

The Aviation Consumer[®]



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EDITOR

Larry Anglisano

SENIOR EDITOR

Rick Durden

EDITORIAL DIRECTOR

Paul Bertorelli

CONTRIBUTING EDITOR

Jonathan Doolittle

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 SW1

Canada

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FIRST WORD

BEYOND GEAR OF THE YEAR

In our world, the editorial year commences in the summer instead of January, and the anticipated editor's choice awards focuses deserved attention on the products and companies that really impressed us in our coverage over the year. As we do every July, we take a half step back and tip the hat to a dozen of them on page 12 of this issue. But there was more that caught our attention the past editorial year, some of it unforgettable. If we had a worst news of the year award, there would be takers.

One that comes to mind is an unapproved parts notification from the FAA's aircraft certification division against Ameri-King Corporation, which has an American headquarters in Huntington Beach, California. Ameri-King is a well-established and surviving avionics

company. I evaluated its avionics products in these pages in the 1990s, and as recently as the February 2016 issue in the 406 ELT upgrade article. Our impressions of its products have been mostly favorable, based on performance and value. The Ameri-King product line is diverse with critical components. There are ELTs, cooling fans, GPS switching relays and annunciators, altitude digitizers and voltage converters, to name a few. It's likely there are—or have been—some installed in your aircraft. One that I fly has the company's AK350 altitude encoder.

According to a report in the *Los Angeles Times*, Ameri-King is being sued by a former employee who says he was illegally fired for whistle-blowing on the company because it allegedly relabeled products to say they were made in the United States, when they were actually made in China. I attempted to reach Ameri-King to get its side of the story, but it didn't respond. I didn't have to search far to find the FAA's story. The FAA's parts notification statement (2016-2013NM460018) says in background that Ameri-King manufactured, sold and distributed components (including lithium batteries) for installation on FAA-certified aircraft that didn't conform to an approved design, yet the company represented them to buyers as FAA approved under a TSO, plus PMA. This is an emergency cease and desist order—which not only demands the company stop manufacturing and selling the components—but also prohibits the company from repairing, altering and even advertising them. Some of the products were supplied to aircraft OEMs. In its March 2016 letter, the FAA recommends removing the affected parts from type-certified aircraft.

You might be wondering what the above picture of Icon Aircraft's good-looking A5 amphibious LSA has to do with Ameri-King. Nothing, actually, and unfortunately for the industry, Ameri-King made too many products to show on this page. Still, Icon is another story that began last July when we commenced our editorial year at AirVenture. That's when Icon's outside public relations company promised *Aviation Consumer* a flight evaluation of the A5, but cancelled at the last minute. Although we were promised a makeup flight, Icon couldn't accommodate us. After much persistence on my part, Icon again agreed to a flight trial and a tour of its California manufacturing facility as long as the coverage would be a lead story, with the airplane featured on the cover. I couldn't definitively agree to these and some other terms involving photography and video production, and we still haven't flown the A5 for a review.

Icon is cautiously controlling media coverage of the A5 and I get that. Sure, our evaluations often find nits to pick; that's what we do. But we remain committed to being as fair and accurate as we can because that's what readers depend on us to do. That has value for readers, for manufacturers and for us.

As we go to press, Icon announced it was laying off 60 employees and terminating 90 contractors, but is moving ahead with its training program. It plans to build several locations around the country, while using the first 20 aircraft it builds for training. Icon also said it is delaying deliveries of the A5 until 2017, at least, and has softened its controversial buyer's agreement.—Larry Anglisano



DA62 VERSUS AEROSTAR

I read your recent coverage of Diamond's DA62 (June 2016 *Aviation Consumer*) and the airplane looks like a work of art. But, \$1.3 million for a machine that barely cruises at 200 MPH, requires sucking on oxygen for serious missions and only has a service ceiling of 20,000 feet?



In my Mooney 252, I once took off from Atlanta, Georgia, right behind a Piper Aerostar 601P and landed right behind it in Washington, D.C. But, while I was using oxygen on the way there, he was flying in pressurized comfort. I bought an Aerostar. The last one was a factory-new model 700P. Flying above the clouds and being called a jet by ATC was always a kick. In the DA62, it seems to me that the kick has to come from the smell of leather. I'm just saying.

Dennis Wisnosky
via email

Actually, you're slightly underestimating the DA62's speed, Dennis. The airplane cruises at about 180 knots or well over 200 MPH. As for its lack of pressurization, we think some buyers will find this to be a tradeoff for simplified operation and maintenance—particularly those stepping up from Diamond singles.

ICON SALES AGREEMENT: READERS WEIGH IN

The arrogance of Icon Aircraft is truly astounding. What we are possibly seeing play out before us is the short life of a new aviation firm—from the potential bankruptcy and fire sale of the assets—to a more savvy customer-oriented entrepreneur/investor group.

Icon has a brief and futile future unless it becomes commercial and customer-centered right now and stops kowtowing to the legal department.

Can you imagine Bill Lear approaching the fledgling light jet market with that kind of fearful paperwork when selling the original

Lear 24 concept aircraft?

It's all about management losing control of customer relations and handing off responsibility to the lawyers, who can kill a deal faster than

a pilot trapped in a flat spin.

Unfortunately, this has happened before. The initial investors in a lawyer-driven company get burnt.

Consider Eclipse and other aviation startups that initially failed, only to be reconfigured when a customer-centered, middle-of-the-line approach is not forthcoming, especially with regard to legal and operating terms and conditions.

Icon and its A5 could thrive under sensible ownership that's not saddled by debt, fear or an expensive non-commercial legal department intent on ruining a great idea.

Brian Henry
via email

As an attorney, CFI and an aircraft owner, I would run—not walk—away from Icon's diabolically written sales contract. A company that comes across as not willing to stand behind its product is a company that I'm not willing to stand behind.

Burt Stevens
Woodbury, Connecticut

We think Icon gets the message loud and clear. Since we covered the controversial sales agreement in our June 2016 issue, Icon has responded to the opposition of the agreement. In a letter issued to the press, Icon CEO Kirk Hawkins said the company is open to changing the buyer's agreement and "doing what is ultimately right for our owners, the industry and the company." Hawkins went as far as saying, "If we need to improve our contract to help safely grow our industry, we will."

Hawkins admitted in a phone conference with the aviation press that the first revision of the 40-page sales agreement was overly complicated and had too much legalese. "It should not have gone

out in the form it did without explanation," he said.

For starters, the new agreement will be shorter, the 30-year airframe life limit will be removed and the subjective "responsible flier clause," in which buyers sign off as being safe, competent and respectful, has been removed.

We think this is a step in the right direction and commend Icon for addressing the controversy head-on. As many of our readers have expressed, Icon's success could hang in the balance.

DECATHLON AEROBATICS

That was a great article on used American Champion Decathlons and Citabrias in the June 2016 issue of *Aviation Consumer*. There is one clarification related to aerobatics.

The Decathlon is approved for +6 and -5 G maneuvers, which is the same as a Pitts. The restriction is no tail slides and no tumbling maneuvers. For those who must, the permitted -5 G aerobatics makes an outside loop or even an English blunt and inverted spin fair game.

When I bought my new Super Decathlon last year, a friend bought a new Xtreme Decathlon. He tumbled it and had some warranty issues with it popping inspection plates. I flew the Xtreme a few times and prefer the Super. The Xtreme is louder and the stick forces are heavier.

Alan Maurer
via email

CONTACT US

Editorial Office
860-614-1987
Email: consumereditor@hotmail.com

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

Online Customer Service:
www.aviationconsumer.com/cs

Used Aircraft Guides:
203-857-3100
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Cub Crafters XCub: High Luxe, Real Speed

Speed and Cub don't usually appear in the same sentence, nor are leather seats a common option. But the new XCub has both, plus bounceless (almost) spring landing gear.

by Paul Bertorelli



If you were a dedicated Cub aficionado and wanted to build yourself the ultra version of the essential Cub idea, what would you do? You'd start with the basic planform, update it with edge-of-tech materials and build methods—carbon fiber, CNC-cut parts, modern avionics—all buttressed with an aerodynamic makeover to tweak performance. Then you'd send the airplane to the place that designs and builds seats for Bentleys and Ferraris and tell them to go wild.

And that, conceding a bit of editorial license, is the idea behind Cub Crafters' new XCub, a full-up new Part 23 airplane that the company claims will raise the bar on the stalwart utility airplane. In fact, Cub Crafters, with the XCub, is borrowing from the automotive world and christening the new aircraft as a sport utility airplane.

The XCub's DNA goes back to the same Piper Super Cub that Cub Crafters cut its business teeth rebuilding beginning in 1980. Not too surprisingly then, the XCub has a half-ton useful load and dainty slow-speed habits, but quite surprisingly it also has 140 MPH

AIRCRAFT FLIGHT TRIAL

cruising speed and multiple-state range with the cabin stuffed full of whatever you can get into it.

The price of this no-compromises retooled Cub will initially be \$297,500, with a short options list that might inch that a bit above \$300,000. As the airplane's product roadmap unfolds, Cub Crafters president Randy Lervold says the sticker may reach into the \$320,000s. The company has a file folder full of eventual upgrade ideas, including floats, bigger engines and, eventually (we hope), IFR certification.

WHERE IT COMES FROM

It's fair to call the XCub a derivative of the Carbon Cub LSA, which is itself a cousin of the original Piper Super Cub. But the XCub so stretches the original Super Cub basis that it's also fair to consider it nearly a clean-sheet design. Cub Crafters' expertise extends to 1980 when owner Jim Richmond began repairing and rebuilding the PA-18 to serve the utility aircraft trade, much of it centered in Alaska. The business was then in and remains headquartered in Yakima, Washing-

ton. CC's first certified airplane was the Top Cub, which is essentially an updated Super Cub. That TC has since been sold to Chinese interests, although CC still builds it under license. In 2006, the company entered the light sport market with the Sport Cub, a lightened version of the Cub airframe with a Continental O-200. That airplane morphed into what became the Carbon Cub, when CC was fishing for a new name following a trademark dispute over the Sport Cub moniker. Thanks to a 180-HP ASTM O-340 engine, the Carbon Cub claimed, at the time of its introduction, the best short-field performance of any LSA. The competition has since closed the gap (mostly), but the Carbon Cub re-

CHECKLIST



Fit, finish and interior are superb, especially the seats.



The XCub will leave a Super Cub for dead, without giving up slow-speed performance.



IFR cert would be a nice-to-have feature. Some buyers might want a glass panel. (It's coming.)

XCub, opposite, has spring-aluminum gear and a redesigned cowl with gill vents. Panel, right, is VFR-capable; more options are planned. Storage areas are generous, including a tablet mount for the rear seat, center photo, and headset storage locker, lower.

mains a strong seller. Shortly after its introduction, the company conducted a paper exercise to explore certifying the Carbon Cub under Part 23. “We figured it would take two years and a million dollars,” says CC’s Lervold. “We missed that grossly,” he adds.

Lervold attributes the expansion of the project—it took six years and multiple millions—to a “textbook case of scope creep.” As is true with so many airplane projects, perfection became the enemy of good enough. “Instead of leveraging what we did in the Carbon Cub, we’ve taken the technology base and created a whole new one. That will sort of trickle back into the rest of the line for years to come,” Lervold told us in an interview in Yakima in early May.

The design brief was to take the basic Cub planform as far as it was practical (and economical) to go, using modern materials and production methods. CC wanted more speed out of the basic airframe while retaining the Cub’s inherent low-speed manners. It eschewed the spartan ethos traditionally applied to the interior and accommodations and pursued a standard closer to that found in a European sports sedan.

Structurally, the XCub has the same basic size and shape as the Carbon Cub, but it’s as much as 300 pounds heavier. It’s 3 inches higher than the Carbon Cub on standard gear. The typical Carbon Cub empty weight is about at the LSA limit of 917 pounds, while the empty weight of the XCub is 1212 pounds. John Whitish, CC’s marketing director, said that this weight might yet be nibbled back, but the airplane’s useful load against a gross weight of 2300 pounds is at least 1088 pounds.

What’s with the additional weight? “Structure,” says Lervold. To meet Part 23 requirements, including float loads, there’s simply more of it throughout the airplane. On the shop



floor, he showed us the difference between the XCub’s vertical fin and that on the Carbon Cub. The X has a dorsal in front of the vertical fin and an aerodynamically shaped leading edge that the Carbon Cub lacks. It’s there to keep the airflow attached to meet certain envelope requirements in Part 23. However, Lervold said he’s noticed the improved fin results in less tail wagging in turbulence. Less to do with weight, but the XCub rudder horn is also smaller. In addition, the Lycoming O-360 used in the XCub is heavier than the CC version of the Titan O-340 mounted in the Carbon Cub, plus the X has a Hartzell composite constant speed prop and the associated governor and quadrant, which add yet more weight.

Also bumping up the weight is a new spring-aluminum gear design, replacing the Cub’s traditional X-frame bungee gear. The airplane will still be available with the traditional gear, however. The spring gear adds 7 pounds to the empty weight but, as we’ll note, it yields some benefits, too.

DRAG REDUCTION

Cub and drag go together like chicken and salad, thus most Cub drivers stoically steer the conversation away from cruise speed and toward the merits of classic yellow paint schemes. Cub Crafters tackled the drag problem by finding ways to eliminate it.

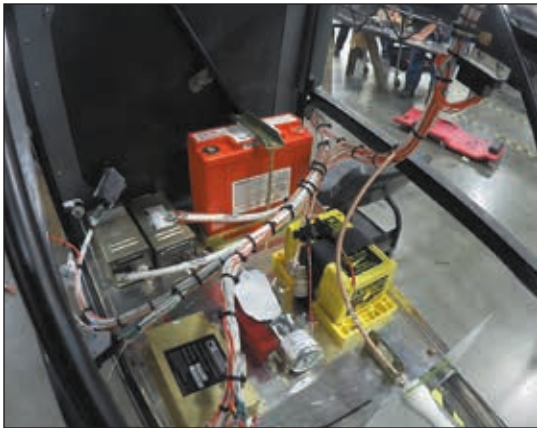
The aforementioned spring gear helped. “This spring gear is a big deal. That’s 10 or 12 miles an hour,” Lervold said. Elsewhere on the airframe, unfaired structural junctions now sport drag-reducing carbon fiber



fairings. A big step was changing the Cub’s traditional cables and turnbuckles into control-tube circuitry and for the ailerons, these are hidden inside the struts, a neat engineering trick. The XCub’s cowl is substantially different than the Carbon Cub’s, primarily for engine cooling to meet Part 23 requirements. It has generous gill vents on both sides, and a reverse



XCubs are built side by side with Carbon Cubs in CC's Yakima shops, left. Avionics live on a neatly engineered shelf behind the baggage compartment, lower.



were designed especially for the XCub and are covered in Sateen Scottish leather, with perforated inserts. The foundation is memory foam and conforms easily to the body's nether regions.

