the satellite. If that level of confidence is important to you, check the website to see if your PLB is on the compliant list. All the units reviewed here are.

For $60/year, you can customize the message and recipient list to turn your PLB into a one-message global text service. We don't think this is worth it for two reasons. One is that better tracker/messenger options are out there (see December 2010 *Aviation Consumer* for Spot and Spidertracks, and coming coverage of DeLorme InReach). The other is that it drains the PLB battery, potentially requiring early replacement.

BEST BETS

Our top pick in this lineup is ACR's ResQLink +; it floats, it flashes, it's got GPS, it's one of the smallest and it's less than $300. If you want the smallest and lightest, the non-floating ResQLink and Kannad's XS-4 are equal picks.

For travel into the hinterlands, we'd consider Kannad's XS-ER because of the extended battery life—doubly so if terrain was both remote and frigid. Our impression is that the AccuSat would also last well beyond the guaranteed 24 hours—and it's about $100 cheaper than the XS-ER—but it's not certified as Class 1.

It really pays to shop around. For example, the AccuSat MT410G MSRP is $450. We saw prices online ranging from $380-$790. Our chart shows the typical prices we saw in our research, as these were universally lower than MSRPs.

Whatever you choose, we think it's money well spent even in a plane with a 406 ELT. Just remember to register your device after you get it so the rescue teams know whose name to call out.

CONTACTS

ACR
954-981-3333
www.acrelectronics.com

GME
207-647-3300 (U.S. only)
www.gme.net.au

Kannad Aviation
503-997-4455 (U.S only)
www.kannadaviation.com

Microwave Monolithics
805-584 6642
www.micro-mono.com

As Cheap as it Gets: Legacy LSA ÷ 4

It's fashionable to flee aviation because of cost, but for less than the weekly grocery budget, you can fly your buns off in a legacy LSA.

by Paul Bertorelli

Fixed costs: $1320/yr.
Insurance share: $400/yr
Dry rate X 50 hrs: $500/yr
Gas @ $5.25: $262.50

$2482.50
$49.65/hr

Even though I parked the Cubbie on a grass field for the beauty shot above, I'm really not much about the romance of flight. While I savor the fragrance of wet turf mixed with avgas exhaust as much as anyone, the thought of a $5500 annual—and I've paid them—tends to turn the rose-colored glasses into a darker shade of cynical.

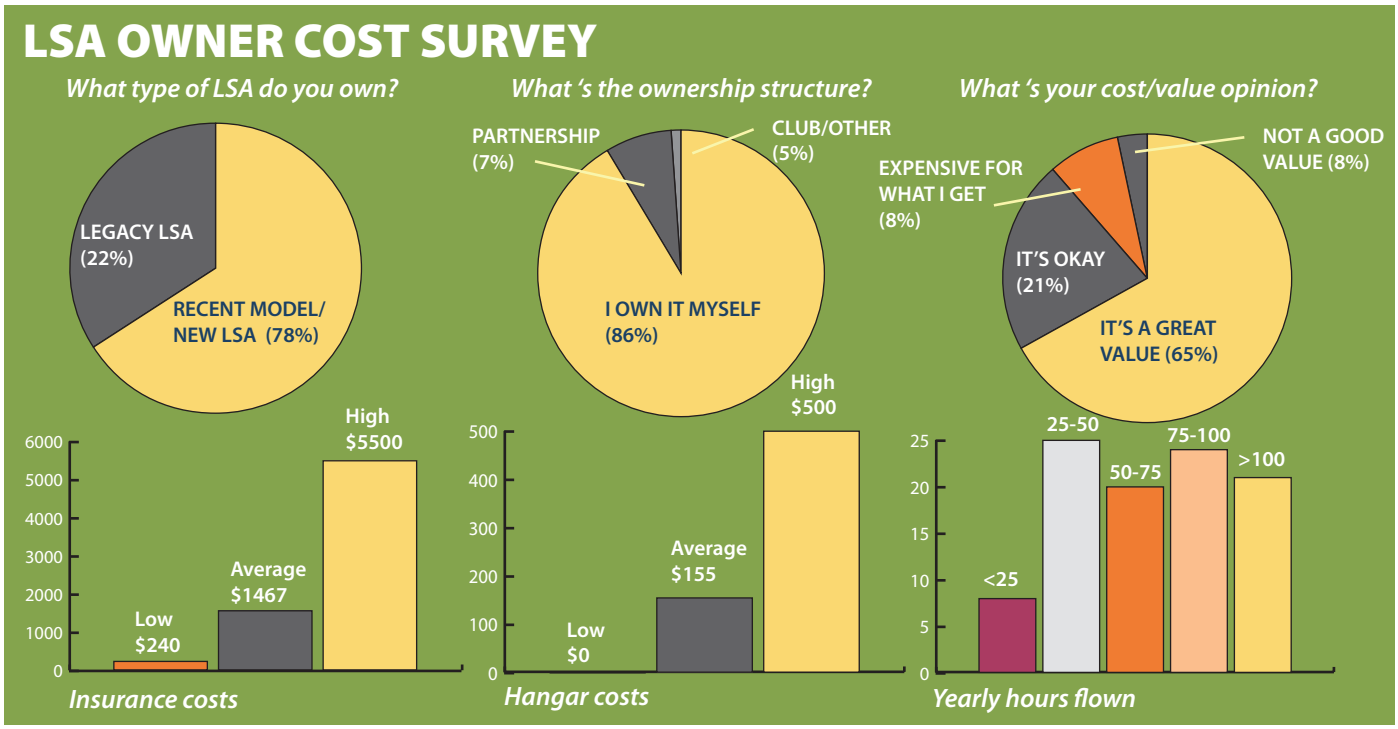
Not that I expect to ever pay a $5500 annual for the Cub, which is exactly the best reason for owning a legacy LSA—not the magic of slipping the surly bonds on rag wings, but the smug satisfaction of doing it for the price of a cheap date at Bob's Big Boy.

How to do that? Split the cost of an already cheap airplane two ways, three ways or four ways. If owning your own airplane increasingly sounds unaffordable, it's much less so in a partnership to the point that the monthly cost can be well under even a modest car payment. There's no pretending the capabilities are remotely similar, but if you want to fly or even own, there's an affordable way to get there

AIRCRAFT OWNERSHIP

THE BIG PICTURE

I'll run the numbers on our partnership Cub in a moment, but first, we were curious about what other pilots and owners are doing. Through e-mail, we hear a constant litany of complaints from owners and pilots exiting aviation because of high costs, many reasoning that airplanes aren't affordable to buy, fuel costs are ruinous and everything else related to flying is too expensive to consider. The LSA rule was invented to address this and although there's evidence that it's attracting both retiring/retread pilots—so-called full-circle pilots—and new entries to the industry, it's also true that the growth has been anemic. The FAA's recent 20-year forecast, which may be less accurate than throwing darts, predicts growth in the U.S. LSA segment of about 56 percent from 2010



to 2032, but that's only about 180 airplanes a year. It doesn't count legacy airframes being flown as LSAs. And it doesn't make much of a dent in the 500 airframes a year that are crashed or otherwise scrapped.

NOT SO BULLISH

This is not a bullish market picture and we've always assumed that the cost of airplanes is the major driver. If that's true, then wouldn't far cheaper legacy LSAs—the Cubs, the Champs, Luscombes and Ercoupe—dominate LSAdom? You'd think, but a survey we conducted recently on our sister publication, *www.avweb.com*, suggests just the opposite. We heard from 168 readers involved in LSA and the majority—78 percent—owned or flew late-model LSAs. Moreover, a third of these were valued at $30,000 or less, but half cost more than $60,000 and another third cost $90,000 or more. Clearly, LSA participants aren't really tilting toward the cheap seats.

Nor do they complain much about the cost/value relationship of owning an LSA, no matter what they paid for it. Two thirds of the pilots who replied to the survey said they thought for what they paid to fly their LSAs, the airplanes were great values.

"There is more than monetary value involved," wrote Joe Fulton. "The hangar can be a refuge. The plane gets me into another zone, removed from some of my everyday cares." We asked our survey participants about costs for their LSAs, and these are shown in the chart above. For our Cub, we're right in the middle of the pack, although far cheaper on an individual basis because we have four partners in the airplane. If our survey is accurate, not many owners form partnerships to make a cheap LSA even cheaper, which surprises me, given the benefits. Only 7 percent of the LSAs surveyed were in partnerships. This adds further credence to the idea that cost isn't as big a driver as we think. Lots of owners are perfectly happy owning a $90,000 airplane that they fly themselves twice a month for a couple of hours.

THE NUMBERS

As LSAs go, our 1938, no-electrical-system C-65 J-3C is probably overvalued at $36,000. But the partnership has shuffled members for a number of years, so the buy-in has been established at $9000 per share.

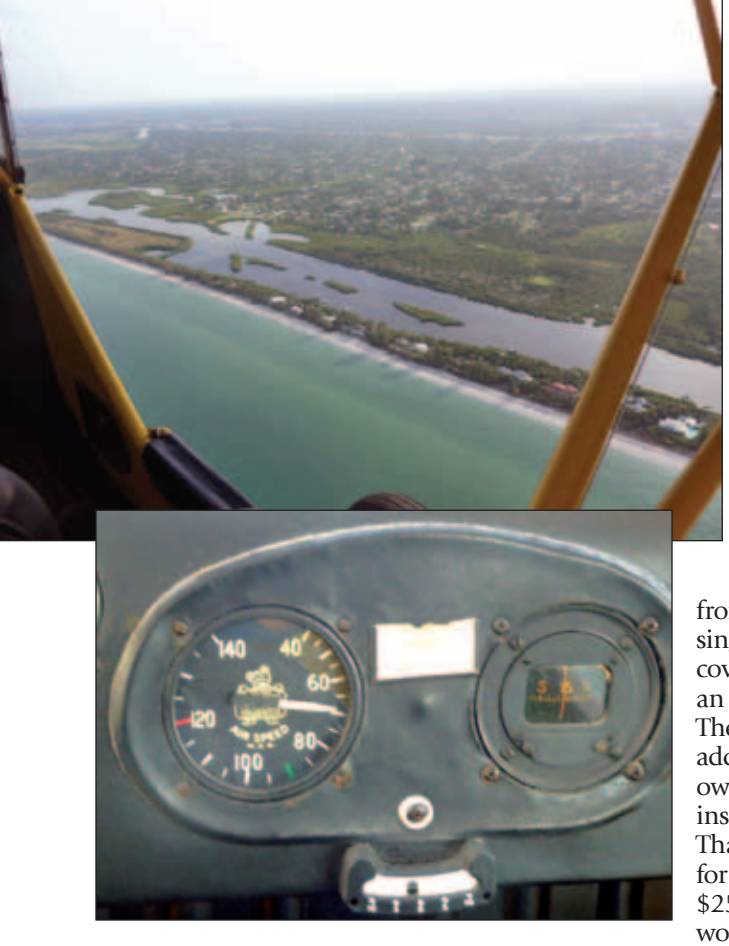
The two single biggest expenses are insurance—about $1900—and hangarage, which costs $294 a month in southwestern Florida. Hangaring a ragwing is a must, so there's no potential savings here, even if we wanted it. Routine maintenance is a bit of a giggle. If Mr. Piper intended the J-3 to be the proverbial no-maintenance battery, he succeeded. Last year we flew the airplane 129 hours and the only maintenance costs were oil changes and one tire. This is one downside of an old classic, however. The 800x4 tires are $250 item, plus tubes.

Annuals are rarely of the eat-you-alive sort. We've paid as little as $325 and as much as $1964 last year when the struts had to be repainted.

Partnerships divvy these costs out in various ways, but we've settled on a $110 per month fixed fee per member that covers hangar and, theoretically, either oil changes, some routine maintenance and part of the insurance. Sometimes it works that way, sometimes it doesn't. We've had to assess each partner the odd $100 to $400 from time to time. We could hike the monthly fee to avoid this, but why tie up the money for such small expenses?

Some partnerships bill hourly flight costs dry, some wet, some not at all. We pay $10 per flight hour, dry. Theoretically, that would generate the $16,000 required for an engine overhaul, but in reality, it gets spent on other things so we're running our airplane with two significant financial vulnerabilities. One is the engine, and the other is re-covering.

This is another downside of fabric-covered legacy LSAs. The fabric won't last forever, even if hangared. Our airplane has a $4500 per partner liability for the re-cover and another $4000 for the engine—coincidentally the value of each partnership, although we certainly didn't plan it that way.



Cheap has a price, top. Slow cruises along the beach are at 70 MPH. Distance isn't much of an option.

If this airplane were in sole ownership, those liabilities would be considerable, but not anything like a serious certified airplane like a Mooney or a Bonanza. Adding up the hangar, insurance, 50 hours of flying, the gas and the odd assessment, cost of ownership in this four-way partnership is about $2500 a year—about as cheap as flying it gets, without stepping down to an ultralight or a powered parachute.

As legacy LSAs go, the Cub is hardly the cheapest to buy and on purchase price alone, it's not necessarily a good cost/value option. You can do better with an Aeronca, a Luscombe or an Ercoupe. But cost of purchase of these airplanes is so low, that a few thousand either way at purchase doesn't make much difference in ownership and operating costs.