As in the Carbon Cub, the side panels are carbon fiber but also leather upholstered. All these stitched goods add weight, but they also tamp down noise and vibration—noticeably. Cub Crafters went around the bend in providing storage pockets and cases;

they're everywhere, 10 in all, including an adjustable iPad holder for the rear-seat occupant. There are so many pockets, in fact, that you might forget where you put what. There's even a headset locker in the rear baggage bulkhead and a clever magnetic keeper to hold the baggage door open.

Like all Cubs before it, the XCub has openable-in-flight doors and windows. But the doors are more substantial and the window latch on the left side has a multi-point latch that secures it against the slightest vibration. Vents are adjustable scoops in the overhead glass, draft-free when closed, gale force when open.

For avionics, the XCub launches into a bit of crack in the product sidewalk. It doesn't have a glass panel, but it has the functional near-equivalent. Center panel is a Garmin aera 796, with an EI CGR-30P providing engine monitoring, power indication and engine instruments. Comm and transponder are the compact Trig TY91 and

scoop to exit air out the bottom. The inlets are about the same size as those on the Carbon Cub. "Passing more cooling air, that slows you down, but the constant speed prop gains back some of the speed and virtually all of the surface intersections are faired," Lervold said.

Floats will be available and that will ding the XCub's speed. But buyers want floats available, even if they... don't want them. "It's important when you sell these airplanes that you have floats available. It's a lot like a motorcycle with hard bags. You might not buy them, but you want to know that you can. Buyers want the float option, even if they don't get it right away," Lervold explains.

The floats will be amphib Wipaire 2100As. As of press time, these aren't approved, but Lervold says the project leads the to-do list.

AVIONICS, INTERIOR

While we exaggerated about the interior being done in a Ferrari shop, the truth is not far off. We would describe the interior as luxe and not anything like you'd expect in a Cub. The seats

TV XCUB VIDEO



AVweb
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TT22, respectively, with ADS-B Out capability an option with the Garmin GDL 84. For a VFR day/night airplane, this suite is mission adequate, in our view. But Lervold said the company would prefer more choices.

"Every product has a life cycle and all the options we've considered are at end of life. We see what's coming so we're going to put something in there that's fresh and has some life. But we're concerned that we're not launching with a glass panel," Lervold explains. In other words, serious buyers will need to inquire what the short-term possibilities are for avionics if the current offerings don't appeal. Our only complaint is that we found the data window on the Trig comm hard to read because of its low mounting.

FLYING IT

What's immediately obvious in flying the XCub is that CC got the ergonomics righter than we would ever expect of a Cub. While ingress is the standard butt-first-fumble-fest-over-the-stick, the seats are impressively well shaped and comfortable. One thing they're working on: The front seat adjustment requires insertion of a loose pin that you can't really see. That will be improved. Controls, especially the front stick, come easily to hand and the stick has a shaped grip with buttons for trim and PTT.

Lervold said the Lycoming may eventually get some form of electronic ignition—it was supposed to launch with the Electroair system—but it now has conventional magnetos, making for a conventional runup. There's no analog tach; that's handled by the EI engine monitor. As in the Carbon Cub, visibility over the nose during taxi is good enough not to require S-turns. Braking and turning are tight and positive.

With two aboard and about half fuel (24 gallons), our takeoff weight was about 1700 pounds, some 500 pounds below gross. With a power loading about 20 percent higher than the Carbon Cub's, the XCub's tail comes up a little later and the launch

off the runway isn't the same startling lurch, but the XCub wastes no time breaking the wheels loose. CC's Whitish says the company is claiming a 170-foot takeoff roll at light weights. We saw initial climb of 1200 FPM at a 1600-foot denalt.

Having flown so many light sport aircraft recently, we found it refreshing to fly a proper Part 23 aircraft with well-harmonized controls and predictable control forces, especially roll. The XCub's improved ailerons impart a near aerobatic roll rate with less observable adverse yaw than we expect from Cubs. In full-flap stalls, the XCub has a gentle and repeatable parachute mode, but it's sensitive to bank. If the wings aren't perfectly level at buffet onset and break, it will fall off sharply in the direction of the bank, requiring a stab of rudder to recover. Interestingly, the clean stall—47 MPH claimed—seemed to have no break, just a mild buffet and parachute mode descending at 600 FPM. Vortex generators on the wing's top surface keep the air glued down so roll control in deep slow flight is excellent.

As with the Carbon Cub, the sight picture over the nose for level flight requires accommodation. With the nose properly pointed for level flight, the picture appears to be nose down. In trimmed level flight, we calculated a TAS of 136 MPH. Lervold said with small tires and at 24 squared, the airplane is capable of 140 MPH or about 122 knots.

Landings in the XCub are a delight for two reasons, one expected and one not. The no-surprise part was the airplane's slow-speed envelope. Minimum energy approaches at 55 MPH feel comfortable and natural, slowing to under 50 over the fence for a three-point touchdown near the 46-MPH stall speed. (The clean stall and full-flap stall are separated by only 1 MPH.) The easy sight picture over the nose in the three-point attitude helps with runway alignment.

The surprise was how the spring-aluminum gear behaves. Unlike spring steel or bungees, it doesn't return the bounce energy with an embarrassing sub-orbital leap, but rather a more gentle "yeah, a little fast there,



CARBON IS MAGIC (NOT REALLY)

When Cub Crafters' Randy Lervold rechristened the Sport Cub the Carbon Cub, it was both a marketing masterstroke and the birthing of a monster. At shows, people sometimes assume the airplane is built entirely of carbon fiber. "And I have

to explain, well, no sir, it's not. It still has aluminum wing spars; it still has 4130 steel fuselage longerons," Lervold says.

"In theory, we could build a Carbon Cub

entirely out of carbon fiber. And it would be a half-million-dollar airplane and it would be probably a hundred pounds lighter than it is now," he adds.

And that neatly bookends the benefits and challenges of carbon integration into a metal airframe. While the Carbon Cub has about 46 carbon fiber components—mostly interior parts—the XCub has about

130. CC had no master plan to integrate carbon, though. "Do we scrutinize every part like we should for tradeoff against manufacturability and aesthetics? No, we don't. Especially in the last year when we decided we have to get this damn thing done," Lervold explains. He says it was left to the engineers to decide where carbon would be used in lieu of other materials.

"In carbon fiber, it's all about being able to do parts you couldn't do in metal or some other material. Weight is part of it, but more often than not, a mold lets you build three-dimensional shapes you just can't do any other way," Lervold says.

But building molds and vacuum bagging the build requires labor and as the company moves forward looking to squeeze cost out of manufacturing, some of that carbon may well be displaced by other materials, although the buyer probably wouldn't notice. After the rush of certification subsidies, that's a necessary part of finding profitability.

I'm gonna give you a 6-inch hop." At equivalent relative energy, an almost-decent touchdown in the Carbon Cub will be a perfect kisser in the XCub. That's true for wheelies, too. It's a bit of a revelation and a step forward for taildraggers. For short-field takeoffs, Lervold recommended full power and just flying off in the three-point attitude. As do most taildraggers, the XCub excels on grass, where we did most of the landings.

CONCLUSION

We predict the XCub will find a good following among buyers who like taildraggers in general and Cubs specifically and who can afford a \$300,000 recreational airplane. Cub Crafters hasn't lacked for buyers of the Carbon Cub and although the XCub is more expensive, it's a more substantial airplane.

Within the limitations of a small company's internal capital, we think CC has done an impressive job of raising the Cub idea to its ultimate

refinement. Perhaps Ultra Cub would be a better marketing grab than XCub. We're impressed that CC has a product roadmap for more improvements.

We still have a wish list, though. First, we would like to see IFR certification. The XCub is likely to be used for sport flying and backcountry fishers and hunters, but CC has stepped the airplane up to the Bigs—bigger speed and range. This inevitably requires weather flying. Not having IFR cert probably won't be a show stopper for many buyers, but it would still be a plus. We hope CC gets to it eventually. For the airplane intro, Lervold said it was just a bridge too far. Whether it needs a full-up glass panel is debatable, in our view, given the capability of the launch package. But buyers typically want all the bling they can get and we think the XCub will eventually have just that.

For more information, contact www.cubcrafters.com or 509-248-9491.

Insight Engine Monitors: Useful Diagnostics

The G-series analyzers are intuitive, value-priced and offer decent troubleshooting utility, but they can't be installed for primary gauge replacement.

by Larry Anglisano

For a few years now, Insight Avionics has been selling its G-series line of color engine analyzers. The company is hardly a stranger to the engine display market. Its first-generation GEM series (graphic engine monitor) sold well and delivered on quality, but these instruments fell short on advanced diagnostic utility for lack of modern software.

The new G1 through G4 series color analyzers change all that for the better. Insight's latest version of operating software enables generous amounts of built-in engine and airframe diagnostics that could save troubleshooting time when the aircraft hits the shop floor, while providing advanced warning of com-

ponent failures. The new feature set also dumbs down the engine leaning technique to a near-foolproof level, which could keep the engine out of the shop in the first place.

In this article we'll look at the entire Insight analyzer line, from entry-level to flagship systems.

GEM PLUG-AND-PLAY

Off the bat, Insight did the sensible thing and engineered the entire G series to work in an existing Insight GEM installation, although it could require some basic wiring changes. In many cases, the new G-series control head (roughly \$1000) can connect with the existing harness and engine probes, eliminating a total rewire. But before you begin any

engine monitor retrofit, pick the right shop for the installation. The worst hands in the

CHECKLIST

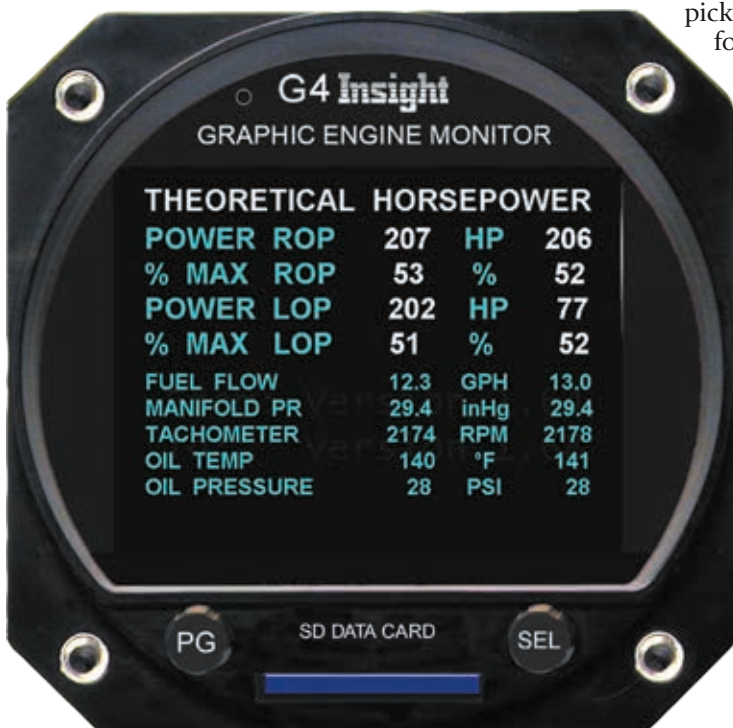
-  Advanced leaning assist mode is intuitive and worth the upgrade to G2.
-  Plug-and-play with vintage GEM systems saves big on installation.
-  Insight is working on an all-in-one primary system, but it's not available yet.

installation can make the best engine monitor useless.

Insight's current entry-level monitor is the 2.25-inch G1, which doesn't have a fuel flow computer. This means you won't have the advanced leaning functions that are standard with other models. The G1 doesn't come with RPM, OAT, manifold pressure, RPM or oil temperature functions. It does have EGT, CHT, TIT and carb temperature capability, plus it's approved for use as a primary EGT/CHT/TIT instrument.

As with all of the G-series monitors, the instrument has a high-resolution color LCD display, while the user controls are limited to two

That's the 3.125-inch G4 for twins, left, displaying horsepower data. The entry-level G1 (right) is a 2.25-inch instrument without fuel flow data.



rotary knobs/buttons at the top and bottom of the instrument's bezel. The top knob controls screen selection, while the bottom knob controls items within the given screen. Each screen assigns its own functional needs to the controls that may change, depending on context.

Some screens have intuitive prompts, including "push to exit," should you get lost in a menu. The basic G1 has three primary screens. This includes the EGT/CHT bar graphs (each cylinder has its own display column displaying both CHT and EGT simultaneously), a basic engine leaning screen and an EGT/CHT sensor probe diagnostic screen. With probe diagnostics, there's no more guessing if an unusual parameter is related to a faulty sensor or a real problem, since this diagnostic screen displays the measured health of each temperature probe.

On the main page, all monitored temperatures are continuously displayed in both a color-coded bar graph and in numeric form at the bottom of each bar. A CHT redline appears on each bar, while the CHT graphic bar turns yellow at 410 degrees and red at 460 degrees. For turbocharged applications, the green TIT bar turns yellow at 1600 and red at 1650 degrees and, while a TIT redline is displayed above the TIT bar. In carbureted applications, the carb temperature function (it's an option on the G1 and standard on the rest) is displayed in the center of the display.

The G1 for four-cylinder applications starts at \$1235 and \$1365 for six-cylinder engines. The carb temperature probe is \$176 and the TIT function for turbocharged engines is an extra \$200. Insight told us a basic installation on a four-cylinder engine might be accomplished in an afternoon, but we think that's optimistic. Installing the control head, removing and reinstalling the cowling, installing the probes, final testing and paperwork could turn into a multi-day project, based on our experience.