OTHER REPORTS

For our survey, we asked owners about insurance costs, hourly operating costs and such expenses as maintenance and hangarage. These vary all over the map, literally, but we were a little surprised at how many people just don't track the cost of owning an airplane.

"Costs? Not calculated. I don't want to know," said one owner of a Van's RV-12 ELSA. But many owners are more fastidious and do want to know. If we thought our Cub was as cheap as it's possible to get, not really. As mentioned, insurance and hangarage are big cost drivers. Our survey revealed insurance costs from a low of $240—a single owner with no hull coverage—to $5500 for an LSA in a flight school. The insurance average cost added up to $1467. Many owners don't carry hull insurance, only liability. That strikes us as rational for an airplane worth only $25,000, but not for one worth $60,000. On the other hand, you'd insure a car costing that much, so we're not sure how much sense it makes. A surprising number said they had no insurance at all, which, no matter how cheap the airplane is, isn't rational. You could lose your shirt for the sake of $400 insurance premium.

Hangar costs vary by locale, with coastal areas costing more and sleepy Midwestern and country airports with the lowest hangar costs. Some owners share hangars with other airplanes and because some LSAs have detachable or hinged wings, hangaring two-for-one is practical. The lowest hangar cost was $57, the highest $500 in the Washington, D.C. area. That LSAs have become a retirement toy was evidenced by the number of owners who reported zero hangar costs. They live on residential airports where hangars are built into the houses. (That's not truly zero, but it's not an additional ownership cost.)

While some owners hide their eyes and just pay the invoices, others are brutally honest with themselves about what it costs to fly their airplanes. These range from a high of $252 to a low of $6, with the average of reported costs about $45. (For our Cub, my real hourly costs are between $40 and $50—cheap by airplane standards, but surprisingly high for an airplane of not impressive utility.) One reason we surveyed owners is to take the temperature of LSA owners with regard to owner satisfaction and overall sense of cost/value. Although we've heard complaints that LSAs are overpriced and under-capable, we didn't hear much of that kind of carping in our survey. "I bought this Legend Cub in 2005 for $81,000 brand new," said Rich Gianotti. "The base price for a new Legend then was $69,000. Excellent value. Unfortunately, the company couldn't make money at that price."

Said Cub owner Jeff Russell, "Pilots complain a great deal about the cost of flying. So be it. It's really about the cost of priorities. If you want to fly, you just might have to not eat out so much or own a top-of-the-line new SUV. I consider my airplane wholly affordable. It does everything I want it to do and more at a very competitive hourly cost. There is, of course, no way to put a price on the fun, adventure and enjoyment it provides. Like the commercial says—priceless."

FINAL THOUGHTS

One idea to reduce costs even further came from owner Gerald Waddell: "My LSA is an SLSA, not ELSA. If buying again, I would strongly consider an experimental because of the extra operating cost. The manufacturer all too often has 'Mandatory Safety Alerts' which are expensive to comply with and, in my judgment and aircraft experience in the maintenance and of corporate to homebuilt aircraft, are generally unnecessary. The best solution to sport or recreational flying cost is the elimination of the Third Class Medical for certain types of GA aircraft, as is promoted by AOPA and EAA."

If our survey and research produced any surprises, it's this: Just as you think your own airplane couldn't be any cheaper to own or operate, someone will show you one that is. Money aside, it's really all about having something to fly. One Legend owner who wrote us summed it up nicely:

"I'm a retired airline pilot and have been a pilot for 57 years. Flying is in my DNA. At this point, I may or may not be able to pass a Third Class physical, so having an LSA reasonably assures me of being able to continue flying into the future. Flying, family, friends and morning coffee are what gets me out of bed each morning."

Telex Ascend for Jets: Not Quiet Enough

Telex's Ascend offers ANR quiet with light-headset comfort. But in the light jets it's designed to serve, we found it not quite up to the task.

by Neil Singer

The Telex line of lightweight headsets, both with and without ANR, is very popular—even dominant—in the relatively quiet cockpits of large corporate and commercial jets. Many new light jets are delivered with two Telex headsets as standard equipment.

Unfortunately, this leads many first-time jet pilots to believe the headsets are adequate for regular use in light jet cockpits. We have found this not to be the case. As the flight progresses and hearing fatigue sets in, it's usually a matter of when, not if, pilots start missing radio calls if they're using lightweight, on-the-ear headsets. The common fix is to get full-cup, over-the-ear headsets common in turboprops and pistons.

Telex makes a good effort with the Ascend to cut the noise without cups using ANR to tackle nearly all the noise reduction. As a bonus, the ANR takes its power directly from the intercom system, eliminating the need for batteries—a trick Telex uses on several headsets. But in our opinion, this effort falls short.

Part of the reason may be the noise frequencies dominating the cockpit of a jet. As opposed to the low-frequency engine and propeller noise of piston and turboprop aircraft, the noise in small jet cockpits tends to be dominated by higher frequency sound. The three worst offenders are windshield bleed air (for aircraft such as the CJ1-3 lacking an electrically heated windshield), "wind" noise increasing as a function of indicated airspeed and environmental system (duct and fan) noise.

FLIGHT TESTS

We tested the headset in two aircraft, a CJ3 and a Phenom 300. In the CJ3 in particular, the need for windshield bleed air and defog fan activation in descent created noise the Ascend did not adequately mask. Turning the ANR off and on seemed to only shift the frequency of background white noise, without causing a noticeable decrease in total sound. As a result, ATC transmissions were much harder to understand, as compared to the Bose X used as a reference.

The headset is exceptionally light, with very low clamping force. There were no noticeable pressure points on top of the head, even after hours of use. The earpieces swivel easily to keep the speakers flat against the head with minimal ear pressure.

Despite this, the headset seemed less suitable for prolonged use with sunglasses than an over-the-ear type. As the Ascend applies pressure directly to the ear, over time our sunglass temples pinched between our ears and skull. With an over-the-ear cup, pressure is applied surrounding the ear, so the temples are only contacting small areas in front of the ear, distinctly more comfortable.

While it may just be personal preference, the mic boom felt too short, putting the mic off to the side of the wearer's mouth. This may have been the cause of what we felt was muddy sound both in sidetone and over the intercom, as reported by the copilot.

The Ascend also lacks its own volume control. This reduces the ability to set differing volumes between pilots. The aircraft audio panel provides some authority to do so, but having a headset-specific control is useful in providing the most volume range between seats. This ability was missed when flying with the Ascend.