LEANING ASSISTANCE

The G2 (which fits a 2.25-inch instrument cutout) has all of the G1 functionality, plus an integrated fuel totalizer. If you have an existing Shadin or JP Instruments fuel computer, Insight offers a fuel flow signal

ADVANCED DIAGNOSTICS AT A GLANCE

The pilot-configurable vertical axis G-force utility captures turbulence and hard landing forces placed on the airframe. Based on an instrument-mounted accelerometer exceeding a set threshold, it records 12-second intervals of turbulence in the log file. The live dynamic G-force utility shows the event in real time.



The vibration analysis graph shows vibration energy in a waveform representing engine motion. The vertical axis of the graph is vibration energy and the horizontal axis is frequency, based on multiples of crankshaft RPM.



The probe diagnostic system shows healthy sensors in green and abnormal ones in red. Since each probe has two wires (positive and negative), the numerical value next to each identifier indicates the resistance (ohms) for each lead. Since resistance increases as the probe ages, you'll know when one is about to fail.



adapter so you can use the existing fuel flow transducer. That could yield a sizable savings on the installation.

The G2 shows the current fuel flow, plus it has a generous fuel computation page. It's also compatible with a variety of GPS navigators for endurance calculations. It's worth noting that none of the G-series monitors have fuel quantity sensing.

The fuel stability feature, which

measures and displays fluctuations in the metered fuel flow, can be useful for spotting clogged fuel injectors and carburetor bowl problems.

The G2 has a starting price of \$2093 for four-cylinder engines and \$2275 for six-cylinder engines. A kit for a six-cylinder turbocharged engine is \$2495.

Intended for fuel injected engines and LOP (lean of peak) operation,

EI CGR-30C CLUSTER GAUGE AS COMPANION

The buzzkill of the otherwise strong Insight engine monitor product line is the lack of a primary replacement model. Insight says it's working on one, but we think some buyers pass on a high-end G-series monitor in favor of an all-in-one replacement from the competition, including JPI and Electronics International.

Still, for Insight customers sold on a G-series monitor, but who are looking to ditch OEM mechanical engine gauges in favor of self-contained electronic ones, Insight's marketing director Brian Wrightman sends them to competitor Electronics International for the CGR-30C electronic engine cluster gauge. We think that's a good option and a worthy companion to an Insight analyzer.

The \$2952 CGR-30C is the same form factor as the company's CGR-30P analyzer, which can legally replace the tachometer and manifold pressure gauge, plus has basic engine monitoring functions. It doesn't have the advanced leaning and diagnostics utility of the Insight G series.

The TSO'd CGR-30C has broad AML-STC approval to replace all existing engine instruments, including fuel quantity gauges. The installation is as streamlined as it can be, thanks to an engine data converter hub.

The CGR-30C uses the EDC-33P (engine data converter) for combining all of the aircraft's engine gauge signals into one serial databus, which reduces the wiring bundle from engine and airframe to the instrument panel by over 100 wires. Better yet, a single EDC can drive multiple CGR display units.

What we like about the CGR-30C cluster instrument is it fits flush in a 3.125-inch instrument hole. Unlike other all-in-one replacement displays that require major instrument panel modification, the CGR is a bolt-in. It has a 144-color active matrix display, which is sunlight readable and has a wide viewing angle. That's a good thing, since many existing mechanical engine cluster gauges are located on the copilot panel.

The CGR can replace up to 16 primary instruments and has three pages, can be configured for strip or arc gauge presentation and has datalogging, a USB interface and a built-in checklist utility. Contact www.buy-ei.com.



Insight's flagship G3 and larger (3.125-inch round) G4 take the integrated fuel computer to a higher level with Insight's patented lean assist feature.

In leaning mode, the instrument intuitively tells you exactly how far the EGTs have dropped since they peaked, whether you are on the rich or lean side of peak and what the fuel flow was during the peak. Rich and lean of peak conditions are displayed on the screen inside number blocks, which are positioned above each cylinder bar and are shaded in either cyan or white for easy recognition.

Entering (and using) the leaning mode should be simple, and on the G3/4, we think it is. The lean function is manually accessed by holding the SEL button, or by leaning the mixture. Begin well rich of peak EGT and the white columns for each cylinder rise until achieving peak EGT. At that point, a lean box appears above the EGT column and the fuel flow on the corresponding EGT column will freeze. This is what the fuel flow was when that cylinder hit peak EGT. Continue leaning the mixture

and white boxes appear above each column as the other cylinders hit peak EGT, showing "L" and the degree value. For rich of peak, stop leaning when the first cylinder peaks and gradually enrichen the mixture until the boxes turn cyan, while showing an "R," plus the temperature value.

It's easy to decipher uneven mixture distribution, or GAMI spread. As each cylinder hits peak, the fuel flow freezes on the corresponding EGT column. The difference between the fuel flow of the first and last cylinder to peak is the GAMI spread.

Insight said they designed the G-series instruments for minimum heads-down time. One example is threshold leaning. Pressing the SEL button opens a menu for setting peak leaning threshold, which is already preset at the factory for 50 degrees lean and 50 degrees rich of peak, but you can change them by turning the SEL knob. When each cylinder hits the lean threshold, the data box turns solid (white-filled) for at-a-glance leaning. This helps aging

eyes that might struggle to read the numbers in the box on the 2.25-inch instrument. Simply lean until you see the boxes turn white.

Electrical bus voltage and OAT is standard on the G2 and above, as is datalogging, which automatically stores data to a supplied SD card for Mac and Windows-based computer analysis. The data can also be accessed in flight. The G1 doesn't have a datalogging feature—the SD card slot on the front of the bezel is used for updating the operating software.

The G3 and G4 come standard with oil temperature and oil pressure sensing and display, plus manifold pressure and RPM display. This data is shown at the top of the display for supplemental reference only.

CONTACT...

Insight Avionics
905-871-0733
www.insightavionics.com

The system also accepts an air data computer input for enhanced fuel computations.

SPECIALIZED ANALYSIS

Insight was the first to incorporate vibration analysis in its monitors, believing that the function is the key to early detection of mechanical failures. Insight says the vibration functions should simply be used as a condition monitoring tool because obviously not every engine will map the same vibration signatures.

The sensing is done with a three-axis accelerometer installed on the engine case bolt, in close proximity to the propeller. Once the sensor is connected (it can be added to any G3 and G4), the instrument displays a dedicated vibration spectrum page with a waveform display. After using the utility for a while, Insight said users will recognize what is normal vibration and what isn't. The trick is spotting new spikes, or recognizing that an existing vibration signature is worsening, evident by its growing in magnitude/wavelength.

Several users—including one who was trying to source the cause of vibration in his Cherokee Six—told us there is a learning curve, which requires operating the engine at different power settings and flight conditions. One user was able to track down airframe vibration originating from a buffeting landing gear door.

Moreover, the utility has various sub-screens (six total) for each of the remote accelerometer's axis measurements. You can zoom in on the displayed waveform to make it easier to examine, while a cursor snaps to nearby vibration spikes in case you miss them. Since the data is saved to the instrument's SD data card (in hexadecimal bytes in the log file) by pressing and holding the top bezel

The lean-assist function comes on all models except the G1. That's a G2 displaying lean of peak data, right.

button, you can load the data to a computer where it opens in Microsoft Excel.

The exhaust valve analysis/periodic temperature variation screen is a tool for spotting slow variations in EGT, which can lead to exhaust valve failure. While the oscillation rate is too slow to be identified by temperature alone, a slow-sampled spectrum analysis can be performed in cruise flight at a constant power setting and altitude. The onscreen vertical graph shows a variation in temperature, while the horizontal line represents minutes of time. Normal indications will be a flat line with at least some graphed noise, but a valve problem could generate a spectral peak. The bottom button allows you to toggle between all cylinders.

There is also a three-axis accelerometer installed in the instrument's chassis. It samples turbulence and landing shock. Insight says the feature is a training aid for flight schools, while also a predictor of structural damage. Since the data is logged to the SD card, operators can keep tabs on unauthorized aerobatic activity or abuse of rental aircraft. There is a two-axis G-load turbulence display of the vertical and yaw axis, plus time and acceleration values. The utility could be useful for knowing when to slow the airplane to maneuvering speed in turbulence.

TWINS AND RADIALS, TOO

Insight offers a version of the G4 for



twin-engine applications, plus several versions for radial engines. On the twin-engine model, you can monitor both engines simultaneously.

For tandem cockpits, Insight developed the G9 front and rear cockpit display combination. These instruments connect together through an RS-232 serial databus and should be available later this year.

As much as we like the G-series line of monitors, we think they're overshadowed in a crowded market. For entry-level monitors on par with the Insight G1, there is the JP Instruments EDM700. It starts at \$1645 for four-cylinder engines and \$2000 for six-cylinder engines, but we think it's showing its age (it doesn't have a color display). The \$2435 EDM730 does sport a TFT color screen, but its rectangular footprint overhangs the instrument panel, despite a chassis that slides into a 3.125-inch instrument cutout. For ease of mounting and advanced features, we give the Insight G-series the advantage.

As for choosing the right Insight model, we think the G1 is right for basic aircraft if you can live without a fuel totalizer. It still has basic leaning functions and as we reported in the June issue of *Aviation Consumer*, there are plenty of options for stand-alone and affordable fuel totalizers.

For fuel injected engines and for running lean of peak, we think the G2 is the hands down better choice. We like its stone simple at-a-glance lean assist feature, its SD-based datalogging capability and the bang-for-the-buck starting price. For finicky engines, the vibration analysis feature in the G3/G4 has some appeal, but at a sizable cost delta.

INSIGHT ENGINE MONITORS COMPARED			
MODEL	BASIC PRICE	MOUNTING	COMMENTS
G1	\$1235 (4 cyl) \$1365 (6 cyl)	2.25-inch	Basic EGT, CHT, TIT, carb temp monitoring. No fuel flow data.
G2	\$2093 (4 cyl) \$2275 (6 cyl)	2.25-inch	Integral fuel flow computer works with advanced leaning assistance capability. Includes SD data-logging.
G3	\$3185 (4 cyl) \$3365 (6 cyl)	2.25-inch	Adds RPM, MP, OAT, fuel stability analysis, air data input, vibration detection and hard landing dynamic analysis.
G4	\$3998 (4 cyl) \$4225 (6 cyl)	3.125-inch	Same functions as the G3, but in a larger bezel. Twin-engine version starts at \$5980 for 4 cylinder engines.
G9	\$5980	3.125-inch	For 7, 8, 9 and 14 cylinder radial engines. Available in a dual-screen tandem configuration.



That's one of CubCrafters' several production floors in the photo to the left. It builds everything, except engines, avionics and tires in its growing American facilities.



Editor's Choice Awards: CubCrafters, Avidyne

CubCrafters takes the prize for the year's best manufacturer, while Avidyne's strong comeback wins the avionics category.

Steve Jobs once said of Apple that the genius of business success was to invent products would-be buyers didn't know they needed. Apple succeeds brilliantly at this, but the advice applies equally to airplanes. He who stands still and treads water will soon wither. Even small companies must innovate and move forward and our editor's choice for the top company doing that this year is CubCrafters, the scrappy taildragger manufacturer based in Yakima, Washington.

As detailed in the story on page 4 of this issue, CubCrafters has cannily plied the Cub-type aircraft niche to not only stay in business, but to prosper with modest growth.

It has thus kept itself near the top of the light sport market in sales volume and with the introduction of the X-Cub reviewed in this issue, it again ventures into the Part 23 market with an airplane that will give Aviat's Husky some serious competition, in our view. Was the market crying out for an ultra Cub, the fastest and most luxurious example of

this class of airplane? Probably not, but now that CubCrafters has it out there, we predict that a lot of buyers are going to want it. For that reason, we're choosing CubCrafters as our top pick for the best manufacturer of the year. Visit CubCrafters at www.cubcrafters.com

BEST MARKET COMEBACK: AVIDYNE CORPORATION

When Avidyne's IFD540 GPS navigator was stuck in FAA certification a couple of years ago, we wondered if the company could survive another year, let alone appear in these pages as avionics company of the year.

In our estimation, it was a blend of Avidyne's marketing approach and customer loyalty, plus a solid and innovative product line, that

brought the company back stronger and more competitive than ever.

Moreover, Avidyne has full-panel solutions, which include ADS-B equipment, traffic and weather systems, integrated autopilot systems, plus three IFD-series slide-in GPS navigators positioned to easily replace the fleet of aging Garmin GNS530s and GNS430s. If this doesn't answer the demand of buyers looking for a worthy alternative to Garmin products, we don't know what will.

We think Avidyne's ingenuity, commitment and resilience has made the avionics market healthier. Visit www.avidyne.com, plus its active community forum (Avidyne Live) at www.forums.avidyne.com.

BEST OIL ANALYSIS SERVICE: BLACKSTONE LABORATORIES

We sent oil samples to five popular labs and ranked them based on their speed of response, quality of reporting, apparent knowledge of aircraft engines and information presented on their websites. The results of the spectral analysis of the oil showing the presence of various elements (metals) provided by the labs were

Avidyne's marketing director Tom Harper, bottom, attributes the company's recent success to innovation, perseverance and a forward-looking product development team.



within a few parts per million of each other—within what we considered normal measuring variation. But what set the two winning labs apart was the quality of service with two being head and shoulders above the competition: Blackstone Laboratories ranked first by a very narrow margin over Aviation Laboratories. Both also provide comments from their technicians on their reports, in addition to the hard data on parts per million of wear metals.

But, Blackstone got the nod because its testing is more involved, provides more information on its easy-to-navigate website and does not charge for its analysis (\$28) until it is performed. Visit them at www.blackstonelabs.com.

MOST AUDACIOUS ELECTRIC CONCEPT: AIRBUS E-FAN 4.0

The electric aircraft market is, at this juncture, largely aspirational. As we reported in the March 2016 issue of *Aviation Consumer*, even the most



advanced projects have yet to show they have market legs. And that applies to the most audacious, too, the Airbus E-Fan 4.0. In this project, Airbus pledges to deliver before 2020 a four-place certified hybrid aircraft for the U.S. market using technologies that just barely exist, at least in the form they hope to apply them. We're reserving judgment on the practicality of this effort, but its boldness simply takes the breath away.

BEST ADS-B TRANSPONDER: L-3 LYNX NGT-9000

Exhausting is the first word that comes to mind (there are others we'll refrain from printing) when looking back at our ADS-B coverage this past editorial year. Eyeball the ADS-B buyer's guide in the April 2016 issue of *Aviation Consumer* and you'll see why. It's a market busting at the seams with panel and portable solutions. A major player is L-3 Avionics.

Since its introduction nearly two years ago, we felt that L-3's transpon-

der-based Lynx NGT-9000 was an excellent all-in-one ADS-B In and Out solution, though we also felt that its high price limited it to higher-end aircraft. But after a few major price reductions (it now starts at \$5395), an entry-level NGT-9000 is within reach of more buyers. Plus, it packs a lot of punch in a single box.

There are several things we like about it. First is its rack-mounted 1090ES transponder form factor, which makes it worthy in high-flying applications and for those needing a transponder upgrade. It's also a multifunction system, capable of displaying dual-band ADS-B traffic and FIS-B weather graphics on its dual color touch displays. We flew with the NGT-9000 and found the operating logic intuitive and the onscreen mapping graphics to be excellent. Visit www.L-3avionics.com.

BEST EXHAUST UPGRADE: LEADING EDGE

When your exhaust system wears out, it's a safety of flight matter. If repair isn't an option, we think it's worth replacing the system with one that is not only robust, but customized to your aircraft and engine and that can increase performance.



We like Leading Edge and Power Flow exhaust systems because they tailor the exhaust pipes to the appropriate length to balance the back pressure on the cylinders. This creates low pressure at each exhaust port at the time it opens to facilitate scavenging the products of combustion and increase power output.

Power Flow builds its custom exhausts for most four-cylinder Lycoming-equipped singles. Prices range from \$4000 to \$5500, with installation time estimated at five to 10



The L-3 NGT-9000, top, is a multifunction color touchscreen 1090ES transponder with integral ADS-B weather and traffic receiver.

hours. There is a 60-day trial period with a full refund of the purchase price (not install and removal cost) if the owner isn't satisfied and returns the system. The warranty is one year or 500 hours of operation.

But we give Leading Edge the very slight edge over Power Flow for its warranty. The warranty is for one year with no limit on hours for all of its systems except for the 180-HP PA-12, which is 10 years or 1000 hours and for the exhaust collectors for 200-series Cessnas it's 20 years or 2000 hours. Prices range from \$4400 to \$6500. Contact Leading Edge Exhaust Systems at www.wemakeyoufly.com and PowerFlow Systems at www.powerflowsystems.com.

BEST ANR HEADSET: BOSE A20 BLUETOOTH

Last summer, Bose released an update to its five-year-old A20, which added much-needed music Bluetooth features to the set's stellar ANR performance. The A20 is in our





We found that Diamond's Austro-powered DA62 aerial SUV, top, delivers on efficiency, cabin amenities and build quality.

long-term product evaluation pool and the more we wear it, the more we like it—especially its Bluetooth music performance. If you have an older A20, a new field-replaceable cable/ANR module assembly enables Bluetooth music capability and the ability to prioritize multiple wireless sources. At \$1100, the A20 Bluetooth is comparably priced with Light-speed's PFX ANR headset. We suggest you try both before buying, but we give Bose the slight edge in comfort and ANR performance.

You can read a full report on the Bose A20 and other high-end ANR headsets in our ANR headset shoot-out featured in the October 2015 issue of *Aviation Consumer*. Contact www.bose.com.

**BEST NEW AIRPLANE:
DIAMOND DA62**

Wouldn't it be fun if, as in the auto industry, new airplane models appeared every year? Not likely in the current market, so when one does emerge, it gets our attention. And the DA62 definitely did.

In this new twin, Diamond has refined the original DA42, enlarged it and given it new engines, more payload and higher cruise speed. We found that the Austro AE330 engines used in the new airplane are the smoothest aircraft powerplants we've ever flown and with FADEC and full auto-feather, they're likely to prove the safest, too. We give Diamond kudos for applying everything it has learned in more than two decades of aircraft design and manufacture

to produce an exceptionally well thought out aircraft. Contact www.diamondaircraft.com

**BEST ALPHABET ACHIEVEMENT:
EAA WITH DYNON D10A STC**

Aviation's alphabet groups tread a fine line between being promoters of the industry and competitors with established aviation companies to fund their basic activities. With



only a few exceptions, they've stayed out of offering products and services that compete with the private sector, but last spring at Sun 'n Fun, EAA surprised us by announcing an STC approval program to allow the installation of non-certified Dynon avionics into certified airplanes. The program was well-received by owners and shops we spoke to and we're standing by to see if it ignites sales. Meanwhile, kudos to EAA for showing leadership in getting it done.

**BEST DISPLAY LENS CLEANER:
iCLOTH AVIONICS**

The easiest way to a \$1000-plus factory repair is cleaning your panel avionics display lens with the wrong solution. That's why we went looking for the safest and most effective avionics-purposed display cleaner and found iCloth Avionics. The company has been making cleaning products for sensitive optical surfaces since 2001, first for eyewear and eventually

for the entertainment screens and flight deck displays in major airline fleets. Each 5- by 7-inch individually wrapped aerospace-grade DuPont Sontara cloth is premoistened with



purified water, surfactants and isopropyl alcohol. iCloth Avionics says the wipes are safe on polycarbonate, glass, plastics and specially coated lenses. We tried them on smartphones, computer monitors and on pricey motorcycle helmet shields and didn't damage any of them. Plus, they're effective.

In our trials, we were pleasantly surprised to find no streaking, no scratching and no hassle. We liked them so much, we bought a 100-pack (\$35) for ourselves. Visit www.iclothavionics.com.

**BEST SUN VISOR:
ROSEN**

No surprise here. Rosen has been our top pick for aftermarket visors every time we've reviewed this product segment. They aren't cheap by



any means, but Rosen uses top materials and careful design methodology to vastly improve what passes for visors in older aircraft. This is why, we're sure, that many new airplanes are now sporting Rosens. Visit www.rosensor.com

**BEST ELECTRONIC AI:
SANDIA SAI340 QUATTRO**

We should really include the FAA on this pick because the agency recently opened up a new market for elec-

tronic primary attitude instruments. As we reported in the December 2015 issue of *Aviation Consumer*, the FAA's PS-ACE-23-08 policy statement finally acknowledges the insidious nature of vacuum instrument failures, while also sympathizing with



aircraft owners faced with expensive upkeep of old-school spinning gyroscopes.

PS-ACE-23-08 says it is acceptable to replace a single-function vacuum-driven attitude instrument with an electronically driven attitude indicator as long as it has an independent standby battery capable of meeting the intent of AC 23.1331, AC 23.1381 and AC 1353(h). We're talking about minor alterations here—no field approvals—as long as the instrument has a TSO. This means installations can be signed off with a logbook entry if certain technicalities are met. Enter Sandia Aerospace's SAI340 Quattro.

At \$3600, the TSO'd SAI340 has four-in-one functionality, including airspeed tape (with airspeed limitation markings), attitude, altitude tape and slip indicator.

The instrument sports a 3.5-inch LCD display and has a chassis designed to fit in a 3-inch instrument cutout, while pitot and static input ports (the instrument uses pitot and static input for data resolution) are built into the rear chassis.

While the SAI340 Quattro was originally developed as a backup instrument, Sandia told us the TSO functions meet all of the standards for use as a standalone primary attitude indicator.

We like that the SAI340 has smart and intuitive battery monitoring, unusual attitude prompting, an easy feature set (controlled by a single push/rotary knob), plus a straightforward installation process. Contact www.sandia.aero.

TRAINING

Instrument Test Prep: Sporty's, King Tops

There is intense competition in the internet-based, instrument test prep world, which is reflected in the high quality and reasonable prices of the courses.

by Rick Durden

We've long thought that the instrument rating knowledge exam is the most challenging written that most pilots take during their flying career. There's no question about it, getting prepared for it involves some serious skull sweat.

We surveyed six of the more popular internet prep courses to see what was available, how they approached getting a student ready for the instrument written, what they cost and their convenience of use—notably whether they could be used on any internet-connected device or didn't require connectivity while using. We came away feeling all were good—it's a competitive market and the high quality of the products reflects it. From the perspective of creating a knowledgeable, all-around instrument pilot and getting ready for the written, we like King Schools and Sporty's. For an inexpensive, power-cram, get-ready-for-the-written-and-nothing-else course, we lean toward Sheppard Air's cold-blooded course.

The FAA stopped publishing the questions and answers to the written in 2007. It constantly makes subtle changes to the questions and answers, so keeping up with what's on the instrument written requires ongoing work by the prep course developers—which all do. Nevertheless, that means that no company has a full database of the current FAA test questions and answers no matter what they claim.

We note that over the next year the FAA is going to be transitioning to a new framework for pilot certification, which it calls Airman Certification Standards (ACS). It will

result in significant changes to all of the written exams, notably reflecting modern avionics on the instrument knowledge test. All of the test prep companies we surveyed told us that they have been keeping in touch with the FAA as it makes this change and are ready to go with updated courses once the instrument ACS are in place.

SPORTY'S

Sporty's (www.sportys.com) written test prep is included within its \$199.99 Instrument Rating Course, offered online, as an iPhone/iPad app and via DVD. We looked at the iPhone/iPad app and appreciated the flexibility it offers in being able to train anywhere there is an internet connection, and that it can be synced across multiple iOS devices—no Android.

The prep course includes 13 hours of videos that are, in our opinion, professionally produced and content-rich. The graphics were clear, the narration concise and while the length varied from just over three minutes to nearly 20 minutes, they broke the complex material down into segments that were reasonably bite-sized.

The videos are not limited to just the material that will be covered on the instrument written—something we applaud—so the course appeared to us to be designed to create a well-rounded instrument pilot who can operate within the system and deal with weather. At the end of most of the videos there is a review quiz in FAA-question format.

What Sporty's calls its "Study Buddy" is an interactive written test



King Schools course flow diagram after clicking on the "Instrument Approaches" segment to get the menu of lesson groups, left. ASA test question with explanation, lower left.



merman about the course and he pointed out that one of the best sources his team has for keeping the course up to date is the flight school at Sporty's. He said that while their students learn from them, they also learn from their students about what makes for the most effective learning materials.

ASA

Long known for its high-quality aviation textbooks and test prep books, ASA (www.asa2fly.com) joined the online instrument written test prep world with its Virtual Test Prep. Priced at \$199.95, it includes 10 hours of video presentations, a digital textbook and its successful Prepware material.

In a structured fashion, the student first reads the digital textbook chapters applicable to an overall section of the course. The student views the video applicable to the topic. The next step is to access the Prepware—FAA-style written test questions—presented first as a study session where the student gets feedback on each answer and then as a quiz that is timed and scored.

As we expected, we were impressed with the quality of ASA's digital textbook. Content dense, we feel it is written to create a knowl-

edgeable instrument pilot and not just pass the written exam. We also consider it a good reference manual for an instrument pilot to have in her or his library.

We think ASA is one step behind the competition when it comes to video. It was good but felt dated at times and not always focused.

The videos themselves are long—rather than break them up into convenient lengths, there is only one video per major topic. Plan on over an hour to get through each one. Even though you can access the course on any device with an internet connection, we were surprised that there was not a convenient way to stop a video, exit the program and then come back later and restart it at the same point. It's necessary to scan through to find your stopping point.

Upon completion of the course and two practice tests with a score of at least 80 percent, ASA provides an endorsement to take the FAA written—or it will provide the evidence of completion and your scores to your CFI so he or she can sign your endorsement.

KING

At \$279, the online FAA Written Exam Course from King Schools (www.kingschools.com) is the most expensive of the courses we reviewed; nevertheless, we think it's worth the price. The course is well-organized, content rich, user friendly and provides a number of handy study aids.

The course is organized into a recommend flow through the major subject areas. Clicking on a subject icon causes a pop-up menu showing lesson groups within the subject. Clicking on a lesson group reveals a menu of the lessons (usually three to six) within the group. Clicking on the lesson itself starts the video for that lesson. It sounds much more complex than it is and it provides a way to break complex subjects into digestible bits—with individual

preparation that is set up in three modes: Learning, Flashcard and Test. The Learning mode is broken down into categories of questions with a detailed explanation of each potential answer. Flashcard mode is just as it sounds. You read the question and give your answer—out loud or in your head—then "flip" the card by tapping "show answer" and see if you were correct. The Test mode provides a simulated exam, with a time limit and selection of questions designed to closely simulate the actual FAA exam.

Once you complete the videos and pass two simulated exams with a score of 80 percent or better, selecting "Written Test Endorsement" allows you to receive your endorsement to take the FAA written directly from the app.

We spoke to Sporty's John Zim-

Screen shot from Sporty's video showing inflight ice buildup on a temperature probe, right. Screen shot of Gleim e-book contents of its instrument approach section, lower right.

videos lasting on the order of 10 minutes.

As soon as a video is over, the first review question appears. Clicking on an answer generates immediate feedback. There is a running "report card" showing progress through the lessons as well as the ongoing percentage score of correctly answered questions.

Once the student watches the video and answers all of the review questions correctly, the lesson title in the course menu turns green and the date of completion is shown. Even if a lesson has been completed, the student can return to it and view the video and go through the questions again.

There is an icon to access the entire library of review questions. In addition, there is an icon to access "hot sheets" issued regularly by King to update course content. King's Barry Knuttila told us that King is regularly receiving information regarding test changes (King personnel are members of the FAA's working group on its knowledge tests), so it updates the course once or twice a month.

Upon completion of all of the lessons, a score of at least 70 percent on the three practice written examinations and clicking on the endorsement icon, the course generates an endorsement for the student to take the FAA knowledge exam.

The course can be synced to any Apple device.

DAUNTLESS

The approach taken by Dauntless (www.dauntless-soft.com) over the last 15 years for its written test prep courses is different than the video or textbook method of most of its competitors. Using the technique of "learning by simulated testing," Dauntless offers downloadable software for its instrument written test prep for \$49.99. Available for PC, Mac, iPad, iPhone and Android platforms, the Dauntless course breaks



down the test prep into 13 knowledge areas.