The Ascend could be a suitable headset in a larger jet with minimal wind noise and a quiet environmental system. The lack of need for battery power and lightweight design would make for a comfortable, easy-to-manage package. Unfortunately, in the noisier cockpits of in-production light jets, we don't think it's the best choice.

Neil Singer is a mentor pilot in light jets and a freelance aviation writer.

CHECKLIST

- ⊕ Lightweight, battery-free design
- ⊖ ANR can't compensate for lack of passive noise reduction
- ⊖ Uncomfortable with eyeglasses or sunglasses over time

CONTACTS

Telex
877-863-4168
www.telex.com

Cessna 185 Skywagon

This aerial pickup truck is still a favorite for those who need maximum load and backcountry performance.

Chuck Jarecki's 185 at Glacier Lake

In an age when the majority of new airplanes are made of plastic and equipped with glass panels and envelope-protected autopilots, it's hard to imagine that as recently as 1985, at least one company was still making a popular taildragger. But it was.

That company was Cessna and the airplane was the 185. It's no stretch to say that if the Skywagon was popular then, it may be even more in demand now, given the prices the latest models fetch on the used market.

Cessna 185 owners don't just like these airplanes, they rave about them. It's not hard to understand why, either. No newer airplanes will do what Skywagon can, in terms of load hauling and taildragger ruggedness. You'll see Cherokee Sixes plying gravel strips in Alaska, but you'll see many more 185s.

There are lots of other working airplanes, but the Cessna 185 is perhaps unique for its reputation as the airborne version of a four-wheel-drive, three-quarter-ton pick-up truck, easily able to haul heavy loads into and out of short, unimproved strips. With plenty of power and two front cabin doors, it's also a prized floatplane. And for all of that, some owners just like them for fun flying.

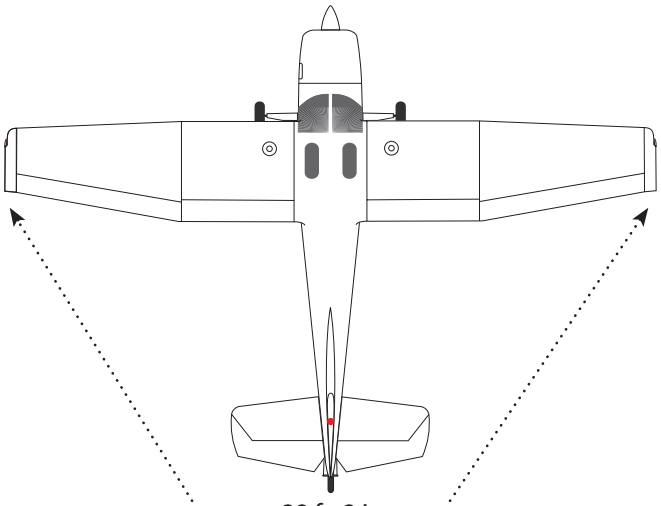
SKYWAGON ORIGINS

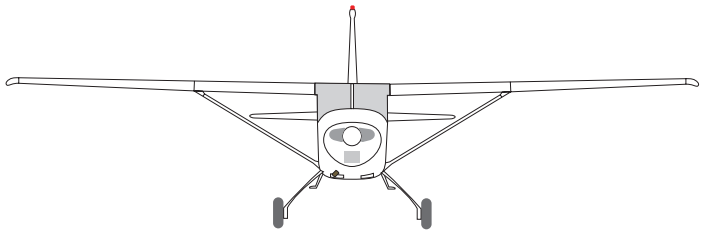
The 185 was a thoroughly logical development in the Cessna product line, which began with the taildragging 120, evolved to the 170 and 180 and then, when owners indicated the need for something bigger, the 185. It came along in 1961, a follow-on product to the Cessna 180, which enjoyed considerable popularity. But don't forget, by 1961, the tricycle gear revolution was well established. The 172 and 182 were out there and so was the 210, the 206 soon to follow.

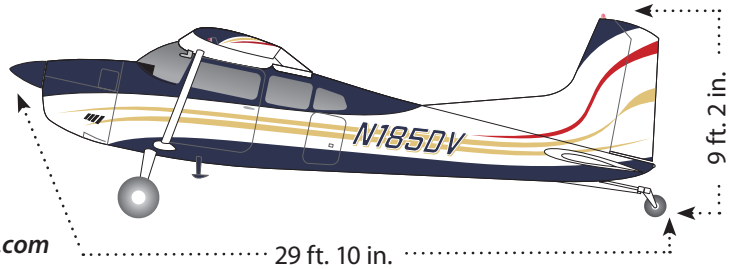
Outwardly, the 180 and 185 evolved into virtually identical-looking airplanes, with comparable overall dimensions and major parts. The primary difference, of course, is the engine. The 180 had a 230-HP Continental, which was adequate but didn't elevate it to the status of a super load hauler.

When the 185 debuted in 1961, it had a 260-HP Continental IO-470F and 84-gallon fuel tanks and could perform the rather remarkable feat of lifting more than its own weight: The useful load of 1680 pounds is about 200 pounds more than its standard empty weight, something bush operators prized. Locked securely in the utility market, the 185 was spared some of the cosmetic "improvements" applied to nosewheel Cessnas. It never got the swept-back tail, for example, or the rear window that was added to the nosewheel line. Buyers bought it for what it did, not for how it looked. Unfortunately, it also never got the fuselage "bulge" applied to some of the nosewheel line, leaving the cabin a little tight at 41 inches wide.

CESSNA 185 SKYWAGON





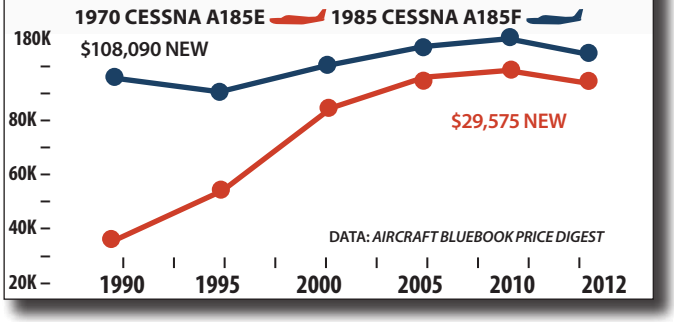


drawings courtesy
www.schemedesigners.com

CESSNA185 SELECT MODEL HISTORY

MODEL YEAR	ENGINE	TBO	OVERHAUL	FUEL	USEFUL LOAD	CRUISE	TYPICAL RETAIL
1961-1963 CESSNA 185,A,B	260-HP CONT IO-470-F	1500	$30,000	65	1600 LBS	145 KTS	±$79,000
1964-1966 CESSNA 185,C,E	260-HP CONT IO-470-F	1500	$30,000	65	1600 LBS	145 KTS	±$82,000
1966-1969 CESSNA A185E	300-HP CONT IO-520-D	1700	$30,000	65	1700 LBS	147 KTS	±$90,000
1970-1974 CESSNA A185E,F	300-HP CONT IO-520-D	1700	$30,000	65	1700 LBS	147 KTS	±$105,000
1975-1977 CESSNA A185F	300-HP CONT IO-520-D	1700	$30,000	65	1700 LBS	147 KTS	±$125,000
1978-1981 CESSNA A185FII	300-HP CONT IO-520-D	1700	$30,000	88	1550 LBS	147 KTS	± $145,000
1982-1985 CESSNA A185FII, A	300-HP CONT IO-520-D	1700	$30,000	88	1550 LBS	147 KTS	± $170,000

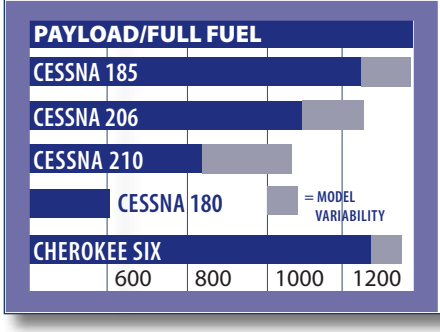
RESALE VALUES

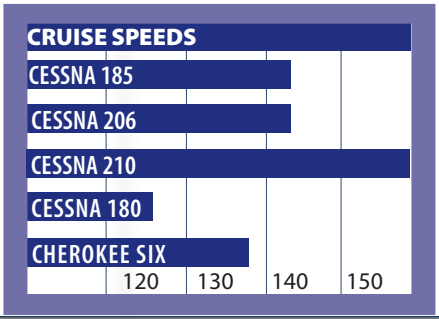


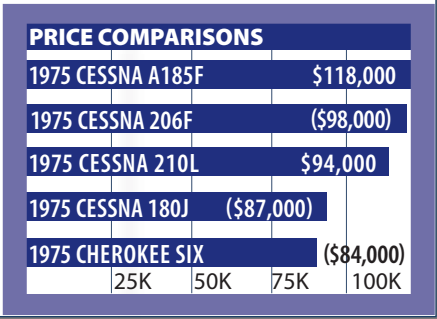
SELECT RECENT ADs

AD 2011-10-09	SEAT RAILS ROLLER HOUSING
AD 2008-2610	ALTERNATE STATIC AIR VALVE
AD 2004-19-04	UPPER SHOULDER HARNESS ADJUSER
AD 2000-06-01	FUEL STRAINER STANDPIPE
AD 1997-26-10	CRANKSHAFT INSPECTION, REPLACE

SELECT MODEL COMPARISONS







However, you could order a new 185 with Edo floats, a massive belly cargo pod that could accommodate 300 pounds or a spray application rig, to name a few options. Towing set-ups and flip-up doors for skydiving operations were also available.

Anyone who hauls stuff for a living always wants more power, so in 1966, Cessna replaced the IO-470F with a 300-HP Continental IO-520D as an option. The 300-HP Skywagons are called A185s.

The bigger engine improved the 185's already exceptional performance. For a mere 10-pound increase in empty weight, the airplane received a 150-pound increase in gross, five more knots of cruise speed and some 200 feet was shaved off the takeoff ground roll, a boon for back-country operators. The engine was such a hit that it was made standard in 1967.

Also new that year was the addition of an aft baggage compartment, along with an optional stretcher door, both of which made loading bulky objects easier. From 1972 through 1979 you could order a full aerial application rig, with belly tank and spray booms. The package turned the airplane into the "AgCarryall."

In 1973, a new cuffed leading wing profile was introduced. The so-called camber lift wing was created by Robertson as part of a STOL kit for the Cessna line and it reduces stall speed slightly, improving roll control at low speeds. Since it's a leading edge mod, Robertson can retrofit it to earlier 185s. The cuffed leading edge is much prized among float operators.

The re-winged 185 became the A185F, which is by far the most numerous variant, accounting for more than half of all airframes. As of 2012, the FAA registry shows 1784 185s of all models; 1224 are A185Fs.

More work-related options came along in 1975, including bubble side windows for photography and skylights. In 1976, flap-extension speed (V_{fe}) went from 96 to 120 knots and the fuel selector was changed to Cessna's all but idiot-proof left-right-both arrangement. Lift handles were added to the tail to give ground handlers a safe means to muscle the airplane on the ramp without damaging the stab. One change that was a mixed blessing was the reduction in usable fuel from 81 to 74 gallons, which cut into the airplane's range.

The 1979 models had a new wet wing fuel system with 88 gallons, 84 of which is usable. The older bladder-style tanks were optional. While the bladders had less potential for leakage, they had other problems, as we'll note in the maintenance section.

The original Skywagon had a two-blade prop, with the three-blade version surfacing as an option in 1978 and becoming standard in 1980. The three-blade can be retrofitted. Owners report no cruise speed loss. It also reduces vibration and noise and climb is said to be better, plus it looks undeniably sexier.

The 185 enjoyed brisk if not spectacular production numbers until 1981, when only 389 were built. By 1984 and 1985, only 34 Skywagons were made as prices shot up and Cessna's sales went the other way. That the average equipped price of a new 185 nearly doubled, from $55,670 in 1979 to $108,090 in 1985 probably didn't help. Today, a good used one of early- to mid-80s vintage will bring between $150,000 and $180,000. Some sellers demand a lot more for one tricked out in glass or floats.

Load a Skywagon with full fuel, four 220-pound people, and perhaps 50 pounds of bags, and the airplane will take off in just over 800 feet and climb at better than 1000 FPM.

PERFORMANCE, HANDLING

Given the performance of retracts equipped with the IO-520, the Skywagon won't set any speed records, but few of them will do what the 185 can: Fly with full tanks, full seats and baggage. Load a Skywagon with full fuel, four 220-pound people and perhaps 50 pounds of bags, and the airplane will take off in just over 800 feet, climb at better than 1000 FPM and then fly 800 miles at 140 knots, outdistancing a handful of retracts and twins. Even at higher altitudes, the IO-520 has plenty left.

Fuel flows range around 14.5 GPH, rich of peak, depending on power setting. Installing GAMIjectors and operating lean of peak will pay for itself with fuel savings and engine longevity with only a moderate loss of cruise speed. We always wondered why Cessna never hung a turbocharger on the 185, as it would

The two-blade prop is often noisier, and it doesn't look as sharp on the ramp.

seem to have made a great deal of sense for the mountain operators. Tornado Alley Turbos will turbonormalize your 185, and owners report cruise speeds of 165-175 knots at FL200 while burning 14.5 GPH.