The student selects one of the knowledge areas and starts with the "test/study mode." It introduces the student to the material by giving an FAA-style test question, the correct answer and an extensive explanation of the answer, often with high-quality graphics.

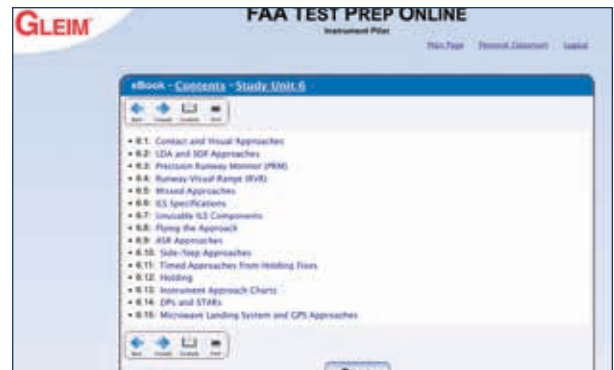
Once the student has gone through the knowledge areas in the test/study mode, the next step is to do it again in Dauntless' "learning and practice" mode, which is a "gentle introduction and practice on the material." The student answers test questions, gets immediate feedback and the system repeats questions the student got wrong.

The course progresses through more intense study modes as the student continues to take practice tests, until taking FAA-style tests in a format that simulates the real thing.

We consider the participatory learning approach an effective way of preparing for the instrument written; however, we are concerned that limiting oneself to simply preparing for the limited knowledge areas covered on the written test will leave holes in an instrument student's education that may or may not be caught during dual instruction.

GLEIM

We've always been impressed by Gleim's (www.gleim.com) no-nonsense "just the facts, Ma'am" approach to training. Its \$99.95



Instrument Pilot Test Prep Online course continues the tradition. It is a semi-structured course that first directs the student to read from an e-book and then take practice quizzes and finally, very realistic practice tests. There are no videos.

The e-book breaks the instrument prep material into 11 units with each unit being broken down into sections that rarely take more than 10 minutes to read carefully. There is no fluff in the material.

Though it's not made clear in the introduction to the course, the e-book material may be read in any order the student desires; however, our review indicated that it is best consumed in the order presented as often material in one segment relies on knowledge obtained in an earlier section.

We liked that from the beginning of the e-book, the entire course is designed to make the student comfortable with the FAA computerized test formats and takes time to explain how they work.

From the e-book the student goes to Gleim's question bank. In Study

continued on page 32



Static discharge wicks are generally riveted on the trailing edge of control surfaces because of solid electrical grounding.

lessly back into the air before RFI is created. It was actually Florida-based Dayton-Granger that patented the wick style of leading-edge discharger, and the company continues to advance the design and remains a leading supplier to this day.

Static dischargers of various designs have been standard equipment on many airplanes for decades—and they generally get ignored—and abused. Spend enough time in any packed aircraft hangar and you'll likely get poked by one.

Static wicks are bonded to the metal structure of the airframe. Because they are constantly transmitting electrons into the atmosphere, they eventually wear out—or at least the tips do. Once that happens, RFI can develop on the airplane.

In addition to radio static, you may experience a corona discharge when flying in precipitation. Corona discharge involves a static charge so great that excess electrons start to ionize air molecules and form a visible corona around sharp objects on the airplane—the end of the prop, antennas or wing tips, for example. The effect is known as St. Elmo's fire. A corona discharge, taken to its extreme, occurs when a spacecraft enters the atmosphere and ionizes the surrounding air, turning it into plasma and wiping out communications until the spacecraft slows.

There is also the condition of streamering, a type of transient electrical discharge that occurs when insulating fiberglass structures (including windshields) are exposed to large differences in voltage.

WICK IT AWAY

Static wicks are high-resistance devices (anywhere from 6 to 200 megohms resistance) that have a much lower corona voltage than the surrounding airframe structure they are attached to. But it's not simply a matter of slapping a wick to the airframe and calling it a day.

Static wicks are essentially useless if they aren't correctly bonded to the surface, meaning there must be

AIRCRAFT MAINTENANCE

Airframe Static Wicks: Worth a Try For RFI

Battling interference problems in an otherwise clean avionics installation? Static discharge wicks may not be a cure-all, but we think they are worth trying.

Staff Report

If you ride long enough through snow, fog and desert dust, you'll likely hear the audio signatures of static built up on the airframe. It can be severe enough to shut down a comm and nav receiver. The troubleshooting chase can be as frustrating for the techs as it is for pilots because everything will likely work perfectly on the ground. Static discharge wicks should be the first accessories to consider, especially when committing to a new avionics installation. But antennas could be the culprit, too.

For this article, we talked with avionics manufacturers, aircraft manufacturers and technicians about the effects of airframe static buildup on new avionics gear, and why healthy static wicks can help. Here's what we learned.

RFI 101

Anytime an aircraft flies, the friction of the air over the aircraft's skin causes the aircraft to build up static electricity. Discharge of the electricity can generate radio frequency interference (RFI) or static noise level.

RFI can become serious enough to interfere with comm and nav radios to the point that reception becomes impossible. Any particulate matter in the air, be it rain, snow, dust, sand or even volcanic ash, will cause more RFI to be generated as the material sticks to the aircraft and any protrusions, especially antennas, which is why they have an anti-static coating.

While RFI most often affects low-frequency and VHF comm and nav radios, it can adversely affect UHF ranges, which includes transponders.

When the charge reaches between 100,000 and 200,000 volts, the electrical fields on an airplane become concentrated on the extremities and air is ionized at the sharpest points on those areas. The voltage isn't going to kill anyone; the current level is low. However, as it discharges into the surrounding air, it creates the RFI that interferes with radios.

In the 1940s, researchers developed static discharge wicks—we now call them static wicks—to remove the electrical charge from an airplane by discharging it harm-

a conductive path from all parts of the aircraft to the wick. That can be a huge challenge on composite aircraft and one reason you might not find static discharge wicks on some Cirrus and Columbia models, to name a couple.

Static wicks are available with and without FAA and PMA approval and with various methods of construction. Dayton-Granger has PMA approval for a variety of discharge wicks for use on piston and jet aircraft. It also provides dischargers to OEMs. Dayton-Granger's Javier Pacheco told us the company continues to advance its wick design, offering the Null Field discharger product, the Mircopoint discharger, the Carbonpoint discharger and a line of composite dischargers. The company also has a history of making high-quality aircraft antennas, plus lightning diversion strips.

No matter the manufacturer, prices can range from \$40 to as high as \$85 or more for a wick suitable for a single or twin, and far more for jets. In general, most wicks for singles and light twins measure roughly 7 inches long and weigh .50 ounces each.

Wichita, Kansas-based Aero-Mach Labs (which purchased longtime OEM supplier TCO Manufacturing a few years ago) sells its static discharge products to Textron for the current Cessna and Beechcraft product line, and its discharge wicks are on Eclipse jets.

Owners may struggle with getting the correct replacement, especially when sourcing them through mail-order supply houses. Aero-Mach's Jon Snider told us selecting the correct replacement wick should be easy because it's usually governed by the original type certificate of the aircraft, and replacement options are prescribed by the aircraft repair manuals.

"We build specific model numbered wicks for Cessna, for example. When it's time to replace them, the repair manual says to replace the wick with a specific part number," he told us. Parts supplier Aircraft Spruce and Specialty stocks a healthy supply of static dischargers for certified and experimental aircraft. It told us it can often provide the correct wick based on the model and vintage of the aircraft. Replacement options are plentiful.

Aero-Mach still makes vintage



Static wicks, top, can be rigid, flexible and with carbon or bristled ends. Some thread into a retaining base for easy replacement. Other than ensuring they stay on the aircraft, be sure to inspect the tips for signs of wear. While you're at it, inspect all antennas for signs of worn antistatic coating and surface cracks.

single-piece wicks found on older models, in addition to its new line of two-piece dischargers. These have a threaded base for easy replacement of broken wicks. While it's possible that a wick can exit the airframe in flight—especially while flying in icing conditions—it's more common for one to come off while on the ground. Maybe it's the result of hangar rash or one gets snapped off by a refueling hose.

That's why we prefer dischargers with a threaded base. If one snaps



off, simply screw the stud of the replacement wick into the base. That's a whole lot easier than riveting a new single-piece wick to the skin of the aircraft.

PROGRESS AT CIRRUS

There is a difficulty in ridding static from a composite airframe. It's not as simple as installing a wick by riveting an aluminum base to the aluminum skin of the aircraft to achieve

P-STAT LESSON: WORSE IN SNOW

As a dedicated student of aviation, I'd read many accounts of static from rain and snow wiping out the Morse Code A and N signals in the headset, which led to some crashes into high terrain in IMC. From time to time I'd experienced static-electricity-induced St. Elmo's fire when flying in precip. In piston singles, it would appear as purple flames around the outer few inches of some or all of the prop disc.

One night in a Learjet, it manifested as eerie purple fingers stretching forward many yards into the night from the nose of the airplane and tip tanks. Never did it adversely affect the radios, although after we landed the Lear, the captain showed me where the paint had been removed from the very front of the nose and tip tanks and said, "St. Elmo always leaves his mark."

I'd heard that static wicks could wear out, but never had much respect for the condition of the static wicks on an airplane I was flying until what I thought was going to be a routine 90-mile flight one night. In the family Cardinal with my wife and daughter, we flew into the snow that was forecast about halfway along our route from Cadillac, Michigan, to Grand Rapids. It was standard Michigan IFR winter weather—the cloud bases were well above our altitude and it was snowing. Big deal. There was no risk of icing and it was cold enough that the snow wouldn't be wet and block the air filter, requiring use of carb heat.

As we flew along, p-static began to build in the headphones. I had that happen a time or two before, and it always cleared itself within a few minutes. This time it didn't. It got so intense that I could not hear the controller or anyone on the frequency. In

addition, the needles for both VORs began to oscillate randomly. A quick check resulted in hearing only static, no identifiers, on both radios.

Turning on the landing light revealed that we were flying in moderate to heavy snow. I knew snow was worse than rain for generating p-static, but I'd never encountered anything like this. I knew it was snowing in Grand Rapids and forecast to continue, so I started considering turning back to Cadillac where it should just be decent VFR with a high overcast. At that point I recalled something I'd learned when encountering St. Elmo's fire and a remark made by an old freight dog.

I held my right hand out in front of me, just above the panel, palm down, fingers spread and moved it toward a spot about two inches from the windshield and slowly swept it left and right. Just as I'd experienced with St. Elmo's fire, tiny purple sparks jumped from under my fingernails to the windshield. I'd thought it was strange and fascinating back then; however, this time it apparently also served to discharge the static buildup on the airplane. The p-static in the radios went away, the VORs returned to proper functioning and I re-established contact with the controller.

After about five minutes, p-static started building again, so I did the hand and windshield thing again. I did it one or two more times before the intensity of the snow diminished and the worn static wicks could handle the static buildup, and I shot a routine approach into Grand Rapids. The next day I called my mechanic and arranged for a new set of static wicks for the airplane.

—Rick Durden

conduction. Still, over the past few years, Cirrus Aircraft did extensive flight testing in hopes of reducing radio noise caused by p-static interference on its composite airplanes. As a result, a field service bulletin was created for third-gen SR20/22 models to include the installation of two static

wicks on each end of the wing (just inboard of the wingtip), in addition to ones on the elevator and rudder. It also involves isolating metal structures and electrically bonding them. Metal structures on the SR airframe needing grounding may include the wing step, air conditioning vent, flap

hinges and the cabin door, to name a few.

ARE NEW AVIONICS MORE IMMUNE?

Yes and no. We asked Garmin engineers about the effects of RFI on its retrofit and OEM avionics, including its most modern integrated suites for jets. One said that some modern systems are impervious to the effect (including GPS receivers) because GPS operates at such a high frequency. However, navs, comms and audio systems operate at lower frequencies and are much more susceptible to static interference if the aircraft has worn or missing static wicks. As one engineer put it, "The importance of static wicks is about the same for a 50-year-old airplane with old avionics as it is for a brand-new one with an ultra modern glass cockpit."

Avidyne's engineering division said it uses several approaches to combat RFI/EMI issues, including ground plane planning, providing low impedance return paths for RFI/EMI, board-level shielding, differential signaling and external signal filtering.

Still, all of this effort has little effect on in-band noise sources, particularly in VHF. As Avidyne explained, as static charges build, move and collapse on the airframe, very wide-band RF energy is released; some amount of this energy will fall in-band for the VHF and other RF receivers. The in-band component of the static noise is picked up by the antenna and amplified in the receiver as if it were the intended signal.

"There is very little that can be done about this at the avionics equipment level, and in this case, preventing the static buildup is the only good solution," it told us.

The takeaway to this article is simple and complicated. From our shop experience chasing RFI interference problems, static discharge wicks may not be the cure-all. We've flown aircraft without static wicks in prime p-static conditions and enjoyed flawless performance, while ones equipped with wicks caused heartburn.

As Avidyne put it: "Static buildup is a very real issue that cannot be mitigated at the equipment level. If the aircraft OEM intended static wicks to be installed, it had a reason for it, and if it didn't, it's still probably a good idea."



AVIONICS FLIGHT TRIAL

Aera or App? No Easy Choice

We scoffed at Garmin's expectation that a new portable GPS could sell against tablet apps. But it could eke out a niche.

by Paul Bertorelli

If smartphones and tablets have seized the high ground for cockpit navigation, Garmin showed last spring that it's not quite ready to surrender its piece of the dedicated portable navigator market. The introduction of the \$849 aera 660 in April shows that Garmin still thinks there's a viable market for a GPS navigator that, although full featured, doesn't run apps, play amusing games, pay at Starbucks or do a million other things that smartphones do.

Has Garmin come adrift from market reality here? Can such a thing compete with tablets and phones?

The aera 660's display, top photo, is more sunlight readable than tablets and phones and has less annoying glare.

The short answer is yes it can and it is, but not in anything like the buying frenzy volume that we saw a decade ago when the tablet was still a lab-bench prototype.

For this article, we're comparing the aera 660 to Garmin's Pilot app, which we'll use as a surrogate in general for other apps. In that context, the app vs. aera decision is not quite so slam dunk as we imagined it would be.