In stock form, the 185 is nearly a STOL airplane. With those big barn door flaps at 40 degrees, stall speed is under 45 knots so 55-knot approach speeds are doable. We've been told of skilled bush pilots plunking the Skywagon down in as little as 300 feet in a rough clearing or river sandbar.

As with any airplane, the technique is a high-alpha approach with flaps and power at a speed between 50 and 55 knots, followed by a full-stall three-pointer. Watch the aggressive braking, however, since the airplane can and will nose over with locked wheels.

Although the airplane handles well in the air, some owners say it's not easy to land and won't tolerate lazy feet on the rudder, especially in crosswinds and the accident reports confirm the assessment. Yet as taildraggers go, it's not overly twitchy and the deck angle allows seeing over the nose so S-turns aren't necessary.

Wheel landings, while doable, require some finesse due to the 185's spring-steel landing gear legs. If the pilot doesn't convert a botched wheelie into a three-pointer, loss of control may follow. Most owners seem to prefer three-pointers, which are aided and abetted by the locking tailwheel, which also helps in crosswinds. Just don't forget to unlock it before taxi turning, otherwise you risk tire damage on the tailwheel.

In the air, handling of a Skywagon is similar to another Cessna product, the Skylane. Trim, unlike that on most Cessnas, is through a jackscrew in the tail rather than via a trim tab, and the system's low gearing means you move the wheel a bit before noticing the effect.

Cessna didn't offer electric trim, but some autopilot installations include it and pilots who have it like

ACCIDENTS: GROUND LOOPS AND ODDITIES

It's hardly unfair to say that the Cessna 185's accident history is a victim of geographical circumstance. That's to say if you operate long enough off too-short river sandbars, too-deep or too-mushy snow or too-smooth water, you're eventually going to prang an airplane.

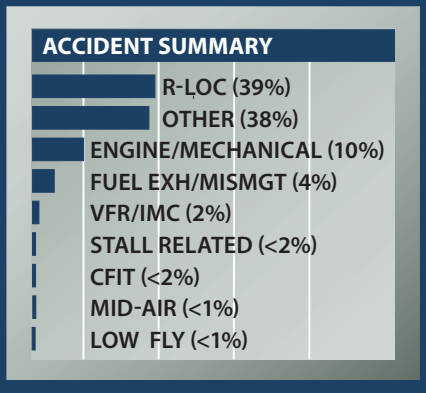
And that's exactly how the Cessna 185 typically comes to grief and Alaska is most likley to be the venue, with Washington, Montana and Idaho running right behind. Our sweep of 205 Skywagon accidents revealed that 75 occurred in Alaska, or about 37 percent.

As the graphic shows, runway loss of control leads the accident parade with the miscellaneous category hard on its heels.

Here's where we have a problem. If an amphib pilot lands on a lake, loses control and piles up on the shoreside rocks, is than an R-LOC? Or something else? We coded it something else.

And something else best describes how 185 pilots lose it on the runway. They don't just limit themselves to plain-vanilla runoffs and groundloops. Oh no, there's a lot of creativity going on here. For instance, taking off on skis from a too-short runway on a warmish day with a slushy surface caused one pilot to lose control and run into trees. As if the 185 itself isn't challenge enough, one pilot took a tour of the tules after he decided to take off in a quartering tailwind gusting to 20 knots. Some of this may simply be bravado born of long experience and over-confidence, but bent metal looks the same whether sundered by a student pilot or an ATP.

The most common float accident is-—you guessed it—landing on water with the wheels down. This virtually gurantees that the pilot can add U-boat commander to his certificate, although it does provide an impromptu opportunity to inspect the bottoms of the floats. Some pilots do the reverse, by the way, landing gear up with floats on a paved runway. Other than a little scraped paint and a bruised ego, these don't amount to much.



Because the 185 is often operated in the mountain west, we found a few density altitude-related accidents. Just because the 185 will lift its own weight, it won't necessarily do that out of Leadville in August.

The other side of this coin may be pilots who try to do the right thing by swapping fuel for cargo, then run out of the former because they pushed the weather or endurance. We found a handful of fuel exhaustion accidents, which is something we tend to see less of these days.

In the other category is a maintenance marker worth a would-be buyer's attention: At least four of the accidents involved some kind of landing gear collapse after what appeared to be a normal landing. These turned out to be corrosion or wear in the landing gear structure or attach bolts. Airplanes that have spent time on floats or skis should be inspected carefully for corrosion and/or cracks in the landing gear structure.

The 41-inch cabin isn't exactly roomy, and the third-row seats are for children only.

it better than the manual system. Cessna never offered electric flaps in the 185, either, a real blessing in our view. Manual flaps are simply superior for ease of use—get them down or up quickly with no question of flap position. They're also more maintenance reliable.

Like most Cessnas, the 185 is susceptible to a trim-induced stall on a full-flap go-around. If the nose-up moment isn't dealt with via forward yoke and trim, the airplane's angle of attack will exceed the stall value. It's better to apply partial power, arrest the sink, then go to 20 degrees of flaps before applying full climb power and retracting the rest of the flaps.

A 185 can haul just about anything you can get into it. But the cabin volume is not all that great compared to a Cherokee Six or Cessna 206. There is no way that anything large will go through the 18- by 20-inch baggage door or the two cabin doors of a 185. On the other hand, the right front door can be removed easily (a mod allows flight with the door off), as can the back seat, but that still doesn't leave much maneuvering room in the cabin for large objects.

The optional fiberglass belly pod is 9 feet long and 14 inches deep and while huge objects still can't be loaded, the pod is ideal for awkward cargo such as chainsaws, tool, skis and fishing gear. (Not to mention the smelly fish.)

INTERIOR, MAINTENANCE

Cessna's marketing photos of the day show interiors with six seats and the airplane was billed as a six-placer. As is typical of such marketing claims, that's a gross exaggeration. Calling the third row "seating" is generous, except perhaps for a child. The seat is limited to 120 pounds and most owners leave it in the hangar, opening more space for baggage.

An option on later 185s was a pair of articulating seats for the front row, with adjustable height and reclining seat backs. The back on the rear seat was split and it too could recline. The seating position is quite upright, with good head and legroom but not generous shoulder room in a cabin measuring 41 inches in width.

Cessna singles have a reputation for being maintainable as well as durable. That's the 185 in spades. It's a derivative airplane, being based on the 180, which was, in turn, a bigger version of the 170. Therefore, Cessna got the flaws hammered out in what was a good airplane from the beginning. Owners tell us to watch these trouble spots: Tailwheel shimmy can be caused by wear of the bolt that holds the fork to the tailwheel spring. Airplanes with McCauley wheels and brakes aren't as desirable as those with Clevelands, which can be retrofitted.

Mufflers tend to crack after a few hundred hours, so inspect them carefully. Airplanes built before 1981 had trouble with the trim because

While certainly capable for IFR, the 185 isn't as rock stable as many of the trigear Cessnas.

in cruise, the jack screw needs 300 foot-pounds of torque to move. This stresses roll pins connecting the trim wheel to the chain drive sprocket. If the pins shear, the trim is stuck. Later airplanes replaced the pins with rivets.

Cessna offered shoulder harnesses as options for all seats in all of its singles after World War II, however, safety didn't sell until the early 1980s and no one ordered them. The good news is that it means retrofitting them is easy; the hard points are under the headliner. From a safety standpoint, especially given the high rate of landing accidents and head injuries to occupants, for the 185, it's a retrofit we strongly recommend.

As Continental engines go, the O-470 and O-520 series have delivered decent service. In many models, the engine installation is at the root of short engine life but that doesn't seem to be the case in the 185. It has a roomy cowl and large cowl flaps, so overheating isn't an issue. Advertised TBO is 1700 hours, which is realistic if the owner is prepared to do a mid-time top overhaul. If the top isn't needed, consider it gravy.

Give Cessna credit for one thing: It has delivered on parts and support, even in the lean years when no piston production was alive. If flown often and worked hard, expect to replace landing gear boxes now and again, plus tailwheel parts.

The Skywagon is a typical Cessna single, so there are plenty of mechanics around qualified to examine one for pre-purchase and to maintain it afterwards. Of particular note, however, is the possibility of corrosion if the airplane has ever been on floats, as many 185s have. Check the logs for this history. Like any corrosion, it can be expensive to repair, and it's likely to be there in some form on any aircraft operated on salt water.

Like the Cessna 206, the 185 can have a belly pod, but the 185 lacks the big cabin doors of the 206.

MODS, CLUBS

Being a bush and utility favorite, lots of mods are available for the185, some of them also found on other Cessna singles. STOL kits are available from Horton www.hortonstolcraft.com and Sierra www.sijet.com. We have received complaints from owners on STOL kits on the 185 in which the ailerons are drooped with full flaps regarding loss of roll control during crosswind landings, possibly due to misrigging causing a lack of up aileron deflection.

Because VGs do essentially the same as a STOL kit without the weight, we would suggest a VG kit from Micro Aerodynamics www.microaero.com, although a number of owners have installed both STOL kits and VGs. Engine and prop upgrades—including the IO-550—from Davis Aviation Services (formerly Bonaire) www.davisaviationservices.com (very positive feedback from

owners on the IO-550 mod on the 185) and long-range fuel tanks can be bought from Flint Aero www.flint-aero.com.

From Tornado Alley Turbo, www.taturbo.com, a turbo normalizing system will allow the 185 to operate in the flight levels. For 185s that do not have the retractable handles on the tailcone forward of the horizontal stabilizer, BAS handles (www.basinc-aeromod.com) will go a long way toward protecting the vertical and horizontal stabilizers and their spars and ribs from damage during ground handling.

Prospective purchasers should join two groups: The Cessna Pilots Association is worthwhile for those who own or regularly fly Cessnas, and the International 180/185 Club is a good model-specific organization.

The latter is more focused on 185s than the CPA and is worth the modest cost of dues, in our view, Cessna Pilot's Association is at www.cessna.org. The International 180/185 Club is at www.skywagons.org.

OWNER FEEDBACK

I have owned a 1976 Cessna A185F for eight-and-a-half years. It had several modifications before I bought it. These included a McCauley three-blade prop, extended baggage compartment, BAS shoulder harnesses and a new paint job. I've also had some mods done since I acquired it, such as a Garmin GNS430W, GMX200 MFD, EI FP-5L digital fuel flow gauge that transmits to the 430W, plus a Garmin transponder and audio panel.

I also added a set of Airglas retractable, composite LH 4000 wheel skis and an Alaska Skycraft SP1-200 fuel/cargo pod with a 28-gallon fuel tank that is plumbed into the aircraft fuel system.

The most significant mod was just completed. Since the stock engine reached TBO and was also subject to the AD on Superior Air Parts cylinders, I replaced the engine. However, I got the STC for the TCM IO-550-D engine to replace the IO-520. It is rated at the same horsepower, but at 2700 RPM instead of 2850 RPM for the IO-520.

The McCauley prop is most efficient at about 2600 PRM. More than that and the prop tips almost go supersonic. So all that is happening is more noise with less power. The bigger engine delivers more power at a lower RPM that is more efficient for the prop.

This is according to tests done by P-Ponk. The results are available on their Website. In any case, the improvement is dramatic. Not that a stock C-185 was any slouch. I have only flown the new engine on wheels for a few hours so far during the break-in period. I'm excited to see what it will do when I put it on floats. The fuel flow is about 2 gallons per hour more, but the cruise speed increased by 10 knots. This airplane is a real workhorse and has the versatility for flying in the bush here in Alaska.

Myles Thomas
Fairbanks, Alaska

In the north, the 185 is the local equivalent of a pick-up truck. Ours is used to access and supply our lake cabin and our son's trap line. Cargo has included boats, motors, lumber, fuel drums, groceries, furs and moose meat. The airplane is used year-round, operating on Edo 3430 floats in summer and Airglide 3600 wheel skis in the winter.

Conventional gear makes for much easier changeovers from wheels to floats and if you want to run skis, 180s, 185s and Cubs are about the only game in town. Aircraft with training wheels make lousy ski planes.

With the 300-HP engine, performance is good on either floats and skis: On wheels, the thing is phenomenal. Useful load on wheels is typically around 1500 pounds. Usually you'll run out of space before you get her over gross.

It's all about utility when it comes to a 185. That means plenty of mods exist for performance, cargo and "alternative" landing gear. (Both photos this page by John Faulkner.)

Performance on the original IO-470 was adequate, but bigger-motored versions are more desirable.

We run the McCauley Black Mac 86-inch three-blade prop which pulls like crazy, but makes an ungodly racket at full 2750 takeoff RPM. When you visit the big city airports where decibel is a dirty word, best dial her back to 2550. You'll still only need 600 to 700 feet of that 10,000-foot runway. One great performance enhancer on the 185 is the manual flap system.

On floats, heavy loads, glassy water and hot days can conspire to make getting off the water difficult. Even once you're at flying speed, you can't rotate, because the heels of the floats dig in, causing more drag. So, the drill is to get to flying speed and then pull on full flaps. She'll leap right out of the water. You level off, milk off the flaps, build up some speed and climb out.