DISPLAY'S THE THING

The 660's overall size is between a largish smartphone like the Apple iPhone 6S and a small tablet, say the iPad mini or the Android-based Samsung Galaxy Tab S or the Nexus 7 or 9. Might as well throw the iPhone 6S Plus in there, too. It's stupid large for a phone, but some buyers like the larger display.

Against these products, the aera

CHECKLIST



The aera 660 has the best connectivity of any dedicated portable.



Operability is similar to GTN-series panel navigators.



Database revision costs have been reduced and additional data added.



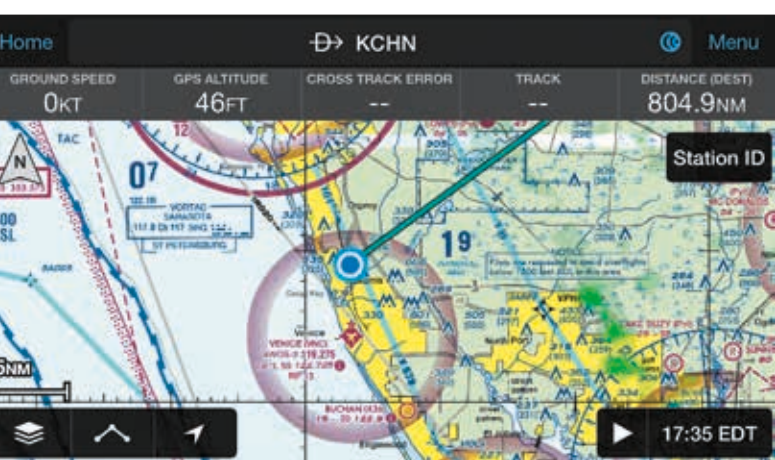
At \$849, the price point may be high for owners used to \$500 tablets.

has two surprising advantages, in our view. The first is that its display is brighter, sharper and more sunlight readable, a difference that's obvious when the devices are placed side by side. Second, the aera operating system—and the physical hardware—is more robust. Since it does less, the aera is less susceptible to the burps, lockups and dead ends that occasionally trouble apps.

The 660's overall size is just 0.2 inch wider and 0.1 inch taller than the aera 500 series, but the display is 5.08 inches on the diagonal compared to 4.3 inches for the 500 aeras. Both devices have color TFT displays with backlighting, but the 660's screen rez is 480 by 800 pixels, three times the density of the 500 series. It's actually similar to the more expensive aera 796, which has become a staple in LSA and EAB panels.

Depending on your cockpit and tastes, the aera 660 has an advantage over a full-size tablet or even a 9-inch display in that it yoke mounts easily and more securely without obscuring the rest of the panel. The tradeoff is that it's not a 9-inch display—nor the iPhone 6S Plus 5.5-inch screen. That means some display features will appear smaller, as does the typography.

Garmin's execution of touchscreen control on the aera 660 is as good as we've seen from them. It's a capacitive interface, not the older resistive design, so it's just sensitive enough for scrolling and pinch scaling, without being oversensitive, as tablets sometimes are. Because of the bright screen, it's easier to stab at the right icon with fewer uncommanded actions.



Bluetooth system, you can port that flight plan right into them, also fairly easily. The aera 660 will handle the porting, but it won't do the flight plan filing.

The 660 is equipped with wireless capability, a first for a Garmin portable, and that's useful for downloading databases and grabbing weather on the ground, albeit not in a briefing format, as with the Pilot app. It saves the fuss of plugging into a computer. For inflight weather,

the 660 accepts datalink FIS-B from a GDL 39 portable or, through Flight Stream, Garmin's installed ADS-B systems. What it will not do is receive and display SiriusXM datalink weather, although that's planned through a new single-purpose receiver in the works for later this year. This alone may change the purchase equation for some buyers, in our view.

On the other hand, the 660 will do some things that the Pilot app (and other apps) won't do, including connecting to Garmin's VHF comm radios to output frequency data. This includes all of Garmin's current digital comms and two legacy units, the SL30 and SL40 boxes, which are now dis-

continued. The aera will also connect to the GTX 345 transponder through Bluetooth (or hardwire) to receive traffic and weather information. Since Garmin stuck an AHRS unit into the 345, it can also port real attitude data—no airdata, though—into either the 660 or the app. This adds detail to both the SynVision feature on the app and the 3D Vision on the aera 660.

There are other pros and cons for the aera and the app. One we like in favor of the app is a screen radial widget that pops up when you touch the map at any point. This mini-menu is context sensitive and immediately gives bearing and distance to the point touched from the aircraft and offers data on nearby weather, waypoints and a direct-to option at the touch of a finger. On the aera, a similar touch reveals data about stuff near the point touched, but available options, such as direct-to, bearing and distance and airport data, are spread around the screen. We wouldn't say one method is better than the other, but we like the radial menu idea.

Although the aera's operating logic is broadly similar to the Pilot app, there are differences in look and feel. For instance, both launch tasks from a home page that looks similar to that found on the GTN navigators.

But the app has 18 icons, versus 11 on the aera 660. That makes the app a bit busier than the aera and there's not much direct correlation between the icons. For example, touching the charts icon on the app pulls up a list of binders where you stash your procedures while doing the same on the aera calls up the last chart you viewed and serves as a menu gateway to switch chart type or to graphically edit the

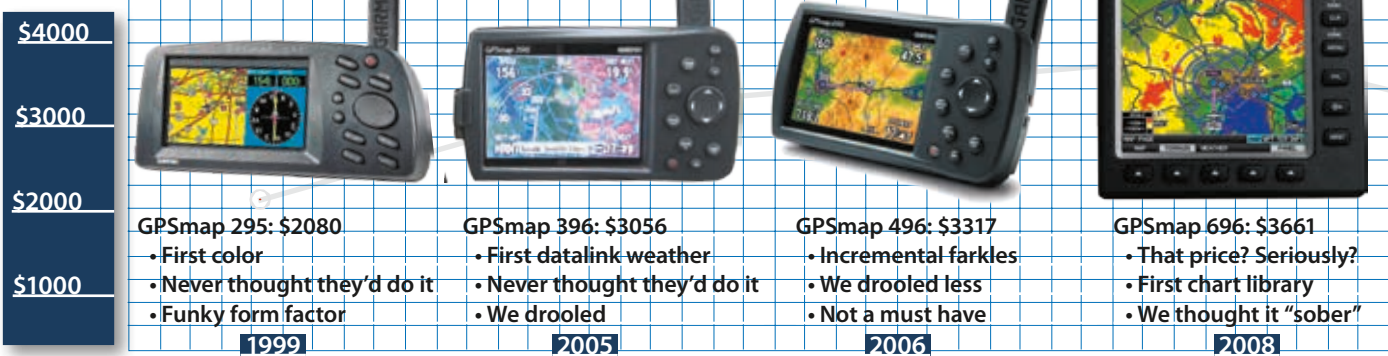
Two images above show aera screen (top) and iPhone 6S at actual size. Dotted and segmented lines depict iPhone 6S Plus and Nexus 7 screen sizes for reference.

Compared straight up against Garmin's Pilot app, the aera 660 is a mixed bag in capability. If your thing is to sit at the breakfast table unsocially ignoring everyone else while you plan, brief and file a flight plan, you've found your magic in the pilot app. And if you also have Garmin's GTN-type navigators and a Flight Stream



PRICE EVOLUTION OF COLOR GPS*

*prices adjusted to 2016 dollars



flight plan line via rubber banding. Speaking of which, both the app and the aera do this, but we think the app is just a bit better at it. Simply touch the screen and pull up the radial widget, then touch the flight plan icon to loosen up the magenta line. The aera requires a menu step through that's not quite as intuitive, in our view.

The 3D vision works differently between the two. On the aera, you get a horizon picture with GPS-derived instrumentation overlaid. These can be changed to either analog or digital instruments. The app has a feature called Navigation that depicts GPS groundspeed, altitude, an HSI and vertical speed and it also has SynVis, which projects synthetic terrain and an HSI arc, but no other instrumentation unless the GDL 39 3D is linked. We don't see either of them as particularly useful or at least as useful as the aera's 3D vision.

These things are somewhat of a gimmick anyway, in our view, since the heavy lifting is done on the map pages with navigation data. The app projects data at the top of the map display while the aera spreads it to the four corners. The data fields on both are customizable. Both the aera and the app display the airport taxi diagram at zoomed-in scales and both georeference the aircraft position.

Buyers in days of yore loved to—and still love to—complain about the cost of data to keep these navigators current. Here, the picture has improved slightly. A single update for the aera sells for \$29.95 while a U.S. package includes the nav database, FliteCharts, IFR/VFR Charts, terrain, obstacles, SafeTaxi, AOPA Airport Directory and fuel prices for a



yearly cost of \$149.95. For the app, \$74.99 a year buys a functionally similar database.

While on the subject of databases, if you buy Garmin's City Navigator package, the aera will find street addresses from the air, but unlike the 500-series aeras, it won't do turn-by-turn street navigation. While the databases are similar, the aera 660 version has

something the app version doesn't: WireAware, which plots the existence of power lines. That could be a handy safety feature for helicopter pilots.

MAKING SENSE OF IT ALL

We initially thought that this comparison would be an easy choice in favor of the app. If you already own the phone or the tablet, the app is free and the database is cheaper, on a subscription basis, than it is for the aera 660. Furthermore, the 660 is the 660, but the tablet world offers a range of choices for less money and a device that does any number of useful tasks, many of them aviation related. Come to think of it, for some buyers, that complexity may be a net negative.

Call us jaded, but gone are the days when Garmin could charge north of \$3000 for a portable, as it did for the GPSmap 696 in 2008. (See chart below.) Intense competition in the tablet and app market hasn't so much leveled the playing field as obliterated it, thus at \$849, the aera strikes us as high priced for what it does. While it does some things better than the app, it doesn't do

them so much better as to justify the cost, in our view.

For owners of the GTN-series navigators who are willing to make the modest investment in Flight Stream, the app will be a powerful tool in prepping, briefing and filing flight plans and then quickly loading them into the navigator in the cockpit. The aera will do that, after a fashion, but it needs wireless access and it won't file.

So why bother with the aera 660 at all? "Because some people just hate tablets," says Kirk Fryar at Sarasota Avionics. When we checked with him in early June, he reported having sold 660s to owners who just don't like messing with either a tablet or a smartphone in the cockpit. "They look at the display next to a tablet and say, 'hey, that's really bright,'" Fryar told us. Also, anyone familiar with the GTN's easy-to-grasp operating logic won't have any trouble adapting to the aera 660. That's not to say the Pilot app is difficult, just different and it does have the inevitable app-type quirks that Garmin navigators generally don't have.

Our recommendation is to buy the aera if you're appnostic and want a capable, updated portable navigator that may have more growth than you'll ever need. It's a step up from the 500-series aera, but not much of one from the aera 796. Otherwise, the Pilot app isn't a bad choice and if that doesn't appeal, there are plenty of others to pick from. However, ForeFlight is the only app that offers similar interoperability with Flight Stream, allowing flight plan transfers. If a portable panel mount appeals, we're told AirGizmo is developing a snap-in rack for the 660 with a target delivery date of the first part of July 2016.





Piper Warrior

It works for training and traveling, plus later models have integrated glass panels.

Back in the day, the quest to come up with the perfect personal airplane may have seemed easy at first. It only needed to perfectly combine ease and cost of operation, ability to carry the right number of passengers and operate from most all airports in the country.

During the post-World War II boom, the major airplane manufacturers to include Aeronca, Luscombe, ERCO, Piper and Cessna, among others, all eventually came to the conclusion that the future for mass-marketing airplanes was wrapped up in something that had four seats and on the order of 150 HP. ERCO (the Ercope folks) never made it past a prototype. Aeronca and Luscombe gave up after limited success, while Cessna and Piper went on to fight it out for decades, while Beech and Grumman-American tried to make inroads.

That niche proved to be the beginning rung of a market ladder where airplanes can excel as trainers, but can also be practical traveling tools. The tradeoff is they won't haul a lot of people or cargo, nor will they do

it quickly, but they offer economical travel. They often serve as a pilot's first "real" airplane after primary training. The market demands that they be reliable, inexpensive to operate and relatively easy to fly. They must excel as rental airplanes—thus be designed to be flown by any pilot, and withstand the consequent beating, while providing a reasonable income to the FBO.

Cessna won that war—the Skyhawk ended up owning that market, and used-airplane prices reflect that dominance, but the Piper PA-28-151 or -161 Warrior came a respectable second. It, and the AGAC AA-5 Traveler/Cheetah, are good, solid airplanes that can be had for less. (Beech's entry, the Sport, is short on performance when compared to the Warrior and Cheetah.)

The AA-5 went the way of the dodo in the late 1970s, and attempts to resurrect it (in the form of the Tiger) failed. Beginning in the mid-1980s, Piper, too, fell on hard times

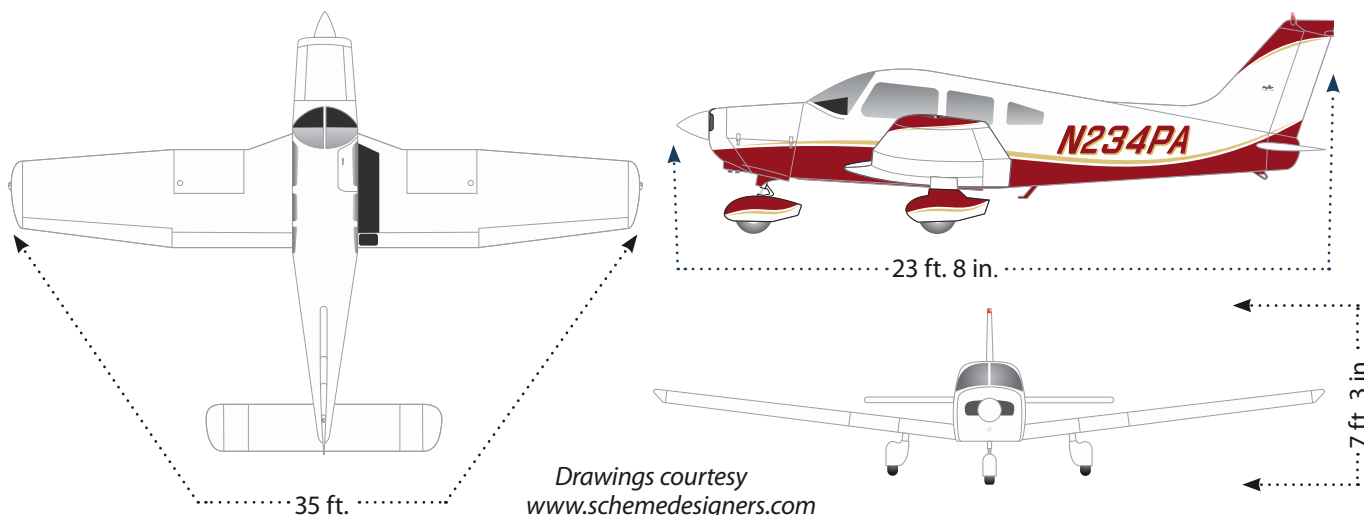


and was forced into bankruptcy, finally emerging several years (and a few abortive buyout attempts) later as the New Piper. In 2006, "new" was dropped from the company's name. Today, all seems good at Piper.

Unlike the Skyhawk, and with only one or two exceptions, the War-

It wasn't designed as an all-glass airplane in the 1970s, but the Warrior became one in 2004 when Piper switched to Avidyne avionics. It eventually switched to an all-Garmin glass suite.

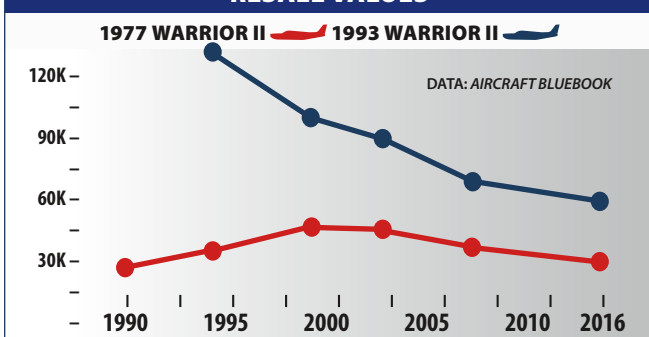
PIPER WARRIOR



PIPER WARRIOR SELECT MODEL HISTORY

MODEL YEAR	ENGINE	TBO	OVERHAUL	FUEL	USEFUL LOAD	CRUISE	TYPICAL RETAIL
1974 PA-28-151 WARRIOR	LYCOMING O-320-E3D	2000	\$20,000	48	989 LBS	110 KTS	±\$25,000
1977 PA-28-151 WARRIOR	LYCOMING O-320-E3D	2000	\$20,000	48	989 LBS	110 KTS	±\$28,000
1977 PA-28-161 WARRIOR II	LYCOMING O-320-D3G	2000	\$20,000	48	981 LBS	118 KTS	±\$28,000
1983 PA-28-161 WARRIOR II	LYCOMING O-320-D3G	2000	\$20,000	48	1096 LBS	118 KTS	±\$34,000
1988 PA-28-161 CADET (VFR)	LYCOMING O-320-D3G	2000	\$20,000	48	1096 LBS	118 KTS	±\$21,000
1997 PA-28-161 WARRIOR III	LYCOMING O-320-D3G	2000	\$20,000	48	1096 LBS	118 KTS	±\$64,000
2000 PA-28-161 WARRIOR III	LYCOMING O-320-D3G	2000	\$20,000	48	1096 LBS	118 KTS	±\$75,000
2005 PA-28-161 WARRIOR III	LYCOMING O-320-D3G	2000	\$20,000	48	1096 LBS	118 KTS	±\$100,000
2011-2012 PA-28-161 WARRIOR III	LYCOMING O-320-D3G	2000	\$20,000	48	1096 LBS	118 KTS	±\$240,000

RESALE VALUES

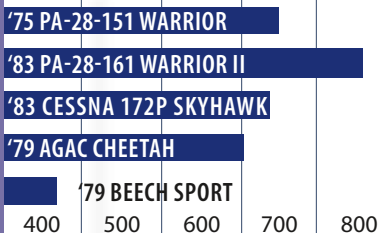


SELECT RECENT ADS

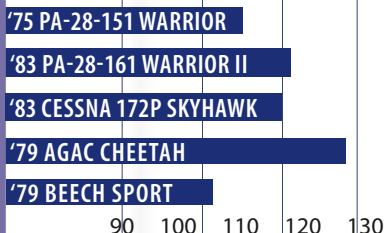
AD 2013-02-13	INSPECT STABILATOR CONTROL SYSTEM COMPONENTS
AD 2010-15-10	INSPECT/REPLACE CONTROL WHEEL SHAFTS
AD 98-01-06	INSPECT/REPLACE PRECISION AIRMOTIVE CORP. CARBURETORS
AD 96-10-03	INSPECT/MODIFY THE FLAP LEVER ASSEMBLY
AD 95-26-13	REPETITIVELY INSPECT OIL COOLER HOSES TO PREVENT FAILURE/RUPTURE

SELECT MODEL COMPARISONS

PAYLOAD/FULL FUEL



CRUISE SPEEDS



PRICE COMPARISONS

'75 PA-28-151 WARRIOR	(\$26,000)
'83 PA-28-161 WARRIOR II	(\$35,000)
'83 CESSNA 172P SKYHAWK	(\$45,000)
'79 AGAC CHEETAH	\$37,500
'79 BEECH SPORT	(\$24,000)



Piper has been offering the new Warrior with dual Garmin G500 PFD systems, attesting to its training mission. Avidyne's Entegra, middle, was offered for several years and included Garmin GNS430s. The majority of used Warriors sport steam gauges and various retrofit radios, bottom.



Late last year, Flight Safety International took delivery of 20 new Warriors.

A glance at current prices of mid-1980s Skyhawks and Warriors shows that PA-28-151/161 prices have closed some of the historical gap with the Skyhawk, but are still a relative bargain: The 1984 Cessna 172P II averages \$10,000 more than a 1984 Piper Warrior (which averages \$35,000 retail), according to the *Aircraft Bluebook*.



HISTORY/ PERFORMANCE

As general aviation was entering its heyday

rior has been in production throughout, even if the number of airframes manufactured in the last several model years could be counted on the fingers of one hand. In the "Warrior III" configuration, the model was marketed mainly as a trainer before quietly disappearing from Piper's lineup a few years ago. But, along with other trainers—including the twin-engine Seminole and the complex Arrow—the Warrior is back in the lineup again. In its marketing, Piper says the Warrior has been a flight school favorite since its inception. Equipped with a Garmin G500, plus a GTN650 touchscreen avionics suite, ADS-B system and other modern electronics, the new Warrior sports a price tag nearing \$300,000.

of the 1970s, Piper's line was beginning to look dated. The basic PA-28 had come out in 1962, and hadn't changed all that much. Piper's PA-28 and -32 singles all had the characteristic, constant-chord "Hershey bar" wing, and the company was about to lower the boom on the sleek Comanche. It was time to update the line.

A new airplane was planned, one that would take aim squarely at the Skyhawk. Previously, Piper didn't really have a strong competitor for the Cessna 172, even though it offered Cherokees with 150 or 160 horses through most of the 1960s. The Cherokee 140 was more cramped, being more of a 2+2 airplane than a true four-place, and it didn't perform as well as the Skyhawk.

The first Warrior was introduced in 1974, powered by a 150-HP Lycoming O-320-E3D engine. It didn't replace the Cherokee 140, though the 140 did succumb to poor sales after the 1977 model year.

The Warrior boasted one big difference: a new, longer, semi-tapered wing with a higher aspect ratio. This new wing helped the handling, with lighter roll control forces, and also boosted the climb rate. It also helped the airplane's looks. The new wing design first appeared on the Warrior, but eventually found its way into all of the PA-28 series as well as onto the PA-32.

Interestingly, the new design represented a deviation from the production efficiencies originally touted as a virtue of the constant-chord wing. And it's fun to recall some Piper engineers, back when it was introduced, boasting that the fat, new, stubby wing was actually every bit as good as the sexier-looking tapered Comanche wing, aerodynamically. Piper's most significant upgrade to the Warrior came in 1977 when a slightly different O-320 engine—the -D3G—was bolted on, offering a 10-HP boost in output. The results were dubbed "Warrior II."

A couple of other evolutionary changes occurred in 1978, when Warriors received more streamlined wheel fairings, and in 1983, when the battery was removed from under the rear seat and placed in front of the firewall. The new fairings—aftermarket versions of which are available under STC—yielded some 7 knots in cruise speed, according to the book (optimistic numbers, users tell us), while the battery change shortened the run to the starter and helped combat starting problems (though these had been largely overcome, according to users, by swapping copper for aluminum cables).

Thanks to the change in weight and balance, shifting the battery location allowed the gross weight and useful load to be hiked by 115 pounds, and extended the aft CG to allow more of a load in the baggage compartment. (The boost is available via STC for older Warriors.)

An attempt to create some interest in a moribund new-airplane market was made in 1988, when Piper released a version of the Warrior, targeting flight schools, called the Cadet. A stripped-down Warrior, it was available in VFR and IFR versions. The experiment continued through the 1994 model year. Another spruce-up resulted in the Warrior III in 1995, which remained in production through 2012.

Today, a 2012 Warrior III with standard equipment will set you back \$289,900, while an average 1974 model brings about \$25,000.

The 10-HP boost in power raised the published 75-percent cruise speed from 116 knots to 121 knots. And the new speed fairings nudged that up to a claimed 127 knots—not exactly blinding, but squarely in league with the Skyhawk, even if easily eclipsed by the Cheetah. Owners told us in no uncertain terms that real-world performance is well less than the book figures: Owners of the 160-HP model reported cruise speeds from 110 to 120 knots. On the good side, the fuel burn at 100 knots can be as low as 8 GPH.

One big gripe by owners of the 150-HP model is a miserable climb rate. "It's taken me to 292 airports in 35 states. As a Jack of all Trades (master of none), it does not climb rapidly, carry a lot of weight or go fast," wrote one owner of a 150-HP model.

One of the nice features is a generous 50-gallon fuel load (with 48 gallons usable). Burning 7.5 to 10 GPH at cruise, these birds yield a fairly good range with four to six hours of flying. One pilot said he flight planned for 4.5 hours with a 45-minute reserve, and one appreciated the endurance when IFR.

Another owner wasn't happy, saying, "There are times when 50 gallons has been limiting, and I would have liked to have had at least 72 gallons, as did some of the Arrows."

Runway performance is adequate, with an owner of a 160-HP model reporting his being flown from a

SIMPLY A CHEROKEE



While revisiting the Warrior series for this report, we pulled the POH from the bookshelf and reminisced about the many trips we enjoyed in them, flying up and down the East Coast of the United States as newly branded pilots. The best were earlier trips in starkly equipped (and well-worn) rentals with King KX170 navcom radios and Loran-C navigators, mixing it up with all the traffic in the busy New York TCA (Class B now).

What still makes that mission easy for newbs is the Warrior's forgiving manners and good ergos.



Like any other Cherokee, the Warrior has manual flaps operated with a robust handle positioned between the two front seats. Cherokee pilots have to keep the fuel tanks balanced: Fuel pump on, fuel selector to the fullest tank, monitor fuel pressure for a bit, fuel pump off. But, as our accident scan on page 28 reveals, pilots screw it up.

Most models have electric pitch trim with a yoke-mounted command switch, but the trim is also manipulated with a wheel behind the flap lever—right where it should be.

grass runway. He says the airplane is "adequate for the 2600-foot strip. I'm careful with four passengers on high density altitude days," however, especially if the grass hasn't been mowed.

COMFORT/LOADING

While past respondents rated comfort only as average, the current consensus is it's quite good. Later Pipers benefit from having some of the best seats in general aviation, from both a comfort and crash-worthiness standpoint. These seats are designed with an S-tube frame similar to the legendary JAARS seat, which progressively deforms during impact, absorbing energy before it reaches the occupant. For greater pilot comfort, there is an optional vertical seat adjustment which some say is great, but others say is prone to malfunctioning.

The fuel selector is located out of sight alongside the pilot's left knee. The need to switch tanks left and

right results in more fuel mismanagement accidents than with the "both tanks" system on the high-wing Cessnas, judging from the accident reports. Naturally, it's also easy to develop an imbalance unless the pilot remembers to switch regularly, and there is no aileron trim for the airplane. This makes at least a wing-leveler autopilot a nice option, in our opinion.

The Warrior's parking brake is a robust handle sticking out from the bottom of the panel. It's simple and strong, and it works. The same goes for the flap system. It's manual, positive, blessedly simple and it just doesn't break.

Like most low-wing aircraft, however, entry and exit is awkward. The Warrior has only one door, so three of the four occupants have to do some contortions to get in place. Emergency egress is problematical, since the rear windows cannot be opened in an emergency (like those of some Bonanzas, for example). The

PA28-161 WRECKS: OTHER AND RLOC

As might be expected of a Swiss Army Knife airplane—the fact that the Warrior is used for virtually all types of general aviation operations other than crop dusting—our search of the most recent 100 accidents turned up every sort we could imagine and some we couldn't.

As we looked at Warrior accidents from the perspective of potential design issues, we saw two areas that got our attention. On the favorable design side, there were 19 runway loss of control (RLOC) accidents—a number we consider low. To make the number even more attractive, only five of the RLOC events involved certificated pilots; the other 14 were students. Overall, we think the ground handling of the Warrior is excellent.

On the negative design side, the fuel system breaks the available fuel into two packages. The pilot has to keep track of where the fuel is and select the appropriate tank—which means there will be mistakes. There were nine fuel-related accidents, four of which involved not positioning the fuel selector appropriately. Pilots with 12 and 17 gallons remaining in one tank put the airplane on the ground after running the other one dry. One pilot turned the fuel selector to the “off” position when changing tanks and another evidently couldn't decide which tank he wanted as he pointed the selector to a spot between the “left” and “right” positions. Five pilots were able to use all the fuel in the airplane before landing in the boonies.

While a left/right/off fuel system is common, it is more prone to fuel-related mishaps than a system where the pilot does not have to switch tanks during a flight and should be treated with respect.