The 185 is a tailwheel airplane with lots of power, a big billboard tail and springy landing gear. If you are new to tail dragging, doing 10 hours first in a Citabria or a Cub would be money well spent. It will also be worth the effort, because the Skywagon will take you to all the places you can't get to in your Cirrus.

We plan on a block fuel burn of 15 GPH on typical trips of an hour. For 300 HP, cruise speed is nothing to brag about: 130 knots on wheels, 115 knots on skis and 110 knots on floats; all at 65 percent power. However, uptown 185s (without oversize tires, bubble windows and a coat of mud) do much better.

The 185 has been very reliable over nearly 14 years and 2000 hours of ownership. This is despite the fact that ours does a lot of off-airport work and is operated in temperatures down to –40 and below. It's also despite the fact that ours, like most of the breed, spent a lot of years as a commercial bush airplane and was rode hard and put up wet more than once.

Given that these airplanes are now 30 to 50 years old (ours was built in 1966), checking for cracks, wear, tear and corrosion is a big part of the annual. Pay particular attention to the landing gear boxes and the gear legs themselves, especially if the aircraft is operated on skis. It is a sobering sight to watch the airplane take off on skis from rough snow. Those chunky spring steel gear legs will be flapping around like limp spaghetti.

Another potential trouble spot is the pair of jack screws used to trim the horizontal stab. They need to be lubed regularly, but are hard to get at (and thus ignored) unless you install the service kit that provides access panels in the fuselage. BAS tail handles are another great mod. For float and ski planes, where lower cruise speeds limit engine cooling, the cowl louver STC (available from the 180-185 Club) is also well worth the trouble.

Parts have not been a problem, with good availability from the aftermarket, used part dealers like Skywagon City and, yes, from Cessna, itself. People gripe about wait times and cost on factory parts, but try going to Ford to get stuff for your 1966 F-100!

For a utility airplane, the 185 suffers from two major faults. First, the cabin is narrow and the back seats are tight on legroom as well as width. Big guys in parkas need to be friendly. Second, the baggage door is postage-stamp sized, and the cargo needs to be schlepped in and out through the front doors. This is the one time you will envy your buddy with the 206. Fortunately, the doors and back seats are easily removable.

Membership in the International Cessna 180-185 Club and Cessna Pilots Association is highly recommended.

John Faulkner
Whitehorse, Yukon

The 185 is a very nice plane to fly, but you are always flying it (not much dihedral) and the main thing is to always be straight down the runway when landing. If you are straight down the runway (whatever it takes), it treats you well.

It is great with the big flaps and you can descend very quickly and land short when required. I take it on a hunting trip every year and fly the meat out (if required), and the strip we have there is 1700-feet long with trees at both ends at about 2600 feet elevation. It handles this well, and I would generally have about 800 pounds of meat, myself (220 pounds), 100 pounds of misc items, and 200 to 300 pounds of fuel and the airplane handles it very well.

I fly with 8.50 tires generally all of the time; I have wheel skis, but not really any use for them in my flying. My wife likes the plane for its versatility and just being a very steady, reliable plane.

Soren Christiansen
Via e-mail

The Aviation Consumer

Letters

(continued from page 3)

aircraft at latest count. One resident had just taken delivery of an airplane equal to the one we saw at the trade show. We each got a ride in a 2008 model Husky during a three-ship formation flight through nearby canyons and mountains.

At the end of the flight, my PIC, an ex-Air Force instructor, greased the landing on the groomed grass strip. Because I had been taking photos, I had forgotten about the gear. Sure enough, after the smooth touchdown, we boinged up and down several times as though riding on bungee cords, which we essentially were. Had the pilot come down harder, I'm sure we would have temporarily departed the ground for a second "landing," the famous taildragger bounce.

The following day we visited the Aviat factory in nearby Afton, Wyoming and made an extensive, half-day examination of the manufacturing facilities, accompanied by Aviat President/CEO Stu Horn, who bought the company in 1996.

The extensive quality control of raw materials, in-house production of parts, new technologies and constant refinement of the finished product makes it clear to me that a refurbished Super Cub cannot compare to a new Husky. My opinion evolved from Husky is "expensive" to wondering how can Aviat make a profit with all they put into each airplane?

For instance, the proprietary techniques and materials involving 14 layers of dope and then paint with sanding between each coat, for a perfectly smooth surface and mirror shine on a fabric-covered aircraft. Horn wanted to take us for a ride in a just-completed Husky to test out the new gear, but the plane wasn't quite finished and we had another engagement.

The following day, however, my PIC in the 2008 Husky did fly that new aircraft with new gear, 200-HP fuel-injected engine and glass panel. He reported "improved visibility over the nose, how quiet it is and the effectiveness of the gear system, although he remains loyal to his "old friend."

Crista Worthy
Hidden Springs, Idaho

Batteries

(continued from page 12)

robust enclosure is also a good idea, although that obviates some of the weight savings. Vutetakis says the electronics can't protect against one risk: internal cell shorts. This can and has happened. "That's why you had the big battery recalls for laptops," he told us. Cell shorting is a risk for all-electric airplanes, but the charging risk is much less because this occurs only on the ground. In either case, the risk may be statistically low, but the consequences are severe.

If it sounds like lithium-ion will never make it into GA starting batteries, it already has. A company called Aerovoltz is marketing lithium-iron-phosphate batteries through Aircraft Spruce for experimental applications. The company's Steve Johnson told us it has thousands of A123-cell Li-ion in the motorsports market with no safety issues. The battery cases are hardened against flame propagation. It's also developing BMS options. Mid-Continent Instruments and Avionics recently announced that it will begin marketing A123's cells, albeit not finished batteries. Mid-Continent is already marketing a line of certified Li-ion backup battery units.

As for certified aircraft, Concorde says lithium-ion will come eventually, but it'll be awhile. Skip Koss told us he doesn't yet see much market for batteries that are definitely lighter than the best lead-acid models and more energy dense, but that will also cost four to five times as much. And Concorde says it won't move forward until it's comfortable that the Li-ion risk is lower than it is now. We agree that taking this one slow is the way to go.

FEEDBACK WANTED

PIPER SUPER CUB

For the November 2012 issue of *Aviation Consumer*, our Used Aircraft Guide will be on the Piper Super Cub, a classic utility taildragger. We want to know what it's like to own these popular bush planes, how much they cost to operate, maintain and insure and what they're like to fly. If you'd like your airplane to appear in the magazine, send us any photographs you'd care to share. We accept digital photos e-mailed to the address below. We welcome information on mods, support organizations or any other pertinent comments. Please send correspondence on the Super Cub by September 1, 2012, to:

Aviation Consumer
e-mail at:
avconsumer@comcast.net