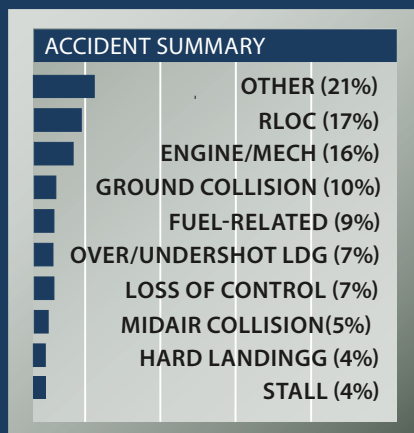
There were 10 on-ground accidents—a puzzlingly high number. Nine involved Warrior pilots who taxied into posts, signs or other airplanes. We can't explain such a high rate—the wings aren't inordinately

long, it has good visibility and we like the way the airplane handles on the ground. We felt sorry for the Warrior pilot who was minding his own business—doing his runup—when another airplane taxied into him.

Of the 17 inflight engine power loss events, five were due to improper or lack of maintenance. That investigators couldn't determine the cause of the remaining 12 didn't give us any warm fuzzies.

There were two deer strikes, something we've noticed has become common in the last 10 years. There were five midair collisions—a surprisingly high number. We expect to see not more than one or two. Of them, two involved instrument students under the hood in airspace used for intensive student training.

With its modest power, we were not surprised to see a number of Warrior accidents involving takeoffs or go-arounds from short runways, especially when loaded at or above gross. All of the stall accidents were on initial climbout from a short field or a late go-around. Others hit obstructions after takeoff or after aborting a takeoff when they decided they couldn't make it. Often the POH numbers made it clear the proposed takeoff was impossible so we weren't terribly compassionate toward pilots who survived those events and later said they couldn't understand why the airplane didn't seem to accelerate or climb.



baggage door is fairly large, however.

Naturally, with a full load of 50 gallons, the Warrior won't carry four adults, but some owners report fueling up only to the tabs (34 gallons), accepting the reduced range and legally flying off to their destination. The baggage compartment will take a full 200 pounds structurally, the same as more powerful PA-28s. That's a lot more than the Skyhawk and Cheetah's maximum of 120 pounds, by comparison.

Most owners say nice things about cabin ventilation, thanks to an abundance of outlets, both overhead and underneath. Unfortunately, there were complaints that in winter the overhead vents were too much of a good thing and could not be completely shut off, giving passengers the chills. Pilots have solved this problem by simply taping up the exterior air inlet on the tail in the winter. We also received reports of the heater baking the ankles of those in front while rear passengers froze.

A few owners had the air conditioning systems available as options on the Cherokee line. Those who did felt the cool air yield in summer was not worth the sacrifice in already-limited payload and performance.

HANDLING/COMPETITION

The Warrior shares with the other Cherokees a gentle nature, pleasant handling and such a reluctance to stall aggressively that some pilots rate it a poor teacher. Several respondents said that with both rudder and stabilator trim, the airplane does not need an autopilot.

We'd rate runway handling as good, despite the number of accidents on both takeoff and landing—especially landing—we uncovered in past checks of FAA accident and incident reports. Further investigation revealed that many were student training accidents.

Pilots report they like the way the aircraft handles in a crosswind landing and feel more secure taxiing in windy conditions with the wide gear stance, as opposed to operating in the high-wing Cessnas.

The Cessna Skyhawk and the AGAC Traveler/Cheetah are the most logical competitors to the Warrior for the attention of buyers who want four-seaters that won't break the bank and who are willing to settle



Upper cowling halves open wide, providing excellent, rapid access to engine and accessories.

for modest performance.

The Cessna has by far the best overall safety record. In a cross-country race, the Cheetah would edge out a 160-HP Warrior with the later wheelpants (the Traveler is slower), and leave the Cessna and the older Warriors in its propwash. And while the Traveler/Cheetah has the most pleasant, facile handling, in our book, it is not as adept at handling short fields. The Cessna gets our nod for getting in and out of little runways.

MAINTENANCE

Here’s where the Warrior should shine, since it’s the opposite of high-tech sophistication. It’s got fixed gear, a fixed-pitch prop, mechanical flaps and a small-bore carbureted engine. It also comes with a cowling providing the best engine access in its class: Doors on either side of the cowling are hinged at the top and secured with double latches. By contrast, gaining similar access to a Skyhawk’s engine requires removing several screws and then lifting off the cowling’s upper half, a two-person job when done correctly.

As expected, owners report relatively low maintenance costs and modest annual inspection fees. But it’s a good thing they have that

cowling: The engine compartment is the source of most upkeep problems. Our checks of Service Difficulty Reports (SDRs) showed a host of problems with carburetors and a number of magneto failures. The powerplant itself was tagged with several failure modes, valves being at the top of the list, followed by camshaft/lifter/pushrod problems, cylinder cracks and rocker arm breakage.

Potential buyers should check to see if there is roughness following engine start, since according to Lycoming that’s one sign the exhaust valves are beginning to stick. (The roughness usually goes away after the engine warms up, incidentally.)

High-time Warriors usually got that way as a result of being in a training environment. As one result, landing gear components and attach points, along with their fasteners, are subject to numerous cracks and corrosion.

If you’re looking at a Warrior equipped with air conditioning, take a look at the bracket that attaches the alternator and compressor. We noted reports that the mounting bolts had broken or worked loose. And in one case the submitter found the bracket was installed backward, subjecting the rear tab of the alternator to stress and misalignment of the pulleys.

MODS/USER GROUPS

One series of mods available from Plane Dynamix (www.planedynamix.com) for earlier PA-28 models



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Generous, effective flaps help with short field performance (upper left). More aerodynamic wheel pants on later models improved performance, but made servicing tires difficult (right).

also can be installed on Warriors. These include a set of vortex generators, modifications to the standard Sensenich prop blade designed to reduce drag, a new, more-efficient cowling and—for -151 Warriors—an upgrade to 160 HP. We have no direct information on these mods' effectiveness, but Art Mattson (who recently sold the company to Plane Dynamix) has regularly set speed records in his Cherokee 140.

Owners of 1977 through 1982 Warrior IIs can get a gross weight increase, from 2325 up to a whopping 2440 pounds. Mostly a paperwork exercise requiring a placard and carrying a later Piper information manual, the STC gives early -161 owners the same gross weight 1983 and later models enjoy. Ventura Aero (www.ventura.aero) offers this mod.

Another interesting STC involves installing a supplemental storage area under the baggage compartment floor, capable of storing up to 25 pounds. The mod, available from Aircrafters Inc. (www.aircrafters.com), includes parts and paperwork for the conversion.

Other mods include ones from LoPresti Speed Merchants (www.speedmods.com), Met-Co-Aire (www.metcoaire.com) and Knots 2U (www.knots2u.com). This includes gap seals and new wingtips—including tips with landing/recognition lights.

As with any personal airplane, we strongly recommend joining its type club. The expertise can save real money when tracking down common parts and problems. Warrior owners are fortunate in that they have an excellent organization, the Piper Owner Society (www.piper-owner.org), which merged with the Cherokee Pilot's Association. There is also a Piper Forum (www.piperforum.com) where Piper pilots exchange thoughts.

OWNER COMMENTS

I have a 1974 Warrior. This is the first year for the PA28-151. It is basically a PA28-140 with a 5-inch stretched fuselage and tapered wingtips. It uses the bulletproof Lycoming O-320 engine. The Cherokee 140 line of aircraft are pretty much used for training, up through the IFR rating. It is not stellar in performance by any means, but does fit the need for quite a few private owners—me included.

My Warrior has a pilot seat that

It glides like nobody's business, and handling is calm and collected at all speeds.

is vertically adjustable and has a gas spring to smooth out the bumps. The poor instructor or passenger has to deal with a non-vertical-adjustable seat. There is a bench type seat in the rear. I don't know of any Warriors that have individual bucket type seats in the rear. The Piper Archer is almost identical to the Warrior. The major difference is the Archer

has the Lycoming O-360 engine, instead of the lower-powered O-320. But, the O-320 serves my needs, for the most part. I can trip-plan for a 100-knot groundspeed on 8.7 GPH. That's roughly five hours of flight time. My bladder and belly won't last that long, but it gives me an idea of where to plan my fuel stops. I live in the mid-Atlantic states and east of the Appalachian mountains. Density altitude does come into play when I want to cross the mountains in the summer. This forces me to make gross weight and routing decisions. This is about the only time I wish I had a bigger engine.

Brent Wing
via email

My family adopted our 1976 bicentennial, red, white and blue Warrior when it was 18 months of age. Now—35 years later—it is still a magical adventure. Seven family members from three generations have earned their private pilot certificates in our family Warrior. The original paint has been touched up and still looks glossy. The interior is 1970s Bahama Blue—a color you can't get anymore.

Over the years, our Warrior has been modified with panel upgrades, a 180-HP engine, up-swept wingtips with landing lights, strobes and flap seals. The mods improved handling and, we think, made it easier to land well.

What do we like about the Warrior? It glides like nobody's business, and handling is calm and collected at all speeds. The graceful wing has no surprises in the stall and maintains good directional control. With the

180-HP engine, it climbs better and will cruise at 120 knots. Even though it now has Archer performance, the Warrior airframe has advantages. The full-opening cowling allows easy inspection of the engine compartment before each flight and the wheels are an inch smaller, which presents less drag in cruise.

For us, it costs less to own and operate than anything except maybe an LSA. On top of that, the pleasure factor is sensational.

Thomas Reindl
via email

I own a 1976 Warrior with the 160-HP STC mod. I like the airplane because it's perfect for loading two adults and two children. So far, my Warrior has been inexpensive to operate (for an airplane). Better yet, service parts are readily available.

One of the downsides is the single cabin door, but it is what it is. The Warrior has honest flying characteristics, with no surprises or bad manners.

I like landing it on gusty days because everything smooths out when you are six feet above touchdown due to the low-wing ground effect, plus a nice wide wheel stance.

That's Hartford, Connecticut-based Connecticut Flight Academy's 1985 Warrior in the photo below. CFA transitions instrument students to the Warrior from its large fleet of Piper Tomahawks.



Everything being equal, it is \$10,000 cheaper than a comparable model year Cessna 172, but with similar performance. I feel that the Warrior's build quality is slightly better than the Cessna.

On average, a 100-knot ground-speed burning 7.5 GPH is typical. You always want more, of course, but that comes with a price. If I move up, it will be to a Piper Arrow, which is essentially the same airframe, but with folding wheels and a constant speed propeller. But, I like my Warrior so much, I might keep it, too.

J. Morgan
via email

I have a 1979 Warrior II (PA28-161) and I love it. It's easy to fly and when the engine is leaned properly, it's economical to feed. It's mechanically simple. During my 15 years of ownership, it has been cheap to maintain.

I own the airplane with a partner, so the costs are shared. We do owner assisted annual inspections and ran the previous Lycoming O-320-D3G engine for 3000 hours before replacing it.

My Warrior is a traveler. In 2012, I flew a grand tour of the United States over the course of a month, which was 6600 NM in 68 flight hours, averaging 7.4 GPH. We flew the Warrior across the Rocky Mountains a few times, to the Grand Canyon and to southern Florida. The airplane has also been to British Columbia.

Domenick Silva
via email

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IFR Test Prep

(continued from page 17)

mode, the student can call up all or some of the questions for the particular topic just covered in the e-book. Clicking on an answer to a question provides instant feedback as to whether the answer is correct and why—an impressive detail. The course also keeps a running tabulation of questions missed and presents that data in a progress review section in a number of formats to allow the student to easily see his or her strong and weak areas.

There is not a lot of information on using the course in the introduction and we found ourselves hitting the wrong key and getting dumped from the website a couple of times.

We liked the clarity and presentation of the FAA figures that are used on the FAA test. It may be because Gleim effectively duplicates the presentation format of the FAA written, but we found them easier to read than many of its competitors' presentations.

Gleim also provides an endorsement for the FAA written through the online course. To get the endorsement the student must have answered all of the required questions in the test prep correctly. If he or she requests an endorsement prematurely, the course presents a list of unanswered questions and directs the student to answer them.

SHEPPARD AIR

The \$40 Sheppard Air (www.sheppardair.com) instrument rating test prep course is via downloadable

software that is unabashedly designed to teach the student just what is necessary to pass the FAA written, including memorizing test questions and answers.

There is no claim that this course will help create a well-rounded instrument pilot. For example, the course instructions advise that if a mathematical calculation is going to take more than 30 seconds, it recommends not learning how to do the calculation, just "learn the concept" and memorize the correct answer.

The course includes a memory aid handout. Students are encouraged to print it out and keep it handy while studying to help memorize test answers.

The course is well-structured and organized, in our opinion. It calls for the student to go through the questions in a subject area with only the correct answer displayed. The student can click on an explanation box and get a very brief explanation of the correct answer. The student is then to go through the questions again with all the answers showing, learning to recognize the correct answer.

Sheppard Air claims that the answers appear in their software as "they appear in the actual test." We have no way of verifying that claim, but it did rate a raised eyebrow as the FAA constantly makes subtle change to its test questions and answers.

After going through the study program as outlined, Sheppard Air recommends taking its practice exam. If the student gets a score of at least 90 percent, Sheppard Air issues a completion certificate and recommends that the student take the FAA exam immediately—as in 24 hours.

FEEDBACK WANTED

CESSNA 172



For the October 2016 issue of *Aviation Consumer*, our Used Aircraft Guide will be on the venerable Cessna 172 Skyhawk. We want to know what it's like to own these aircraft, 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 (**full-size, high-resolution please**) you'd like to share to the email below. We welcome information on mods, operating expenses or any other comments. Send correspondence on the Skyhawk by August 1, 2016, to:

Aviation Consumer
Email at:
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We do not recommend a prospective instrument pilot start his or her studies from scratch using the Sheppard Air written prep course. However, we think that the course can be an effective intensive cram-and-take-the-exam-tomorrow procedure for the pilot who has taken some sort of instrument ground school and has an understanding of the basics.

CONCLUSION

We like the quality of all the prep courses, especially of King and Sporty's, with ASA and Gleim close behind. For pure, simple test prep without any pretext of creating a well-rounded private pilot, we lean toward the low price of Sheppard Air but like the explanations and graphics of Dauntless.